APPENDIX A

A.1. Nodal formulation

Even though the mathematical approach based on the solution of stress/strain relationships, equations of motion and equilibrium, and constitutive laws was set in Chapter 2; it is necessary to reduce the equations from an integral or differential form to a finite-difference form as illustrated in earlier examples on exponential growth. In other words the FLAC models will be discretised in a nodal formulation. Therefore finite-difference approximation is needed both in time and space to allow computer simulation in FLAC. The time is commonly discretised by subdivision in small constant calculation steps, whereas the use of discretised grids of nodes represents an approximation of the spatial continuum. A final important constraint imposed in FLAC is that the material derivation of the nodal velocities has to be reduced to zero to obtain a condition of static equilibrium. This is reasonable if it is imagined a natural example such as an earthquake. Earth motion in this case is due to accumulation of stresses due to plate tectonics abruptly released and converted into strain energy until an equilibrium state is reached. FLAC aims at equilibrium to simulate such natural tendency to minimise energy.

Reduction to a nodal form of classes of equations introduced (e.g. translational (ξ_{ij}) and rotational (ω_{ij}) strain-rates) is firstly obtained reducing the laws at the tetrahedron scale. A deforming tetrahedron can be thought as a velocity field. In analogy to other conservative fields using the Gauss or divergence theorem:

$$\iiint_V v_{i,j}\, dV = \oiint_S v_i\, n_j\, dS \tag{A.1}$$

it can be demonstrated that the flux escaping from an element of volume (V) containing a source of constant intensity (e.g. a stationary fluid) is equivalent to the sum of the fluxes exiting from a closed surface surrounding the volume independent of the surface area interested by the flux. The symmetry of the problem lead then to a reduction to a finite summation of fluxes escaping from multiple surfaces of the FLAC tetrahedron, allowing a linear approximation of the nodal velocity as follows:

$$v_{ij} = -\frac{1}{3V}\sum_{l=1}^{4} v_i^l\, n_j^{(l)}\, S^{(l)} \tag{A.2}$$

The (A.2) is essentially a finite summation over the indexes (l) that represent the four nodes of each tetrahedron. The superscript (l) indicates a nodal property that is considering the sum of the contributions of all adjacent tetrahedrons acting on a certain node. (S) is the area of each face.

Substitution into (2.66 – Chapter2) and (2.67) leads to a nodal formulation of translational and rotational strain rates (σ_{ij},ξ_{ij}):

$$\xi_{ij} = -\frac{1}{6V}\sum_{l=1}^{4}\left(v_i^l\, n_j^{(l)} + v_j^l\, n_i^{(l)}\right) S^{(l)} \tag{A.3}$$

$$\omega_{ij} = -\frac{1}{6V}\sum_{l=1}^{4}\left(v_i^l\, n_j^{(l)} - v_j^l\, n_i^{(l)}\right) S^{(l)} \tag{A.4}$$

The (A.3) and (A.4) shows that nodal velocities can be used to represent forces applied to the whole tetrahedral grid and the relative strains and their rates resulting from the application of such stresses in time. In this regard seems to be clearer the meaning of a Lagrangian representation that look at the kinematic behaviour of individual nodes. In contrast, the required generalisation is brought by the nodal formulation of the laws of motion.

A.2. Theorem of the virtual work

The principle of *virtual work* is a convenient way to treat the laws of motion and it is used here to derive a nodal formulation for the Cauchy's equations. It is based on the concept of kinetic energy in the form of thermodynamic work internal and external (W_i, W_e) although unnecessary as the two represent the same measurement of strain in the considered model, the separation is however instructive. Taking the Gauss theorem as an analogy: the *work* performed on a generic surface would be equivalent to a flux of energy transferred from the environment into the system incrementing its energy although such energy rather than be stored is taken up by deformation and released internally producing work that corresponds to the rearrangement of the nodes of the tetrahedrons. The two are therefore the same quantity although described from a different frame of reference:

$$W_i = \int\int_V\int v_{i,j}\, dV \tag{A.5}$$

$$W_e = \oiint_S v_i\, n_j\, dS \tag{A.6}$$

Comparing with the (A.1) it can be defined:

$$W_i = W_e \tag{A.7}$$

After these considerations the (2.68) can be expressed as representing W_e in the form:

$$W_e = \sum_{n=1}^{4} \delta v_i^n\, f_i^n + \int_V \delta v_i\, B_i\, dV \tag{A.8}$$

the two terms on the left side of (A.8) represent respectively the contribution of contact forces (f_i) and body forces here considered coupled with the material derivative of the velocity (B_i), in this case note that rather than calculating the work for a tetrahedron in term of virtual displacement, it is considered the nodal virtual velocity (δv_i^n) representing therefore a rate of external virtual work (W_e). On the other hand, the Cauchy's relationships for the theorem of virtual work (A.7) have to be equated to the nodal formulation of the internal rate of displacement (W_i). It is in this case convenient to recall the (A.72) replacing strain with internal stresses as follows:

$$W_i = -\frac{1}{6}\sum_{l=1}^{4}\left(\delta v_i^l \sigma_{ij} n_j^{(l)} + \delta v_j^l \sigma_{ij} n_i^{(l)}\right) S^{(l)} \tag{A.9}$$

Such relationship can be further simplified in light of the symmetrical character of the stress tensor regrouping in the (A.10), where (T_i) is the stress vector:

$$T_i^l = \sigma_{ij} n_j^{(l)} S^{(l)} \tag{A.10}$$

W_i becomes:

$$W_i = -\frac{1}{3}\sum_{n=1}^{4} \delta v_i^l T_i^l \tag{A.11}$$

With further rearranging and combining the (A.8) with the (A.11) a relationship that provides a value for the nodal force (f_i):

$$-f_i^n = \frac{T_i^n}{3} + \frac{\rho b_i V}{4} - m^n\left(\frac{dv_i}{dt}\right)^n \tag{A.12}$$

where the first term on the right side represents the internal work component whereas the other two terms account respectively for the body forces here considered function of the material derivative of the nodal velocity:

$$b_i = \left(\frac{B_i}{\rho} + \frac{dv_i}{dt} \right) \qquad \text{(A.13)}$$

and the contact forces obtained considering fictitious nodal masses (m) that are adjusted in FLAC to stabilise the solution. The (A.12) can be further generalised to the whole body considering the sum of the contributions of all nodes (n_n) and relative inertial terms (P_i):

$$F_i^{<l>} = M^{<l>} \left(\frac{T_i}{3} + \frac{\rho b_i V}{4} \right)^{<l>} + P_i^{<l>} \qquad <l> = 1, \ldots n_n \qquad \text{(A.14)}$$

To reach a static condition, after a perturbation has been imposed to the body, as seen from definition (A.7) the sum of all forces should progressively tend to zero. $F_i^{<l>} \rightarrow 0$ during reorganisation resulting in stress accumulation and release of strain in time.

From the outlined relationships it is concluded that the spatial approximation is soundly based on the concepts of discretization and minimization of energy of the modelled body. Similarly to the forme discretization is adopted in FLAC to reduce the continuity of time to finite intervals. FLAC computes nodal velocities on the basis of a central finite difference approximation in which each time step is half of the Δt used to compute the forces and displacements of the nodes. The approach can be demonstrated to give a second order approximation error of time derivatives the velocity approximation is given as an example; it can be expressed in finite difference form after integration of the second law of Newton as follows:

$$v_i^{<l>}\left(t+\frac{\Delta t}{2}\right)=v_i^{<l>}\left(t-\frac{\Delta t}{2}\right)+\frac{\Delta t}{M^{<l>}}F^{<l>} \qquad \text{(A.15)}$$

here the term M refers to the sum of all the contributions (m) of the tetrahedrons surrounding the node of interest $<l>$.

A.3. The Mohr-Coulomb constitutive model and its relationship to the motion equations

The constitutive models work conceptually in a similar way, they try to differentiate between the plastic and the elastic component of the strain tensor. The distinction is possible thanks to the experimental mechanics models available. The simulated materials will be deforming in a variable manner for an applied stress accordingly to their relative properties (e.g. cohesion, the friction angle, the elastic/shear modulus, etc.). The objective is to describe the co-rotational stress increments in time (co-rotational is a convention in which the stress rates are measured by an observer rotating at the same angular velocity of the particle considered – here the suffix on top of the co-rotational stress ($\breve{\sigma}$) is omitted because all stresses are co-rotational). Note that in a plastic deformation the co-rotational stress increments represent only the elastic part of the deformation. To make a distinction between a plastic and elastic response of a material, a yield function is therefore assigned to the model (e.g. Fig. A.1):

$$f\left(\sigma_{ij}\right)=0 \qquad \text{(A.16)}$$

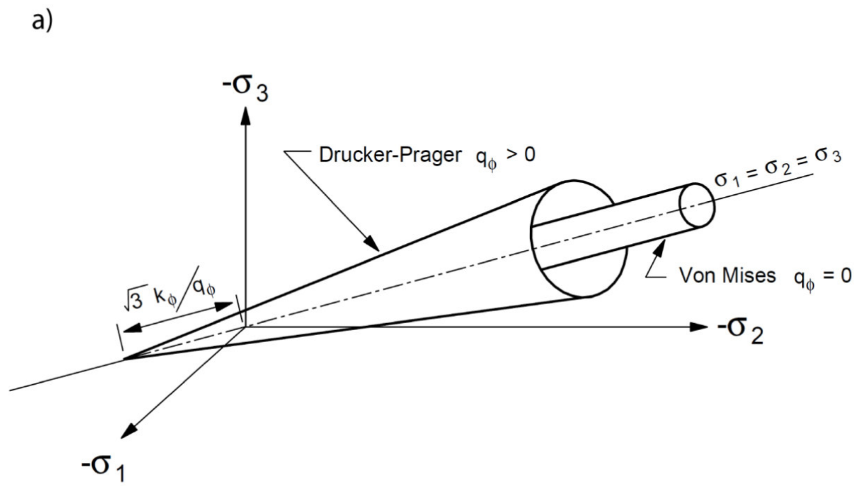
The (A.16) is equal to zero when the material fails for a certain combination of compressive or tensile stresses. For the Mohr-Coulomb material the (A.16) is represented by two functions (Fig. A.2) becoming:

$$f^{s}=\sigma_1-\sigma_3 N_{\Phi}+2c\sqrt{N_{\Phi}} \qquad \text{(A.17)}$$

which is the Mohr-Coulomb criteria, and also for a tensile failure the criteria becomes:

$$f^{t}=\sigma_3-\sigma^{t} \qquad \text{(A.18)}$$

in such examples of yield functions it is outlined the dependency of the point of yield from mechanical terms other than confining stresses, i.e., the cohesion (c), a function of the friction angle (N_{Φ}) (A.17), and the tensile strength (σ^{t}) in the (A.18). Usually a generic Mohr-Coulomb material subject to an applied stress reacts firstly in an elastic manner until it yields and subsequently deform plastically.



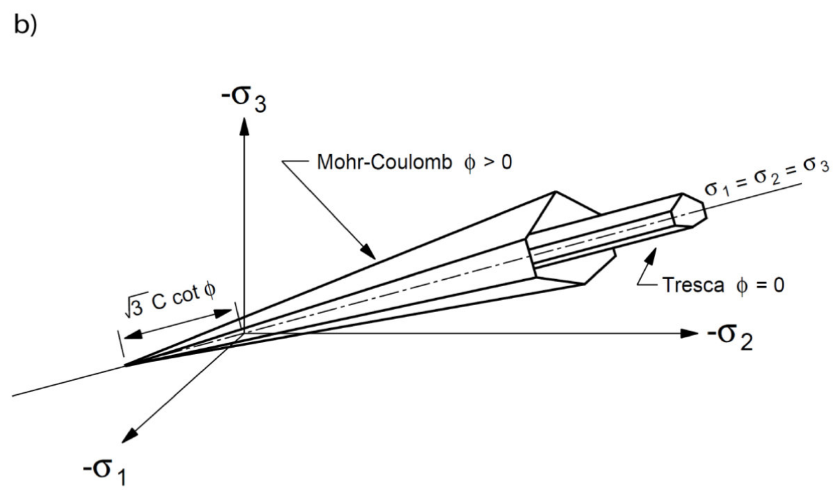


Fig. A. 1 Example of yield surface function in stress space respectively for: (a) Drucker-Prager and Von Mises yield (conical) surfaces in principal stress space; (b) Mohr-Coulomb and Tresca failure envelops (irregular hexagonal). Adapted from (Itasca, 2003).

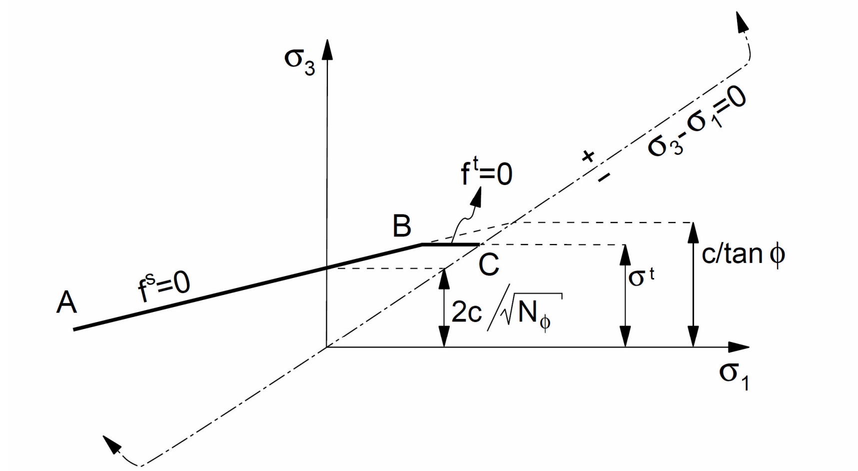


Fig. A. 2 Composite Mohr-Coulomb criterion with tension cut-off. represented in planar space (σ_1, σ_3). Compressive stress considered negative with $\sigma_1 \leq \sigma_2 \leq \sigma_3$. The failure envelope $f\left(\sigma_1, \sigma_3\right) = 0$ is defined within the interval A-B following Mohr-Coulomb type behaviour, whereas the curve in section B-C is characterised by a tensile failure criterion in which $\sigma_3 \leq \dfrac{c}{\tan(\Phi)}$ with cohesion (c) and friction angle (Φ). The yield function for shear/tensile failure (f_s, f_t) are violated where (σ_1, σ_3) fall above the lines corresponding to higher deviatoric stresses (σ_1, σ_3) or when the tensile strength (σ_t) is exceeded (Itasca, 2003).

The total strain increment ($\Delta\varepsilon_i$) is therefore defined by:

$$\Delta\varepsilon_{ij} = \Delta\varepsilon_{ij}^{e} + \Delta\varepsilon_{ij}^{p} \qquad \text{(A.19)}$$

both strain increments can be used to calculate the stress increments that generated them. Usually the elastic component responds to a linear law such as Hook's law whereas non-linearity may result from the plastic component of strain that is represented by:

$$\Delta\varepsilon_{ij}^{p} = \lambda \left(\frac{\partial g}{\partial \sigma_{ij}} \right) \tag{A.20}$$

This relationship based on the flow rule outlines that the direction of the plastic strain increment vector is normal to the potential surfaces of (*g*) with λ representing a constant. When the function (*g*) is equal to the yield function (*f*) the material is considered associative. The spatial association of the two tensorial fields (stress-rate and strain rate) is linear as in the elastic case. Non-associative materials however are the most common in natural examples as they commonly dilate during deformation (e.g. Vermeer and de Borst, 1984; Ord, 1991; McLellan, 2004). Non-associative materials have $f\left(\sigma_{ij}\right) \neq g\left(\varepsilon_{ij}^{p}\right)$; therefore, there are conditions in which the material may deform plastically before reaching a yield condition based for instance on the Mohr-Coulomb criterion.

An iterative approach is used to guess a possible value for the state of stress after a certain stress increment has occurred; the new stress (*N*) would be defined by:

$$\sigma_{ij}^{N} = \sigma_{ij} + \Delta\sigma_{ij} \tag{A.21}$$

If it is considered that the stress increment, as seen, is reduced by the plastic component of the strain rate tensor then a possible way to make a definitive distinction between the two components of deformation is to formulate what is defined as an *elastic guess* in which it is assumed that the material is non-plastic or perfectly elastic and then using an iterative method the stress increment values are recomputed until they meet the yield function for the chosen constitutive relationship. It is then given the following:

$$\sigma_{ij}^{N} = \sigma_{ij}^{I} - \lambda S_i \left(\frac{\partial g}{\partial \sigma_{ij}} \right) \tag{A.22}$$

in which the new stress state is obtained, as discussed, subtracting the linear term $S_i(.)$ from the elastic guess (σ_{ij}^{I}). Once the co-rotational stress increment is defined it can be used in conjunction with the equations of motion to derive more realistic nodal velocities in the FLAC models.

A.4. Effect of fluid flow in a deforming porous media

One of the advantages of FLAC is the availability of a fluid flow module that can be coupled to the deformation module. This is represented by a set of equations with a general organisation similar to the mechanical module. In this regard the equations of motion are replaced by the Biot and Darcy's laws that defines the variation of fluid flow, a quantity that can be characterised with a fluid intensity field such as the one described by fluid discharge vectors (q_i) in 3D, or in alternative a scalar function that is represented by the spatial variation of pore pressure (p) to understand the distribution of equipotentials in the fluid flow field. This latter representation is particularly useful as seen in chapter 4 and chapter 5 to evaluate possible fluid pathways during deformation. In this context FLAC has the advantage that it can capture the effect of deformation on fluid flow or alternatively the effect of fluid pressure in dissipating the confining pressure (Terzaghi, 1945). In particular, FLAC makes use of the Biot coefficient (α) to couple mechanical calculations with transient fluid flow. In addition to this the software allows also to consider the effect on temperature on the volume variation of modelled materials using a linear thermal expansion coefficient (α_t), and in undrained conditions adopting a thermal coefficient (β).

Here it is given a brief description of the fluid-flow equations and their interaction with the constitutive functions introduced in the mechanical part of this review. The linear quasi-static theory of Biot is used in this context to couple deformation and diffusion processes in Darcy's type flow. It is considered a porous material as a media that can transfer and store fluids. However, such properties can vary accordingly to a series of parameters that can be defined internal if they depend upon the system subjected to flow (e.g. permeability) or external if they are controlled by the environment. An example is given providing the equation that serves to calculate the coefficient of diffusivity (c):

$$c = \frac{k}{\frac{1}{M} + \frac{\alpha^2}{\alpha_1}} \tag{A.23}$$

where k is the permeability, M represents the Biot modulus, α is the Biot coefficient, α_1 is a function of the bulk and shear modulus. An external parameter could be for instance exemplified by temperature variations or the control of hydraulic gradient. To mathematically constrain these components a mass-balance equation is formulated below. This relationship opportunely combined with the fluid constitutive relation provides a differential equation in terms of pore pressure that can be solvable for certain conditions providing a means for the fluid flow. For small deformations the equation is given by:

$$-q_{i,i} + q_v = \frac{\partial \zeta}{\partial t} \tag{A.24}$$

the (A.23) can be interpreted similarly to the divergence theorem presented above in the (A.1) because it uses the same principle of conservation of mass. In other words the intensity of the flow is a measure of the divergence of the flow field, which is here in (A.24) represented by the partial derivative in time on the right side. On the left side of the same equation $q_{i,i}$ is the spatial variation of the discharging vectors (outflow) whereas q_v represents the volumetric fluid source intensity. The shape of potential surfaces is then controlled by fluid sources, leaks or other morphological boundaries that directly defines the fluid flow directions within a confined reservoir. However, other more intrinsic parameters need to be considered, as seen, to fully describe the problem of modelling fluid migration within saturated porous media. According to this the fluid flow intensity gradients are also governed directly by the storage capacity of a reservoir. Volumetric variation is the prominent controlling factor, but this in turn is function of strain distributions, temperature and pore pressure variations. This lead to a different formulation of the (A.24) that incorporates these variables:

$$\frac{\partial \zeta}{\partial t} = \left(\frac{1}{M} \frac{\partial p}{\partial t} \right) + \alpha \frac{\partial \varepsilon}{\partial t} - \beta \frac{\partial T}{\partial t} \qquad \text{(A.25)}$$

here pore pressure gradients (p), strain-rate (ε) and temperature gradients (T) are all linearly related to the variation of fluid content per unit volume of porous material (ζ). Combining the (A.24) with the (A.25) and rearranging it follows:

$$-q_{i,i} + q_v^{\times} = \frac{1}{M} \left(\frac{\partial p}{\partial t} \right) \qquad \text{(A.26)}$$

where

$$q_v^{\times} = q_v - \alpha \frac{\partial \varepsilon}{\partial t} + \beta \frac{\partial T}{\partial t} \qquad \text{(A.27)}$$

the (A.26) is used to calculate the pore pressure (p) variation in time knowing the parameters condensed in (A.27) and also calculating q_i using the Darcy's law that for an homogeneous isotropic solid is given by:

$$q_i = -\frac{k}{\eta}\, p_{,i} \qquad \text{(A.28).}$$

This equation, by definition, relates the discharge vector intensity (flow velocity) to the intrinsic permeability coefficient (k), and the gradient of the pore pressure (p) in space.

If the velocity of the fluids percolating a porous media is controlled by the spatial variability of the scalar field of pore pressure distributions; in turn, the pore pressure itself may vary accordingly to the (A.26) and (A.27), depending on the parameters (e.g. material properties). Mechanical constitutive laws in this regard are accordingly modified to account for such variations. Recalling the general form of the constitutive equations (2.69) an updated incremental expression of the co-rotational stress increment is given by:

$$\Delta\left[\breve{\sigma}\right]_{ij} + \alpha\,\Delta p \delta_{ij} = H^{\times}_{ij}\left(\sigma_{ij}, \Delta\varepsilon_{i,j} - \Delta\varepsilon^{T}_{i,j}\right) \qquad \text{(A.29)}$$

the thermal-mechanical coupling is defined as:

$$\Delta\varepsilon_{ij}^{T} = \alpha_t \, \Delta T \delta_{ij} \tag{A.30}$$

fluid flow correction terms are present on both sides of the constitutive equation (A.29). In particular, the additional term on the left side outlines the influence of the pore pressure increment in reducing (similarly to the effective stress concept) the co-rotational stress component. The stress correction term comprehend also the Biot coefficient (α) and the Kronecker Delta (unitary tensor (δ_{ij}), used to convert to tensorial form the scalar field of pore pressure). On the right side of (A.29) as also in (A.30) the strain increment is influenced by the effect of temperature increments that may for instance increase the volume of the porous media expanding its matrix. The (A.29) also shows the interconnection existing among the mechanical and fluid flow modules. Correction terms in the constitutive equation, for example, could lower the co-rotational stress increment causing a reduction of nodal velocities.

Outlined equations are solved in FLAC using a finite different approach. The numerical scheme rests on a nodal formulation of the mass balance equation. This approach is not reviewed here because it is equivalent to the mechanical formulation presented above, which leads to the nodal form of the Newton's law. This simply involves the substitution of pore pressure, specific discharge vector and pore pressure gradient for velocity vector, stress and the strain-rate tensors, respectively. Nonetheless the solution of ordinary differential equation is obtained using two distinct discretization models in time (implicit/explicit formulation) in the fluid flow module.

However, the scope of this section on FLAC was primarily focused on the understanding of the concept of discretization and the general organisation of the software, for a deeper understanding the reader is referred to the FLAC documentation (Itasca, 2003).

APPENDIX B

B.1. Weights of Evidence formulation

The Weights of Evidence method and relative algorithms are briefly discussed here (adapted from Bonham-Carter, 1994 and Carranza, 2004).

The Weights of Evidence method is a way to express the likelihood of finding a mineral deposit based on a certain representation of knowledge, which is a conditional probability function *P*(*x*). The knowledge itself is mathematically expressed as Weights of Evidence, numerical scores derived from a measure of the spatial association between known deposits (*D*) and a considered pattern (B_n) . The spatial association represents a conditional probability expressed as follows:

$$P\left(D \mid B_n\right) = P\left(D \cap B_n\right) / P\left(B_n\right) \tag{B.1}$$

where $P\left(D \vdots B_n\right)$ is the conditional probability of finding D overlapping with a pattern B_n which is proportional to the area of D and B_n and inversely proportional to $N(T)$ as $P(B_n) = N(B_n)/N(T)$. It is also possible to express the conditional probability of finding a pattern (B_n) overlapping with (*D*). $P(D \cap B_n)$ is equal to $P(B_n \cap D)$; however the conditional probability is different because the same area of intersection is divided by diverse prior probabilities as follows:

$$P\left(B_n \mid D\right) = P\left(B_n \cap D\right) / P(D) \tag{B.2}$$

Equations (10 and 11) can be combined to obtain the following representation of posterior probability (equivalent to conditional probability):

$$P\left(D \mid B_n\right) = P\left(B_n \mid D\right) P(D) / P\left(B_n\right) \tag{B.3}$$

A similar expression can be derived as a measure of correlation of D with the absence of a pattern (B_n) from known deposits (D):

$$P\left(D \mid \overline{B_n}\right) = P\left(\overline{B_n} \mid D\right) P(D) / P\left(\overline{B_n}\right) \tag{B.4}$$

These conditional probabilities are expressed for convenience as odds and also are converted in a logarithmic form to obtain the Weights of Evidence values. Odds can be defined as:

$$O = \frac{P}{1-P} = \frac{P}{\overline{P}} = P\left(D \mid B_n\right) / P\left(\overline{D} \mid B_n\right) \tag{B.5}$$

From equations (B.3, B.4) conditional probabilities can be substituted to obtain, for instance, the conditional odd of deposits given the presence of B_n:

$$O\left(D \mid B_n\right) = O\left(D\right) \cdot P\left(B_n \mid D\right) / P\left(B_n \mid \overline{D}\right) \tag{B.6}$$

In logarithmic form, both the presence or absence of B_n are expressed for convenience as follows, where W_n is the weight depending on the pixel considered, as this may fall within either an area where B_n occurs or is missing:

$$postlogit\left(D \mid B_n\right) = prilogit\left(D\right) + W_n^+ \tag{B.7}$$

$$postlogit\left(D \mid \overline{B_n}\right) = prilogit\left(D\right) + W_n^- \tag{B.8}$$

Rearranging these equations (B.7, B.8) the Weights of Evidence can be calculated as follows:

$$W_n^+ = \ln\left[P\left(B_n \mid D\right) / P\left(B_n \mid \overline{D}\right)\right] \tag{B.9}$$

$$W_n^- = \ln\left[P\left(\overline{B_n} \mid D\right) / P\left(\overline{B_n} \mid \overline{D}\right)\right] \tag{B.10}$$

Equations (B.7, B.8, B.9, B.10) can be combined in a single algorithm, representing the Bayes rule of combination, where the k coefficient defines if the pattern is present or absent as a function of the pixel (n) considered:

$$postlogit\left(D \mid B_n^{k(n)}\right) = prilogit\,(D) + \sum_{n=1}^{n} W_n^{k(n)} \tag{B.11}$$

A posterior probability value that represents the sum of all the evidential layers is computed from equation (B.11) back-calculating its value as follows:

$$P_{Post} = \left(\frac{e^{\sum_{n=1}^{n} W_n^{k(n)} + lnO\,(D)}}{1 + \left(e^{\sum_{n=1}^{n} W_n^{k(n)} + lnO\,(D)} \right)} \right) \tag{B.12}$$

An estimate of the error involved with the calculation of the Weights of Evidence can be expressed using the asymptotic assumption of Bishop et al. (1975). These represent the variances of the Weights of Evidence as a function of the total area of study expressed as total number of pixels (unit cells) $N(T)$. The mathematical relationships are also function of the area of known occurrences $N(D)$. The equations are:

$$s^2\left(W_n^+\right) = \left(\frac{1}{N\left(B \cap D\right)}\right) + \left(\frac{1}{N\left(B \cap \overline{D}\right)}\right) \tag{B.13}$$

$$s^2\left(W_n^+\right) = \left(\frac{1}{N\left(\overline{B} \cap D\right)}\right) + \left(\frac{1}{N\left(\overline{B} \cap \overline{D}\right)}\right) \tag{B.14}$$

These values were used to compute either the studentised value of the Contrast (*C*) and also for the calculation of the error involved in the estimation of posterior probabilities (P_{post}). This is derived from a multiple combination of layers that form multiple classes (*k*) of pixel column combinations:

$$s^2\left(P_{Post}\right)=\left[\frac{1}{N\,(D)}+\sum_{n=1}^{n}\left(s^2\left(W_n^{k\,(n)}\right)\right)\right]\cdot P_{Post}^2 \qquad \text{(B.15)}$$

The available estimate of the variance of the posterior probability is used to compute the error involved in the estimation of the number of predicted mineral deposits in a certain region:

$$s\left(N(D)_{Pred}\right)=\sqrt{\sum_{n=1}^{n}\left[\left(N\,(k)\right)^2\times s^2\left(P_{Post}\right)\right]} \qquad \text{(B.16)}$$

This latter equation can be used to increase the statistical robustness of the NOT test (Chapter 3).

APPENDIX C

C.1. Wofe Modeler

Compiled in VB 2005 (Express Edition)

```
Software used to compute Byesian probability in WofE (Chapter 3)


Region " Software developed by Feltrin Leonardo - James Cook
University"

Imports System.IO
Imports System.Text
Imports System
Imports System.Drawing
Imports System.Drawing.Printing
Imports System.Collections
Imports System.ComponentModel
Imports System.Windows.Forms
Imports System.Data
Imports Rebuild_wofe.Form5

'these instructions are initialising "libraries" to open and write txt
files- see line and drawing
Public Class Form1

    Inherits System.Windows.Forms.Form
    'variable used in case of multi selection of bool geology
    Dim BoolM() As String



    'variables inserted to allow bitmap functionalities
    Private bmpImage As System.Drawing.Bitmap
    Private bayesmap As System.Drawing.Bitmap
    Private curZoom As Double = 1.0
    Private curRect As Rectangle
    Private originalSize As New Size(0, 0)
    Private mouseDownPt As New Point(0, 0)
    Private mouseUpPt As New Point(0, 0)
    Private zoomMode As Boolean = False
    Private imagesize As System.Drawing.Bitmap
    Private myfile() As Byte
    Private cellsz As Double

    'Variables that are used by missing evidence functionalities
    Dim d() As Byte
    Dim PkD() As Single
    Dim PDx() As Single
    ' Dim Px() As Single
    Dim SigmaSQm() As Double
    Dim s2Pk() As Double
    Dim s2Pkf As Double
    Dim s2Pkf_miss As Double
```

```
    Dim Dep As Integer
    Dim SigmaSQ_missingev() As Double







    Public Property Image_size()
        Get
            Return imagesize
        End Get
        Set(ByVal value)
            imagesize = value
        End Set
    End Property



    'variables for wofe
    Dim FileNames() As String
    Private Shared bmpsizepub As Integer
    Private Shared AD_w, AI_w, AG_w, AT_w As Double 'shared variables
expressing areas as cell numbers; they work in all sub routines
    Private Shared SumArray() As Byte
    Private Shared SumArray2() As Byte
    Private Shared WplusARR(), WminusARR(), ContrastARR(),
Stud_CwARR(), sqvar_WplusARR(), sqvar_WminusARR(), _
    stdv_ContrastARR(), stdv_WplusARR(), stdv_WminusARR() As Double
    Private Shared ar() As String


    'it is left to test 2bmp under process might be some inconsistency
of overlap of data as
    'exporting we lose precision
    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button1.Click
        Dim cellsz = TextBox9.Text
        If TextBox9.Text = Nothing Then
            MsgBox("Please insert the required cell size in square
kilometres")
            Exit Sub
        End If

        'we delete all files with old data

        If RadioButton2.Checked = True Then

            Try
```

```
My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Wplus.t
xt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Wminus.
txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Contras
t.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\sqvar_W
plus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Wp
lus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\sqvar_W
minus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Wm
inus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Co
ntrast.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Stud_Cw
.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\ArrayCu
mAI.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\ArrayCu
mAG.txt")

            Catch : MsgBox("no files to delete")
            End Try

            Dim myarray2() As Byte

            'we have to import the string header of multilayer info
(multiple binari files 1 0 maps)
            'to do that we need a list with the names of the files we
need to load and then we use for to create

            'Dim header As String = Nothing

            Dim a As String
            a = TextBox1.Text

            'header = My.Computer.FileSystem.ReadAllText(a)
            'MsgBox(header & "Check and delete any final space
character")
            'MsgBox("Check and delete any final space character")
```

```
            Dim myarray() As String = BoolM

            'Dim c As Integer
            'For c = 0 To myarray.Length - 1
            '    myarray(c) = "c:\wofe\bmp_geol\" & myarray(c)
            'Next

            'now we need a for loop to load the files if multiple
layers are chosen
            Dim s As Integer
            For s = 0 To myarray.Length - 1

                myarray2 =
My.Computer.FileSystem.ReadAllBytes(myarray(s).ToString)

                'this convert one file.bmp to a myarray
                ' Dim binary(myarray2.Length - 1) As Byte



                'we jump on the cleaning algo each time to clean up
the bitmap


                Dim r As Integer
                'Here we need some code that cleans up the bitmaps for
us, we declare 2 new myarrays that will be locally storing
                'the original BMP in binary format. Then we get the
data out of them and feed SumArray and SumArray2
                Dim OriginalAD() As Byte =
My.Computer.FileSystem.ReadAllBytes(TextBox8.Text) 'we use the deposit
layer
                Dim OriginalAG(myarray2.Length - 1) As Byte

                OriginalAG = myarray2

                Try
                    r = (ComboBox3.Text * ComboBox4.Text) ' the number
of cells needed to get the number of good data pixels
                Catch : MsgBox("provide rows and columns numbers")
                    Exit Sub
                End Try

                'MsgBox("Numeber of Cells " & r)
                'Dim po As New Integer
                'Dim ps As Integer
                'Dim pq As Integer
                Dim SumArray(r - 1) As Byte
                Dim SumArray2(r - 1) As Byte
                'tronca arrays con remove command
```

```
                Array.Reverse(OriginalAD)
                Array.Resize(OriginalAD, r)
                Array.Reverse(OriginalAD)

                SumArray = OriginalAD

                Array.Reverse(OriginalAG)
                Array.Resize(OriginalAG, r)
                Array.Reverse(OriginalAG)

                SumArray2 = OriginalAG


                ''For cycles to load arrays (SumArray...
                'For po = (OriginalAD.Length) - r To OriginalAD.Length
- 1
                '    ps = (po - ((OriginalAD.Length) - r))
                '    SumArray.SetValue(OriginalAD(po), ps) ' SumArray
-> AD
                ''Next
                'For po = (OriginalAG.Length) - r To OriginalAG.Length
- 1
                '    pq = (po - ((OriginalAG.Length) - r))
                '    SumArray2.SetValue(OriginalAG(po), pq) '
SumArray2 -> AG
                'Next

                'MsgBox(SumArray2.GetValue(r - 1))
                'MsgBox(OriginalAG(OriginalAG.Length - 1))

                Dim b As Integer = 0
                Dim Sum As Double = 0
                Dim Sum2 As Double = 0
                'Dim SumCounter As Integer
                'Dim Counter(255) As Integer
                'Dim CounterTwo(255) As Integer

                'These following are two constants AD and AT Area of
deposits and Total Study area

                ' algebric sum of array (AD) we get just 1s not 0
counted, therfore the area of deposits cells
                For b = 0 To SumArray.Length - 1
                    Sum = Sum + SumArray(b) '-1 is inserted as the
array starts from 0
                Next b
                Label9.Text = Sum.ToString() 'Output AD
                Dim AD As Double = Sum
                'assign shared variable for w calc
                AD_w = Sum * cellsz
```

```
                ''''''''''''''''''''''''''''''''''''''''''''''''''''
                'here we add the conversion to deposit number
                Label35.Text = Sum * cellsz & "pixels"
                ''''''''''''''''''''''''''''''''''''''''''''''''''''
                'Sum of all cells to get total area expressed as cell
units (AT)
                Dim AT As Double = SumArray.Length
                Label8.Text = AT.ToString() 'Output AT
                AT_w = r * cellsz

                'This part is inserted to calculate the weights


                Dim a2 As Integer = SumArray2.Length 'array limit for
cycle
                Dim b2 As Integer

                'The following code has to be run in case of binary 0
1 classes of files
                ' algebric sum of array (AG) we get just 1's not 0
counted, therfore the area of geology or other things
                For b2 = 0 To SumArray2.Length - 1

                    Sum2 = Sum2 + SumArray2(b2) '-1 is inserted as the
array starts from 0
                Next
                Label10.Text = Sum2.ToString() 'Output AG

                Dim AG As Double = Sum2
                AG_w = AG * cellsz ' see above


                'we want to add each element of an array with an
element of a second array with same index
                'firstly we declare the 2 arrays, first geo second
deposit
                'If geo is multiclass this code cannot handle it
therefore it has to run only in case of 0,1 image
                'To make it work with the multiclass it has to cycle
with AG variation, we need a new array {AI}
                'we want also store the result in a third array
                'define the lenght as Array have specific lenght

                'we declare the boolean array
                Dim third(SumArray.Length - 1) As Byte
                Dim q As Integer
                'here we create the for loop, which makes a
multiplication of pixels ( = to boolean intersection)
                For q = 0 To SumArray.Length - 1
                    'third is an array that stores the value AI for
each pixel
                    third(q) = (SumArray(q) * SumArray2(q))
                Next
```

```
                Dim AI As Double
                For q = 0 To SumArray.Length - 1
                    AI = AI + third(q)
                Next

'My.Computer.FileSystem.WriteAllBytes("c:\wofe\pmh_final.rst", third,
False)
                Label11.Text = AI.ToString 'Output AI
                AI_w = AI * cellsz ' see above


                'Here we get the weight using previous variables
WEIGHT MODULE

                Dim Wplus As Double
                Dim Wminus As Double
                Dim Contrast As Double
                Dim Stud_Cw As Double
                Dim sqvar_Wplus As Double
                Dim sqvar_Wminus As Double
                Dim stdv_Contrast As Double
                Dim stdv_Wplus As Double
                Dim stdv_Wminus As Double

                Try



My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Array
CumAI.txt", AI_w.ToString & " ", True)
                Catch ex As Exception

My.Computer.FileSystem.CreateDirectory("c:\wofe\weights_calc_output\")

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Array
CumAI.txt", AI_w.ToString & " ", True)

                End Try

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Array
CumAG.txt", AG_w.ToString & " ", True)


                'Equation for W+

                Wplus = Math.Log(((AI_w / AD_w) * ((AT_w - AD_w) /
(AG_w - AI_w))))
                Label19.Text = Wplus.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Wplus
.txt", Wplus.ToString & " ", True)
```

```
                'Equation for W-

                Wminus = Math.Log(((AD_w - AI_w) / AD_w) * ((AT_w -
AD_w) / (AT_w - AD_w - AG_w + AI_w)))
                Label20.Text = Wminus.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Wminu
s.txt", Wminus.ToString & " ", True)


                'Equation for Cw

                Contrast = Wplus - Wminus '21
                Label21.Text = Contrast.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Contr
ast.txt", Contrast.ToString & " ", True)

                'Equation for v(W+)

                sqvar_Wplus = (1 / AI_w) + (1 / (AG_w - AI_w))


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\sqvar
_Wplus.txt", sqvar_Wplus.ToString & " ", True)

                'Equation for s(W+)
                stdv_Wplus = Math.Sqrt(sqvar_Wplus) '23
                Label23.Text = stdv_Wplus.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Wplus.txt", stdv_Wplus.ToString & " ", True)

                'Equation for v(W-)

                sqvar_Wminus = (1 / (AD_w - AI_w)) + (1 / (AT_w - AG_w
- AD_w + AI_w))


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\sqvar
_Wminus.txt", sqvar_Wminus.ToString & " ", True)

                'Equation for s(W-)
                stdv_Wminus = Math.Sqrt(sqvar_Wminus) '24
                Label24.Text = stdv_Wminus.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Wminus.txt", stdv_Wminus.ToString & " ", True)
```

```
                'Equation for s(Cw)
                stdv_Contrast = Math.Sqrt(sqvar_Wplus + sqvar_Wminus)
'25
                Label25.Text = stdv_Contrast.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Contrast.txt", stdv_Contrast.ToString & " ", True)

                'Equation for the studentized value of Cw '22
                Dim Stud_CwARR(255) As Double
                Stud_Cw = Contrast / stdv_Contrast
                Label22.Text = Stud_Cw.ToString


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Stud_
Cw.txt", Stud_Cw.ToString & " ", True)

                'output lines relative to each value we get a number
of array


                AI = Nothing
                AG = Nothing
                AI_w = Nothing
                AG_w = Nothing
                Wplus = Nothing
                Wminus = Nothing
                Contrast = Nothing
                Stud_Cw = Nothing
                sqvar_Wplus = Nothing
                sqvar_Wminus = Nothing
                stdv_Contrast = Nothing
                stdv_Wplus = Nothing
                stdv_Wminus = Nothing
                'WplusARR(255) = Nothing
                'WminusARR(255) = Nothing
                'sqvar_WplusARR(255) = Nothing
                'stdv_WplusARR(255) = Nothing
                'sqvar_WminusARR(255) = Nothing
                'stdv_WminusARR(255) = Nothing
                'stdv_ContrastARR(255) = Nothing
                'ContrastARR(255) = Nothing
                SumArray = Nothing
                SumArray2 = Nothing


            Next
            MsgBox("Well done leo!")
            Exit Sub


        Else
```

```
            Try

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Wplus.t
xt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Wminus.
txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Contras
t.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\sqvar_W
plus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Wp
lus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\sqvar_W
minus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Wm
inus.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\stdv_Co
ntrast.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\Stud_Cw
.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\ArrayCu
mAI.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\AIhisto
.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\AGhisto
.txt")

My.Computer.FileSystem.DeleteFile("c:\wofe\weights_calc_output\ArrayCu
mAG.txt")
            Catch : MsgBox("no files to delete")
            End Try


            'Here we need some code that cleans up the bitmaps for us,
we declare 2 new arrays that will be locally storing
            'the original BMP in binary format. Then we get the data
out of them and feed SumArray and SumArray2
            Dim OriginalAD() As Byte =
My.Computer.FileSystem.ReadAllBytes(TextBox8.Text) 'we use the deposit
layer
```

```
            Dim OriginalAG() As Byte =
My.Computer.FileSystem.ReadAllBytes(TextBox7.Text) 'we use the geo

            Dim r As Integer = (ComboBox3.Text * ComboBox4.Text)
            'MsgBox("Numeber of Cells " & r)
            Dim po As Integer
            Dim ps As Integer
            Dim pq As Integer
            Dim SumArray(r - 1) As Byte
            Dim SumArray2(r - 1) As Byte

            'For cycles to load arrays (SumArray...
            For po = (OriginalAD.Length) - r To OriginalAD.Length - 1
                ps = (po - ((OriginalAD.Length) - r))
                SumArray.SetValue(OriginalAD(po), ps)
            Next
            po = 0
            For po = (OriginalAG.Length) - r To OriginalAG.Length - 1
                pq = (po - ((OriginalAG.Length) - r))
                SumArray2.SetValue(OriginalAG(po), pq)
            Next

            'MsgBox(SumArray2.GetValue(r - 1))
            'MsgBox(OriginalAG(OriginalAG.Length - 1))

            Dim b As Integer = 0
            Dim Sum As Double = 0
            Dim Sum2 As Double = 0
            Dim SumCounter As Integer
            Dim Counter(255) As Integer
            Dim CounterTwo(255) As Integer

            'These following are two constants AD and AT Area of
deposits and Total Study area

            ' algebric sum of array (AD) we get just 1s not 0 counted,
therfore the area of deposits cells
            Dim a As Integer = SumArray.Length - 1
            For b = 1 To a
                Sum = Sum + SumArray(b - 1) '-1 is inserted as the
array starts from 0
            Next b
            Label9.Text = Sum.ToString() 'Output AD
            Dim AD As Double = Sum
            'assign shared variable for w calc
            AD_w = Sum * cellsz
            ''''''''''''''''''''''''''''''''''''''''''''''''''''
            'here we add the conversion to deposit number
            Label35.Text = Sum * cellsz & " km^2"
            ''''''''''''''''''''''''''''''''''''''''''''''''''''
            'Sum of all cells to get total area expressed as cell
units (AT)
            Dim AT As Double = SumArray.Length
```

```
            Label8.Text = AT.ToString() 'Output AT
            AT_w = r * cellsz ' input by user



            'This code creates an histogram array (counter)used to
detect the type of evidence image used
            'works anlysing the third element of Counter() if the sum
of all the values except the first two of Counter() is equal to
            '0, then we deal with a binary 0 1 file
            'Compute the sum of all elements of Counter() except the
first two (0,1) why?
            'Counter for a 0 1 type file will give a final sum = to 0.
This is true as we
            'we are using cleaned arrays (SumArray see up stripping)
            'Conter refers to AG array
            For a = 0 To SumArray2.Length - 1 'histo for AG class

                Counter(SumArray2(a)) += 1
                ' MsgBox(Counter(a))

            Next a
            Try


                For b = 0 To Counter.Length - 1

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\AGhis
to.txt", Counter(b).ToString & " ", True)
                Next

            Catch ex As Exception

My.Computer.FileSystem.CreateDirectory("c:\wofe\weights_calc_output\")

                For b = 0 To Counter.Length - 1

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\AGhis
to.txt", Counter(b).ToString & " ", True)
                Next


            End Try


            'Checking the type of data....
            For a = 2 To Counter.Length - 1
                SumCounter = SumCounter + Counter(a)
            Next a

            'we need a second histo for AI not sure if I have to
insert it below
```

```
            'now we write on a file txt or compile a database.....


            'Dim objStreamWriter As StreamWriter


            ''Open the file. The software runs and save each time on
hist, therefore we might need to solve the issue of
            ''copying above the same file (problem can be solved with
user imput or using a delete opion instruction)
            'objStreamWriter = New StreamWriter("c:\wofe\histoAG.txt",
True, _
            '    Encoding.Unicode)

            ''Write out the numbers on the same line.

            'Dim c As Integer
            'For c = 0 To 255
            '     objStreamWriter.Write(Counter(c) & " ")
            'Next c
            ''Closes the file.
            'objStreamWriter.Close()




            'If the sum is 0 then the image is binary therefore use
the following code to caculate AG
            If SumCounter = 0 Then
                MsgBox("Binary file [0,1]")

                Dim a2 As Integer = SumArray2.Length 'array limit for
cycle
                Dim b2 As Integer
                'The following code has to be run in case of binary 0
1 classes of files
                ' algebric sum of array (AG) we get just 1's not 0
counted, therfore the area of geology or other things
                For b2 = 1 To a2

                    Sum2 = Sum2 + SumArray2(b2 - 1) '-1 is inserted as
the array starts from 0
                Next b2
                Label10.Text = Sum2.ToString() 'Output AG
                Dim AG As Double = Sum2
                AG_w = AG * cellsz ' see above


                'we want to add each element of an array with an
element of a second array with same index
                'firstly we declare the 2 arrays, first geo second
deposit
                'If geo is multiclass this code cannot handle it
therefore it has to run only in case of 0,1 image
```

```
                'To make it work with the multiclass it has to cycle
with AG variation, we need a new array {AI}
                'we want also store the result in a third array

                'define the lenght as Array have specific lenght
                b = SumArray.Length
                Dim third(b) As Byte

                'here we create the for cycle, which makes a
multiplication of pixels ( = to boolean intersection)
                For a = 1 To b
                    'third is an array that stores the value AI for
each pixel
                    third.SetValue(SumArray(a - 1) * SumArray2(a - 1),
a - 1)
                Next a
                Dim AI As Double = 0
                For a = 1 To b
                    AI = AI + third(a - 1)
                Next a

'My.Computer.FileSystem.WriteAllBytes("c:\wofe\pmh_final.rst", third,
False)
                Label11.Text = AI.ToString 'Output AI
                AI_w = AI * cellsz ' see above


                'Here we get the weight using previous variables
WEIGHT MODULE

                Dim Wplus As Double
                Dim Wminus As Double
                Dim Contrast As Double
                Dim Stud_Cw As Double
                Dim sqvar_Wplus As Double
                Dim sqvar_Wminus As Double
                Dim stdv_Contrast As Double
                Dim stdv_Wplus As Double
                Dim stdv_Wminus As Double

                'Equation for W+
                Wplus = Math.Log(((AI_w / AD_w) * ((AT_w - AD_w) /
(AG_w - AI_w))))
                Label19.Text = Wplus.ToString
                'Equation for W-
                Wminus = Math.Log(((AD_w - AI_w) / AD_w) * ((AT_w -
AD_w) / (AT_w - AD_w - AG_w + AI_w)))
                Label20.Text = Wminus.ToString
                'Equation for Cw
                Contrast = Wplus - Wminus '21
                Label21.Text = Contrast.ToString
                'Equation for v(W+)
                sqvar_Wplus = (1 / AI_w) + (1 / (AG_w - AI_w))
```

```
                'Equation for s(W+)
                stdv_Wplus = Math.Sqrt(sqvar_Wplus) '23
                Label23.Text = stdv_Wplus.ToString
                'Equation for v(W-)
                sqvar_Wminus = (1 / (AD_w - AI_w)) + (1 / (AT_w - AG_w
- AD_w + AI_w))

                'Equation for s(W-)
                stdv_Wminus = Math.Sqrt(sqvar_Wminus) '24
                Label24.Text = stdv_Wminus.ToString
                'Equation for s(Cw)
                stdv_Contrast = Math.Sqrt(sqvar_Wplus + sqvar_Wminus)
'25
                Label25.Text = stdv_Contrast.ToString
                'Equation for the studentized value of Cw '22
                Stud_Cw = Contrast / stdv_Contrast
                Label22.Text = Stud_Cw.ToString


                AI = Nothing
                AG = Nothing
                AI_w = Nothing
                AG_w = Nothing
                Wplus = Nothing
                Wminus = Nothing
                Contrast = Nothing
                Stud_Cw = Nothing
                sqvar_Wplus = Nothing
                sqvar_Wminus = Nothing
                stdv_Contrast = Nothing
                stdv_Wplus = Nothing
                stdv_Wminus = Nothing
                WplusARR(255) = Nothing
                WminusARR(255) = Nothing
                sqvar_WplusARR(255) = Nothing
                stdv_WplusARR(255) = Nothing
                sqvar_WminusARR(255) = Nothing
                stdv_WminusARR(255) = Nothing
                stdv_ContrastARR(255) = Nothing
                ContrastARR(255) = Nothing

                SumArray = Nothing
                SumArray2 = Nothing



                '------------------------------------------------------
----------------------------------------------------------------------
--------------
            Else
```

```
                'we want to add each element of an array with an
element of a second array with same index
                'firstly we declare the 2 arrays, first geo second
deposit
                'If geo is multiclass this code cannot handle it
therefore it has to run only in case of 0,1 image
                'To make it work with the multiclass it has to cycle
with AG variation, we need a new array {AI}
                'we want also store the result in a third array
                'Counter() is a list of all AG in order from 0 to 255,
we need to feed the AG to produce the AI array
                'Looping through Counter we pick each value and
perform the computation of AI and W


                'this code works for a single AG array calculation

                'define the lenght as Array have specific lenght

                Dim third(SumArray.Length - 1) As Byte



                'here we create the for cycle, which makes a
multiplication of pixels ( = to boolean intersection)
                For a = 1 To SumArray.Length
                    'third is an array that stores the value AI for
each pixel
                    third.SetValue(SumArray(a - 1) * SumArray2(a - 1),
a - 1) 'SumArray2 is a single array of AG
                Next a
                'We get third() which represents the array
intersection
                'Now we run HISTO on third()
                'CounterTwo refers to AD array
                For a = 0 To third.Length - 1 'histo for AG class

                    CounterTwo(third(a)) += 1
                Next a
                For b = 0 To Counter.Length - 1

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\AIhis
to.txt", CounterTwo(b).ToString & " ", True)
                Next
                ' MsgBox(Counter(a))



                'In both cases AG and AI has to be estimated as
cumulative proportions, therefore we need to progressively sum up
                ' the different elements of the two arrays to obtain 2
new arrays with cumulative growth of areas
```

```
                Dim n As Integer
                'Dim s As Integer
                'Dim p As Integer
                Dim ArrayCumAG(Counter.Length - 1) As Double
                ArrayCumAG(0) = Counter(0)
                For n = 1 To Counter.Length - 1
                    ArrayCumAG(n) = ((Counter(n)) + ArrayCumAG(n - 1))

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Array
CumAG.txt", ArrayCumAG(n).ToString & " ", True)


                    'This code requires too much resources
                    'For n = 0 To SumArray2.Length - 1

                    '    For s = 0 To n
                    '        p = p + SumArray2(s)
                    '    Next s
                    '    ArrayCumAG(n) = p
                    '    p = 0

                    'ArrayCum is the array that contains cumulative AI
proportions
                Next n
                'we correct the first value for (0) derived by non
intersection during bool
                CounterTwo(0) = (CounterTwo(0) - (r - Sum))
                'AI cumulative prop...Changed we keep same values as
CounterTWO

                Dim ArrayCumAI(CounterTwo.Length - 1) As Double
                'For b = 0 To 255
                '    ArrayCumAI(b) = CounterTwo(b)

                'Next


                'cumulative of AI increasing with distance analysis
                ArrayCumAI(0) = CounterTwo(0)
                For n = 1 To CounterTwo.Length - 1
                    ArrayCumAI(n) = ((CounterTwo(n)) + ArrayCumAI(n -
1))

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Array
CumAI.txt", ArrayCumAI(n).ToString & " ", True)
                Next n

                'After evaluation of multiclass layers we obtain two
final arrays (ArrayCumAI(); ArrayCumAG())

                'In this case the module WEIGHT is integrated and
modified to run with two arrays of AG and AI values that run in
parallel
```

```
                'Here we get the weight using previous variables
WEIGHT MODULE


                Dim Wplus As Double
                Dim Wminus As Double
                Dim Contrast As Double
                Dim Stud_Cw As Double
                Dim sqvar_Wplus As Double
                Dim sqvar_Wminus As Double
                Dim stdv_Contrast As Double
                Dim stdv_Wplus As Double
                Dim stdv_Wminus As Double
                Dim WplusARR(255) As Double
                Dim WminusARR(255) As Double
                Dim sqvar_WplusARR(255) As Double
                Dim stdv_WplusARR(255) As Double
                Dim sqvar_WminusARR(255) As Double
                Dim stdv_WminusARR(255) As Double
                Dim stdv_ContrastARR(255) As Double
                Dim ContrastARR(255) As Double
                'delete all files in data folder




                For a = 0 To Counter.Length - 1
                    'Equation for W+
                    AI_w = ArrayCumAI(a) * cellsz  'we convert in area
of deposits km2

                    AG_w = ArrayCumAG(a) * cellsz 'we convert the area
in km^2 from cells

                    Wplus = Math.Log(((AI_w / AD_w) * ((AT_w - AD_w) /
(AG_w - AI_w))))
                    Label19.Text = Wplus.ToString
                    WplusARR.SetValue(Wplus, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Wplus
.txt", WplusARR(a).ToString & " ", True)

                    'Equation for W-

                    Wminus = Math.Log(((AD_w - AI_w) / AD_w) * ((AT_w
- AD_w) / (AT_w - AD_w - AG_w + AI_w)))
                    Label20.Text = Wminus.ToString
                    WminusARR.SetValue(Wminus, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Wminu
s.txt", WminusARR(a).ToString & " ", True)
```

```
                    'Equation for Cw

                    Contrast = WplusARR(a) - WminusARR(a) '21
                    Label21.Text = Contrast.ToString
                    ContrastARR.SetValue(Contrast, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Contr
ast.txt", ContrastARR(a).ToString & " ", True)

                    'Equation for v(W+)

                    sqvar_Wplus = (1 / AI_w) + (1 / (AG_w - AI_w))
                    sqvar_WplusARR.SetValue(sqvar_Wplus, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\sqvar
_Wplus.txt", sqvar_WplusARR(a).ToString & " ", True)


                    'Equation for s(W+)
                    stdv_Wplus = Math.Sqrt(sqvar_WplusARR(a)) '23
                    Label23.Text = stdv_Wplus.ToString
                    stdv_WplusARR.SetValue(stdv_Wplus, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Wplus.txt", stdv_WplusARR(a).ToString & " ", True)


                    'Equation for v(W-)

                    sqvar_Wminus = (1 / (AD_w - AI_w)) + (1 / (AT_w -
AG_w - AD_w + AI_w))
                    sqvar_WminusARR.SetValue(sqvar_Wminus, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\sqvar
_Wminus.txt", sqvar_WminusARR(a).ToString & " ", True)

                    'Equation for s(W-)
                    stdv_Wminus = Math.Sqrt(sqvar_WminusARR(a)) '24
                    Label24.Text = stdv_Wminus.ToString
                    stdv_WminusARR.SetValue(stdv_Wminus, a)


My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Wminus.txt", stdv_WminusARR(a).ToString & " ", True)
                    'Equation for s(Cw)
                    stdv_Contrast = Math.Sqrt(sqvar_WplusARR(a) +
sqvar_WminusARR(a)) '25
                    Label25.Text = stdv_Contrast.ToString
                    stdv_ContrastARR.SetValue(stdv_Contrast, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\stdv_
Contrast.txt", stdv_ContrastARR(a).ToString & " ", True)
```

```
                    'Equation for the studentized value of Cw '22
                    Dim Stud_CwARR(255) As Double
                    Stud_Cw = ContrastARR(a) / stdv_ContrastARR(a)
                    Label22.Text = Stud_Cw.ToString
                    Stud_CwARR.SetValue(Stud_Cw, a)

My.Computer.FileSystem.WriteAllText("c:\wofe\weights_calc_output\Stud_
Cw.txt", Stud_CwARR(a).ToString & " ", True)



                Next a


                'output lines relative to each value we get a number
of arrays

                'AI = Nothing
                'AG = Nothing
                AI_w = Nothing
                AG_w = Nothing
                Wplus = Nothing
                Wminus = Nothing
                Contrast = Nothing
                Stud_Cw = Nothing
                sqvar_Wplus = Nothing
                sqvar_Wminus = Nothing
                stdv_Contrast = Nothing
                stdv_Wplus = Nothing
                stdv_Wminus = Nothing
                WplusARR(255) = Nothing
                WminusARR(255) = Nothing
                sqvar_WplusARR(255) = Nothing
                stdv_WplusARR(255) = Nothing
                sqvar_WminusARR(255) = Nothing
                stdv_WminusARR(255) = Nothing
                stdv_ContrastARR(255) = Nothing
                ContrastARR(255) = Nothing
                SumArray = Nothing
                SumArray2 = Nothing

                MsgBox("Weighting Completed!")



            End If

            'Make sure the 2 images have same size and resolution
before u start intersecting and weighting

        End If
```

```
    End Sub


    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button2.Click
        My.Forms.Form2.Show()
    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button3.Click
        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\"
        selectFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then

            TextBox7.Text = selectFileDialog1.FileName

            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
            'End If
        End If
    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button4.Click
        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\"
        selectFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then



            TextBox8.Text = selectFileDialog1.FileName

            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
```

```
            'End If
        End If
    End Sub

    Private Sub Button5_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button5.Click
        'multiselect option
        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\"
        selectFileDialog1.Filter = "bitmap file (*.bmp)| *.bmp"
        selectFileDialog1.FilterIndex = 1
        selectFileDialog1.RestoreDirectory = True
        selectFileDialog1.Multiselect = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then
            'ar() can be used to process the data for calculation of
weights
            Dim ar() As String = selectFileDialog1.FileNames
            Dim a As String = Join(ar, "")
            TextBox1.Text = a

            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
            'End If
            BoolM = ar
        End If
    End Sub


    Public Function BinaryConv(ByVal bound As Byte, ByVal myarray() As
Byte, ByVal bmpSize As Integer, ByVal FileName As String) As Double

        'we need to strip the header and store it somewhere
        Dim headerLength As Integer
        headerLength = (myarray.Length) - bmpSize
        'Dim ab As Integer
        Dim stripArray() As Byte
        stripArray = myarray
        Array.Resize(stripArray, headerLength)
        Array.Reverse(myarray)
        Array.Resize(myarray, bmpSize)
        Array.Reverse(myarray)

        'For ab = 0 To headerLength
        '    stripArray(ab) = myarray(ab)
        'Next
        'My.Computer.FileSystem.WriteAllBytes("c:\wofe\hearer.bmp",
stripArray, False)
```

```
        'we need to perform a bit conversion to get a 0,1 binary type
        Dim a As Integer
        Dim value As Byte
        For a = 0 To myarray.Length - 1

            value = myarray(a)


            If value >= bound Then
                myarray(a) = 0
            Else
                If value < bound Then
                    myarray(a) = 255
                End If

            End If


        Next


        'problem is that final...(2) give an array with length 3, with
3 elements not 2, therefore use -1
        Dim finalarray((stripArray.Length + myarray.Length) - 1) As
Byte
        Dim ac As Integer
        For ac = 0 To stripArray.Length - 1
            finalarray(ac) = stripArray(ac)
        Next
        For ac = stripArray.Length To finalarray.Length - 1
            finalarray(ac) = myarray(ac - stripArray.Length)
        Next
        'we need to create a folder where we can store the evidential
boolean layers

        My.Computer.FileSystem.WriteAllBytes("c:\wofe\image.bmp",
finalarray, False)
        Form4.Show()

    End Function

    Private Sub Button6_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button6.Click
        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\wofe\"
        selectFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then
```

```
            TextBox2.Text = selectFileDialog1.FileName

            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
            'End If
        End If
    End Sub

    Private Sub Button7_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button7.Click

        Dim myarray() As Byte =
My.Computer.FileSystem.ReadAllBytes(TextBox2.Text)
        Dim bound As Integer
        Dim bmpsize As Integer
        bound = Byte.Parse(TextBox3.Text)
        bmpsize = Integer.Parse(TextBox4.Text)
        bmpsizepub = bmpsize
        Me.BinaryConv(bound, myarray, bmpsize, TextBox2.Text)


    End Sub


    Private Sub Button9_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button9.Click
        Dim a As Integer
        'Dim b As Integer

        Dim FileName(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As String
        Dim Wplus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim Wminus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single


        For a = 0 To Bayes_Data_Source_ModelDataGridView.Rows.Count
            Try

                FileName(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(6).Value
                Wplus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(1).Value
                Wminus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(2).Value

            Catch : Exit For
```

```
            End Try
        Next

        Bayes(FileName, Wplus, Wminus)

    End Sub

    Public Function Bayes(ByVal FileName() As String, ByVal Wplus() As
Single, ByVal Wminus() As Single) As Byte

        ' I need to firslty select the bitmaps created with convert,
then store the strings in the first column
        'manually we type in the weights and ask for that with a msg
box
        'all is set and ready for the calculation
        'we need to select each row and use the loop to convert the
pixels to an array of weights
        'we need to sum up the images to the prior probability image
        Dim Form5Inst As New Form5
        Dim Dep As Integer
        Dep = Form5Inst.AD(TextBox8.Text)

        imagesize = Bitmap.FromFile("imagesize.bmp")


        Dim postlogit((imagesize.Height * imagesize.Width) - 1) As
Single 'four
        Dim weightedArray((imagesize.Height * imagesize.Width) - 1) As
Single 'six necessary to weight step
        Dim rescale((imagesize.Height * imagesize.Width) - 1) As
Single 'seven

        Dim ab As Integer
        For ab = 0 To FileName.Length - 1




            ' imagesize = Bitmap.FromFile(FileName(ab))
            If FileName(ab) = Nothing Then
                Exit For
            End If
            Dim evidence As Bitmap =
Bitmap.FromFile(FileName(ab).ToString)

            Dim myfile((evidence.Width * evidence.Height) - 1) As Byte
            Dim color As System.Drawing.Color
            Dim county As Integer
            Dim countx As Integer
            Dim s As Integer
            For county = 0 To evidence.Height - 1
```

```
                For countx = 0 To evidence.Width - 1
                    color = evidence.GetPixel(countx, county)

                    If CInt(color.B) <> 0 And CInt(color.G) <> 0 And
CInt(color.R) <> 0 Then
                        myfile(s) = 1
                    Else
                        myfile(s) = 0
                    End If

                    s = s + 1
                Next
            Next
            s = 0
            Dim value As Byte
            Dim ard As Integer

            If FileName(ab) Is Nothing Then
                Exit For
            Else


                'here we convert the image in evdence layer using the
weights
                For ard = 0 To myfile.Length - 1

                    value = myfile(ard)

                    If value = 0 Then
                        weightedArray(ard) = Wminus(ab)
                    Else
                        weightedArray(ard) = Wplus(ab)
                    End If
                Next

            End If


            'modified''''''''''''''''''''to exclude textbox6
input'''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
'''''''''''
            'now we need to add the evidence layer created to the
prior probability
            'prilogit should be calculated as the ratio D/T the
conversion in ODDS and
            'ln function gives prilogit value
            'I need the deposit layer and the tot number of pixels

            ' Dim Dep_conv As Single = Dep * 0.000269
            Dim priprob As Single = (Dep / (imagesize.Height *
imagesize.Width))
            Dim priOdd As Single = priprob / (1 - priprob)
            Dim con As Single
```

```
            con = Math.Log(priOdd)


            Dim ac As Integer
            Dim priorlogit((imagesize.Height * imagesize.Width) - 1)
As Single 'five

            ' con = Single.Parse(TextBox6.Text)
            For ac = 0 To ((imagesize.Height * imagesize.Width) - 1)
                priorlogit(ac) = con
            Next


            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit(ac) = postlogit(ac) + priorlogit(ac) +
weightedArray(ac)
                Else
                    postlogit(ac) = postlogit(ac) + weightedArray(ac)
                End If
            Next



        Next


        'now we need to rescale the double in a way that we can
generate a byte array

        Dim ad As Integer
        Dim aq As Integer
        Dim postodds(postlogit.Length - 1) As Single
        Dim postprob(postlogit.Length - 1) As Single
        Dim postprobByte(postlogit.Length - 1) As Byte
        For aq = 0 To postlogit.Length - 1
            'we convert to probability


            postodds(aq) = Math.Exp(postlogit(aq))

            postprob(aq) = postodds(aq) / (1 + postodds(aq))

        Next
        Array.Copy(postprob, rescale, postlogit.Length)
        Array.Sort(rescale)

        Dim min As Single = rescale(0)
        Dim max As Single = rescale(rescale.Length - 1)
        My.Computer.FileSystem.WriteAllText("c:\wofe\scale.txt",
min.ToString, False)
        My.Computer.FileSystem.WriteAllText("c:\wofe\scale.txt",
max.ToString, True)
```

```
        For ad = 0 To postprob.Length - 1

            ' we shift or translate the scale to get a minimum of 0
            'min must become firslty equal to 1 so if min*x=1
            Try
                Dim alfa As Single = (1 / min)
                postprob(ad) = postprob(ad) * alfa
                postprob(ad) = (postprob(ad) - (min * alfa))
                postprob(ad) = (postprob(ad) * 255) / ((max * alfa) -
(min * alfa))
                postprobByte(ad) = CByte((postprob(ad)))
                postprob(ad) = (postprob(ad) * ((max * alfa) - (min *
alfa))) / 255
                postprob(ad) = (postprob(ad) + (min * alfa))
                postprob(ad) = postprob(ad) / alfa

            Catch ex As Exception
                MsgBox("something wrong with the input?")
                Exit Function
            End Try

        Next

My.Computer.FileSystem.WriteAllBytes("c:\wofe\postprobebyte.bin",
postprobByte, False)

        MsgBox("Pprob Completed!")

    End Function


    Private Sub Button8_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button8.Click

        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\"
        selectFileDialog1.Filter = "bitmap file (*.bmp)| *.bmp"
        selectFileDialog1.FilterIndex = 1
        selectFileDialog1.RestoreDirectory = True
        selectFileDialog1.Multiselect = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then


            bindingNavigatorAddNewItem.PerformClick()
            Dim ar() As String = selectFileDialog1.FileNames

            ' Dim a As String = Join(ar, " ")
```

```
            Dim a As Integer
            Dim b As String
            Dim c As String
            FileNames = ar
            For a = 0 To ar.Length - 1

                b = ar(a)
                c = ar(a)
                b = b.Substring(b.LastIndexOf("\") + 1)

                Try

Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(0).Value = b

Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(6).Value = c
                Catch ex As Exception

                    bindingNavigatorAddNewItem.PerformClick()

Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(0).Value = b

Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(6).Value = c

                End Try


            Next
            '  bindingNavigatorDeleteItem.PerformClick()
            ' MsgBox("Insert relative weights")

            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
            'End If

        End If
    End Sub


    'Public Function ArrayMax(ByVal math() As Double) As Double

    '    Dim a As Integer
    '    Dim av As Double
    '    Dim b As Double
    '    Dim c As Integer
    '    Dim d As Integer
    '    For a = 0 To math.Length - 1

    '        b = b + math(a)

    '    Next
    '    av = b / math.Length
```

```
    '    Dim newmath(math.Length - 1) As Double
    '    For c = 0 To math.Length - 1
    '        If math(c) >= av Then
    '            newmath(c) = math(c)
    '        End If

    '    Next


    'End Function

    Public Function ArrayAn(ByVal ar() As Single) As Integer

        Dim a As Integer

        Dim c As Integer

        Dim counter(10) As Single

        c = 0
        Try
            For a = 0 To ar.Length - 1
                If ar(a) <> ar(a + 1) Then
                    counter(c) = ar(a)
                    counter(c + 1) = ar(a + 1)
                    c = c + 2
                End If
            Next
        Catch : Exit Try
        End Try
        Dim d As Integer
        For d = 0 To counter.Length - 1

My.Computer.FileSystem.WriteAllText("c:\wofe\arrayanalysis.txt",
counter(d), True, System.Text.Encoding.Unicode)

        Next
        ' Return MsgBox("ok")

    End Function

    Private Sub Button10_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button10.Click
        If TextBox9.Text = "" Then
            MsgBox("Please insert a valid cell size value")
            Exit Sub
        End If
        My.Forms.Form5.Show()
    End Sub

    Public Function imagesizefunc() As Integer

        Dim a As Integer
```

```
        imagesize = Bitmap.FromFile("imagesize.bmp")

        a = (imagesize.Width * imagesize.Height)
        Return a
    End Function



    Private Sub Button13_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button13.Click
        'start new ot ot

        Try
            cell = Me.TextBox9.Text
        Catch ex As Exception
            MsgBox("Please provide cell size")
            Exit Sub
        End Try

        d = Nothing
        PkD = Nothing
        PDx = Nothing

        SigmaSQm = Nothing
        s2Pk = Nothing
        s2Pkf = Nothing
        s2Pkf_miss = Nothing
        Dep = Nothing
        bmpsizepub = Nothing
        AD_w = Nothing
        AI_w = Nothing
        AG_w = Nothing
        AT_w = Nothing 'shared variables expressing areas as cell
numbers; they work in all sub routines


        Dim a As Integer
        'Dim b As Integer

        Dim FileName(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As String
        Dim Wplus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim Wminus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim sWplus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim sWminus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single

        For a = 0 To Bayes_Data_Source_ModelDataGridView.Rows.Count
            Try
```

```
                FileName(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(6).Value
                Wplus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(1).Value
                Wminus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(2).Value
                sWplus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(4).Value
                sWminus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(5).Value
            Catch : Exit For
            End Try
        Next

        missing_evidence_Pk(FileName, Wplus, Wminus)
        'missing_evidence_PDx(FileName, Wplus, Wminus)
        'SigmaSQ_missing_evidence()
        SigmaSQ(FileName, sWplus, sWminus)
        OminbusTest_NewOminibus()

    End Sub

    Private Function missing_evidence_Pk(ByVal FileName() As String,
ByVal Wplus() As Single, ByVal Wminus() As Single) As Integer

        'looks fine
        'here we use the first part of bayes to get the value of
posterior probability
        'we have to use the postlogit array as prior probability when
we calculate P(d:x)
        'and P(d)
        'weights are automatically picked from the data grid view, but
the arrays with final summation of weights
        'has to be stripped of values that are not included within
deposits and missing evidence ???
        'we need to input a layer representing the area of missing
evidence = bmp indexed image then perform a boolean with
        'deposit and this layer to get only values useful for the
calculation, we consider only missing evidence as we are
        'using it to calculate the posterior probability resulting
when missing evidence is intersected
        'therefore a cumulative area obtained combining all the
missing evidence on a single layer positively defines
        'the pixel where this calculation is meaningfull
        'in any case we cannot calculate sigma^2(p) for missing
eveidence if there is no missing evidence
        Dim Form5Inst As New Form5

        Dep = Form5Inst.AD(TextBox8.Text)
        imagesize = Bitmap.FromFile(FileName(0))

        'Static header() As Byte 'on
```

```
        Dim postlogit((imagesize.Height * imagesize.Width) - 1) As
Single
        Dim postlogit_miss((imagesize.Height * imagesize.Width) - 1)
As Single
        'four
        Dim weightedArray((imagesize.Height * imagesize.Width) - 1) As
Single 'six necessary to weight step
        ' Static rescale((imagesize.Height * imagesize.Width) - 1) As
Single 'seven

        Dim ab As Integer
        For ab = 0 To FileName.Length - 1

            If FileName(ab) = Nothing Then
                Exit For
            End If
            Dim evidence As Bitmap =
Bitmap.FromFile(FileName(ab).ToString)

            Dim myfile((evidence.Width * evidence.Height) - 1) As Byte
            Dim color As System.Drawing.Color
            Dim county As Integer
            Dim countx As Integer
            Dim s As Integer
            For county = 0 To evidence.Height - 1
                For countx = 0 To evidence.Width - 1
                    color = evidence.GetPixel(countx, county)

                    If CInt(color.B) <> 0 And CInt(color.G) <> 0 And
CInt(color.R) <> 0 Then
                        myfile(s) = 1
                    Else
                        myfile(s) = 0
                    End If

                    s = s + 1
                Next
            Next
            s = 0
            Dim value As Byte
            Dim ard As Integer

            If FileName(ab) Is Nothing Then 'solves issue of final (0)
                Exit For
            Else


                'here we convert the image in evdence layer using the
weights
                For ard = 0 To myfile.Length - 1

                    value = myfile(ard)
```

```
                        If value = 0 Then
                            weightedArray(ard) = Wminus(ab)
                        Else
                            weightedArray(ard) = Wplus(ab)
                        End If
                    Next


                    'For y = 0 To imagesize.Height - 1
                    '    For x = 0 To imagesize.Width - 1
                    '        'value = imagesize(a)


                    '        If imagesize.GetPixel(x, y) =
Color.FromArgb(0, 0, 0) Then
                    '            weightedArray(x * y) = Wminus(ab)
                    '        Else
                    '            weightedArray(x * y) = Wplus(ab)
                    '        End If

                    '    Next
                    'Next


                End If

                'now we need to add the evidence layer created to the
prior probability
                'prilogit should be calculated as the ratio D/T the
conversion in ODDS and
                'ln function gives prilogit value
                'I need the deposit layer and the tot number of pixels


                ' Dep = Form5Inst.AD(TextBox8.Text)
                ' Dim Dep_conv As Single = Dep * 0.000269
                Dim priprob As Single = (Dep / (imagesize.Height *
imagesize.Width))
                Dim priOdd As Single = priprob / (1 - priprob)
                Dim con As Single
                con = Math.Log(Double.Parse(priOdd))


                Dim ac As Integer
                Dim priorlogit((imagesize.Height * imagesize.Width) - 1)
As Single 'five

                ' con = Single.Parse(TextBox6.Text)
                For ac = 0 To ((imagesize.Height * imagesize.Width) - 1)
                    priorlogit(ac) = con
                Next
```

```
            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit(ac) = postlogit(ac) + priorlogit(ac) +
weightedArray(ac)
                Else
                    postlogit(ac) = postlogit(ac) + weightedArray(ac)
                End If
                'we get a postlogit value that is the sum of all
images- as postlogit is declared
                'outside the For "ab" loop, each cycle updates its
value

            Next



''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
''''''''''''''''''''''''''''''''''''''''''''''
            'From this point we introduce new code that considers the
missing eveidence
            'the code loads the missing eveidence layer a boolean
image
            'where pixel columns contain missing information the
weights are turned to (0)

            Dim MissingEv As String
            Dim MEArray() As Byte
            Dim test As String =
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value.ToString

            If Not
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value.ToString =
"" Then

                MissingEv =
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value
                MEArray =
My.Computer.FileSystem.ReadAllBytes(MissingEv)
                Array.Reverse(MEArray)
                Array.Resize(MEArray, imagesize.Height *
imagesize.Width)
                'Array.Reverse(MEArray) changed as all others were not
reversed to original like bayes to display purpose

                Dim a As Integer
                For a = 0 To MEArray.Length - 1
                    If Not MEArray(a) = 0 Then
                        'seems that here we turn to 0 all the pixels
that has at least one layer with missing evidence in it
                        'the weightedArray is computed multiple times
for each j layer so we put 0 in each layer with missing
                        'evidence
                        weightedArray(a) = 0
```

```
                    End If
                Next

            End If

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
''''''''''''''''''''''''''''''''''''''
            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit_miss(ac) = postlogit_miss(ac) +
priorlogit(ac) + weightedArray(ac)
                Else
                    postlogit_miss(ac) = postlogit_miss(ac) +
weightedArray(ac)
                End If
                'we get a postlogit value that is the sum of all
images- as postlogit is declared
                'outside the For "ab" loop, each cycle updates its
value

            Next
        Next

        ' I think that here we can insert some code to filter out the
postlogit that are needed for the missing ev.
        ' postlogit will be used as p(d:x)




        'MsgBox(postlogit(postlogit.Length - 1).ToString)
        'Dim am As Integer
        'For am = 0 To postlogit.Length - 1

        '    'we need to convert to integer
        '    'Dim MyDouble As Double = 42.72
        '    'Dim MyInt As Integer = CType(MyDouble, Integer)
        '    '' MyInt has the value of 43.



        'Next

        'For am = 0 To postlogit.Length - 1
        '    My.Computer.FileSystem.WriteAllText("c:\wofe\test",
postlogit(am), True)
        'Next
```

```
        'now we need to rescale the double in a way that we can
generate a byte array

        'Dim ad As Integer
        Dim aq As Integer


        Dim postprob(postlogit.Length - 1) As Single
        Dim postprob_miss(postlogit.Length - 1) As Single
        '  Dim postprobByte(postlogit.Length - 1) As Byte
        For aq = 0 To postlogit.Length - 1
            'we convert to probability
            'postodds= exp(postlogit)
            'postprob= postodds/(1+postodds)


            'this post prob is Pk of Carranza 2004
            postprob(aq) = Math.Exp(postlogit(aq)) / (1 +
Math.Exp(postlogit(aq)))
            postprob_miss(aq) = Math.Exp(postlogit_miss(aq)) / (1 +
Math.Exp(postlogit_miss(aq)))


            'we recover the alghorithm need to be modified the input
as we have to filter out the areas without the
            'missing evidence
            'note that we need just the pixels intersecting a deposit
            'therefore we have to perform the summation of weights
only overlapping with pixel 1 of deposit layer
            'an if statement should work
            'we consider only the weights of layers holding the
missing evidence as the other weights were previously
            'updated, therfore we introduce an updated prior
probability that already considers the weight of layers
            'without missing evidence
        Next

        'These below are two arrays with values of Posterior prob in
case of non-missing or missing evidence
        'We can save these arrays as binary files but this will need
to convert them in a scale of 255 bytes
        PkD = postprob_miss
        PDx = postprob

        If CheckBox1.Checked Then

            BinArcon(PkD)
```

```
            Try
My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"PkD_miss.bin")
            Catch ex As Exception
                File.Delete("c:\wofe\PkD_miss.bin")
My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"PkD_miss.bin")
            End Try
        Else
            PkD = PDx
            File.Delete("c:\wofe\PkD_miss.bin")
        End If

        BinArcon(PDx)
        Try
            My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"PDx.bin")
        Catch ex As Exception
            File.Delete("c:\wofe\PDx.bin")
            My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"PDx.bin")
        End Try




        'Dim acd As Integer
        'Dim counter As Integer
        'Dim d() As Byte =
My.Computer.FileSystem.ReadAllBytes("d.bin")
        'For acd = 0 To postprob.Length - 1
        '    If d(acd) > 0 Then
        '        PkD(counter) = postprob(acd)
        '        counter = counter + 1
        '    End If
        'Next



        'My.Computer.FileSystem.OpenTextFileWriter("Pk.txt", False,
System.Text.Encoding.Unicode)
    End Function



    Private Sub Button12_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button12.Click
        My.Forms.Form6WofeViewer.Close()
        My.Forms.Form6WofeViewer.Show()
    End Sub
```

```
    Private Function SigmaSQ(ByVal FileName() As String, ByVal
sWplus() As Single, ByVal sWminus() As Single) As Integer

        ' I need to firslty select the bitmaps created with convert,
then store the strings in the first column
        'manually we type in the weights and ask for that with a msg
box
        'all is set and ready for the calculation
        'we need to select each row and use the loop to convert the
pixels to an array of weights
        'we need to sum up the images to the prior probability image


        Dim s2SumWeights((imagesize.Height * imagesize.Width) - 1) As
Single

        Dim s2SumWeights_miss((imagesize.Height * imagesize.Width) -
1) As Single

        Dim ab As Integer

        For ab = 0 To FileName.Length - 1
            Dim weightedArray((imagesize.Height * imagesize.Width) -
1) As Single 'six necessary to weight step
            ''''''new code from here
            If FileName(ab) = Nothing Then
                Exit For
            End If
            Dim evidence As Bitmap =
Bitmap.FromFile(FileName(ab).ToString)

            Dim myfile((evidence.Width * evidence.Height) - 1) As Byte
            Dim color As System.Drawing.Color
            Dim county As Integer
            Dim countx As Integer
            Dim s As Integer
            For county = 0 To evidence.Height - 1
                For countx = 0 To evidence.Width - 1
                    color = evidence.GetPixel(countx, county)

                    If CInt(color.B) <> 0 And CInt(color.G) <> 0 And
CInt(color.R) <> 0 Then
                        myfile(s) = 1
                    Else
                        myfile(s) = 0
                    End If

                    s = s + 1
```

```
                Next
            Next
            s = 0
            '''''''''''''to here
            'here we start looping the different layers
            Dim value As Byte
            Dim ard As Integer

            If FileName(ab) Is Nothing Then
                Exit For
            Else

                'here we convert the image in evdence layer using the
weights
                For ard = 0 To myfile.Length - 1

                    value = myfile(ard)

                    If value = 0 Then
                        weightedArray(ard) = Math.Pow(sWminus(ab), 2)
' here we get the variance from the previously calculated standard dev
                    Else
                        weightedArray(ard) = Math.Pow(sWplus(ab), 2)
                    End If
                Next


            End If
            Dim ac As Integer

            'progressively the weights grow
            For ac = 0 To s2SumWeights.Length - 1
                'this result works if no missing evidence is
considered
                s2SumWeights(ac) = s2SumWeights(ac) +
weightedArray(ac)

            Next



            'From this point we introduce new code that considers the
missing eveidence
            'the code loads the missing eveidence layer a boolean
image
            'where pixel columns contain missing information the
weights are turned to (0)

            Dim MissingEv As String
            Dim MEArray() As Byte
            Dim test As String =
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value.ToString
```

```
            If Not
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value.ToString =
"" Then

                MissingEv =
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value
                MEArray =
My.Computer.FileSystem.ReadAllBytes(MissingEv)
                Array.Reverse(MEArray)
                Array.Resize(MEArray, imagesize.Height *
imagesize.Width)
                'Array.Reverse(MEArray) changed as all others were not
reversed to original like bayes to display purpose

                Dim a As Integer
                For a = 0 To MEArray.Length - 1
                    If Not MEArray(a) = 0 Then
                        weightedArray(a) = 0
                    End If
                Next

            End If

            'progressively the weights grow
            For ac = 0 To s2SumWeights.Length - 1
                'this result works if missing evidence is considered
                'note that s2SumWeights_miss is different
                s2SumWeights_miss(ac) = s2SumWeights_miss(ac) +
weightedArray(ac)

            Next
        Next



        Dim cellsz = TextBox9.Text
        Dim s2Pk(PkD.Length - 1) As Single
        Dim arl As Integer
        Dim s2Pk_tot(PkD.Length - 1) As Single
        Dim s2PDx(PDx.Length - 1) As Single
        For arl = 0 To s2SumWeights.Length - 1

            'here we consider missing evidence as not really missing
so we use either positive or negative s2(weights)
            s2PDx(arl) = (((1 / (Dep * cellsz)) + s2SumWeights(arl)) *
Math.Pow(PDx(arl), 2))

            'here we consider the missing evidence as 0 so the s(W)
become 0 when the evidence is missing, this is equivalent to
            'summing up only patterns that have weights on them
            If CheckBox1.Checked Then
                s2Pk(arl) = (((1 / (Dep * cellsz)) +
s2SumWeights_miss(arl)) * Math.Pow(PkD(arl), 2))
```

```
            End If
            'here we get the total s(Pk) adding the re-estimated
influence of missing evidence due to its uncertainty
            'this should improve our error estimate
            'here I want a message box that split the calculation

            If CheckBox1.Checked Then
                s2Pk_tot(arl) = s2Pk(arl) + SigmaSQ_missingev(arl)
            End If

        Next
        'out of this we get 2 matrix one is s2pk and the other is
s2Pk_tot, we have already created the function that
        'converts probability arrays to maps so we just need to
provide the files to that function
        'For uncertainty maps we just then want s2pk and s2Pk_tot
        If CheckBox1.Checked Then
            s2Pkf_miss = Spk_sum(s2Pk_tot)
            BinArcon(s2Pk_tot)
            Try

My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"s2Pk_tot_miss.bin")
            Catch ex As Exception
                File.Delete("c:\wofe\s2Pk_tot_miss.bin")

My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"s2Pk_tot_miss.bin")
            End Try

        End If
        s2Pkf = Spk_sum(s2PDx)
        BinArcon(s2PDx)
        Try
            My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"s2PDx.bin")
        Catch ex As Exception
            File.Delete("c:\wofe\s2PDx.bin")
            My.Computer.FileSystem.RenameFile("c:\wofe\arraybin.bin",
"s2PDx.bin")

        End Try
        'This function provides the final s^2(Pk)results considering
the two cases of missing or non missing evidence,
        ' these also represent the s^2(N{D}pred)
        'remains to estimate the values of N{D} and N{Dpred}, we have
to be careful
        ' as there is a change of variables also during the estimation
of N{D}pred
        'if we consider the missing evidence

    End Function
```

```
    'Public Sub SigmaSQ_missing_evidence()

    '    Dim a As Integer
    '    Dim b(PkD.Length - 1) As Double

    '    For a = 0 To PkD.Length - 1
    '        If PDx(a) - PkD(a) = 0 Then
    '            b(a) = 0
    '        Else
    '            b(a) = Math.Pow((PDx(a) - PkD(a)), 2) '* 'frequency
of occurrence for class deltaPpost(k)(1 / (imagesize.Width *
imagesize.Height) * cellsz)
    '        End If
    '    Next
    '    SigmaSQm = b
    'End Sub


    Private Function Spk_sum(ByVal Input() As Single) As Single
        cellsz = TextBox9.Text

        Dim arr1(Input.Length - 1) As Single
        Input.CopyTo(arr1, 0) 'e.g. s2Pk
        Dim arr2(arr1.Length - 1) As Single
        Dim arr3(arr2.Length - 1) As Single

        Dim b As Integer = 0
        Dim spk As Double = 0
        Array.Sort(arr1)
        Dim a As Integer = Nothing
        'This cycle loop through the array s2Pk and define its classes
that are summarised in arr2
        For a = 0 To arr1.Length - 2
            If Not arr1(a) = arr1(a + 1) Then
                Array.ConstrainedCopy(arr1, a, arr2, b, 1)
                b = b + 1
                arr2(b) = arr1(a + 1) 'classes

            End If
        Next

        Array.Resize(arr2, Array.IndexOf(arr2, Nothing))
        'This cycle counts the number of elements within s2Pk for each
defined class
        For a = 0 To arr2.Length - 1
            For b = 0 To arr1.Length - 1
                If arr2(a) = arr1(b) Then
                    arr3(a) = arr3(a) + 1 'counter
                End If
            Next
        Next
        Array.Resize(arr3, Array.IndexOf(arr3, Nothing))
        Dim arr4(arr2.Length - 1) As Single
```

```
        'This cycle creates an array that computes the square value of
the area of each class mutiplied for its value then finally
        'all the cumulative classes of spk are summed up to get the
total value (this number when is big it means that there might be
overestimation)
        For a = 0 To arr2.Length - 1
            arr4(a) = Math.Pow((arr3(a) * cellsz), 2) * arr2(a)
            spk = spk + arr4(a)
        Next
        'MsgBox((spk), MsgBoxStyle.OKOnly)
        Return spk

    End Function
    Private Sub OminbusTest_NewOminibus()

        'we need to compute the summation of Pk or PDx depending if we
consider missing evidence or not
        'Carranza uses PDx instead of Pk to verify the influence of
missing evidence layers

        Dim cellsz = TextBox9.Text
        Dim a As Integer
        Dim NDpred As Double = 0
        Dim NDpred_m As Double = 0
        For a = 0 To PkD.Length - 1

            NDpred_m = NDpred_m + PkD(a) 'these are not standard
deviations

            NDpred = NDpred + PDx(a)

        Next
        PkD = Nothing
        PDx = Nothing
        Dim OT As Single = 0
        Dim OT_m As Single = 0
        OT = Dep / NDpred
        Label39.Text = OT
        OT_m = Dep / NDpred_m
        Label41.Text = OT_m
        ' MsgBox("OT should be higher than 0.85<< " & "OT  " &
OT.ToString & "OT_m  " & OT_m.ToString)

        Dim NewOT As Single = 0
        Dim NewOT_m As Single = 0

        NewOT_m = ((NDpred_m * cellsz) - (Dep * cellsz)) /
Math.Sqrt(s2Pkf_miss)
        Label45.Text = NewOT_m
        NewOT = ((NDpred * cellsz) - (Dep * cellsz)) /
Math.Sqrt(s2Pkf)
        Label43.Text = NewOT
```

```
        ' MsgBox("NewOT should be lower than 0.7>> " & "NewOT  " &
NewOT.ToString & "NewOT_m  " & NewOT_m.ToString)

        Dim file As System.IO.StreamWriter
        file =
My.Computer.FileSystem.OpenTextFileWriter("c:\wofe\NOT&OT.txt", False)

        file.WriteLine("OT   OT_m")
        file.WriteLine(OT & "   " & OT_m)
        file.WriteLine("NewOT   NewOT_m")
        file.WriteLine(NewOT & "   " & NewOT_m)
        file.Close()


    End Sub

    Public Sub open_dep()
        'Dim myStream As Stream

        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\wofe\"
        selectFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() = DialogResult.OK Then

            Me.TextBox8.Text = selectFileDialog1.FileName


            'myStream = selectFileDialog1.OpenFile()
            'If Not (myStream Is Nothing) Then
            ' Insert code to read the stream here.
            'myStream.Close()
            'End If
        End If



    End Sub


    Private Sub saveToolStripMenuItem_Click(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
saveToolStripMenuItem.Click
        If Me.Validate Then
            Me.Bayes_Data_Source_ModelBindingSource.EndEdit()

Me.Bayes_Data_Source_ModelTableAdapter.Update(Me.BayesDataSet.Bayes_Da
ta_Source_Model)
        Else
```

```
            System.Windows.Forms.MessageBox.Show(Me, "Validation
errors occurred.", "Save", System.Windows.Forms.MessageBoxButtons.OK,
System.Windows.Forms.MessageBoxIcon.Warning)
        End If

        Try
            My.Computer.FileSystem.CopyFile("Bayes.mdb",
"c:\wofe\DataBase\Bayes.mdb")
        Catch ex As Exception

My.Computer.FileSystem.DeleteFile("c:\wofe\DataBase\Bayes.mdb")
            My.Computer.FileSystem.CopyFile("Bayes.mdb",
"c:\wofe\DataBase\Bayes.mdb")
        End Try
    End Sub

    Private Sub exitToolStripMenuItem_Click(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
exitToolStripMenuItem.Click
        Me.Close()
    End Sub

    Private Sub openToolStripMenuItem_Click(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
openToolStripMenuItem.Click
        Try
            My.Computer.FileSystem.CopyFile("Bayes.mdb",
"c:\wofe\DataBase\Bayes.mdb")
        Catch ex As Exception
            Exit Try
        End Try




        'this is to open bmp files and display or manipulate them
        Dim openFileDialog As New OpenFileDialog
        openFileDialog.Filter = "Data Files(*.MDB)" + "|*.MDB;|All
files (*.*)|*.*"
        openFileDialog.FilterIndex = 2
        openFileDialog.RestoreDirectory = True



        If DialogResult.OK = openFileDialog.ShowDialog() Then


            Dim a As String = openFileDialog.FileName
            Try
                My.Computer.FileSystem.RenameFile("Bayes.mdb",
"Bayes_saved.mdb")
            Catch ex As Exception
                My.Computer.FileSystem.DeleteFile("Bayes_saved.mdb")
```

```
                My.Computer.FileSystem.RenameFile("Bayes.mdb",
"Bayes_saved.mdb")
            End Try

            My.Computer.FileSystem.CopyFile(a, "Bayes.mdb")

        ElseIf DialogResult.Cancel Then
            Exit Sub


        End If


        'TODO: This line of code loads data into the
'FirstDatabaseDataSet.sysdiagrams' table. You can move, or remove it,
as needed.

Me.Bayes_Data_Source_ModelTableAdapter.Fill(Me.BayesDataSet.Bayes_Data
_Source_Model)



        '    bmpImage = CType(Bitmap.FromFile(openFileDialog.FileName,
False), Bitmap)
        '    Me.AutoScroll = False
        '     ' Me.AutoScrollMinSize = New Size(CInt(bmpImage.Width *
curZoom), CInt(bmpImage.Height * curZoom))
        '     ' Me.Invalidate()
        '     ' zoomMode = True
        'End If
        '' curRect = New Rectangle(0, 0, bmpImage.Width,
bmpImage.Height)
        ''originalSize.Width = bmpImage.Width
        ''originalSize.Height = bmpImage.Height
    End Sub

    Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        'TODO: This line of code loads data into the
'BayesDataSet.Bayes_Data_Source_Model' table. You can move, or remove
it, as needed.

Me.Bayes_Data_Source_ModelTableAdapter.Fill(Me.BayesDataSet.Bayes_Data
_Source_Model)
    End Sub

    Private Sub bindingNavigatorSaveItem_Click_1(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
bindingNavigatorSaveItem.Click
        If Me.Validate Then
            Me.Bayes_Data_Source_ModelBindingSource.EndEdit()
```

```
Me.Bayes_Data_Source_ModelTableAdapter.Update(Me.BayesDataSet.Bayes_Da
ta_Source_Model)
        Else
            System.Windows.Forms.MessageBox.Show(Me, "Validation
errors occurred.", "Save", System.Windows.Forms.MessageBoxButtons.OK,
System.Windows.Forms.MessageBoxIcon.Warning)
        End If
        Try
            My.Computer.FileSystem.CopyFile("Bayes.mdb",
"c:\wofe\DataBase\Bayes.mdb")
        Catch ex As Exception

My.Computer.FileSystem.DeleteFile("c:\wofe\DataBase\Bayes.mdb")
            My.Computer.FileSystem.CopyFile("Bayes.mdb",
"c:\wofe\DataBase\Bayes.mdb")
        End Try
    End Sub

    Private Sub Bayes_Data_Source_ModelDataGridView_MouseWheel(ByVal
sender As Object, ByVal e As System.Windows.Forms.MouseEventArgs)
Handles Bayes_Data_Source_ModelDataGridView.MouseWheel
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\"
        selectFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        'If selectFileDialog1.ShowDialog() = DialogResult.Cancel Then
        '    Exit Sub
        If selectFileDialog1.ShowDialog() = DialogResult.OK Then

            Me.Bayes_Data_Source_ModelDataGridView.CurrentCell.Value =
selectFileDialog1.FileName

            '    'myStream = selectFileDialog1.OpenFile()
            '    'If Not (myStream Is Nothing) Then
            '    ' Insert code to read the stream here.
            '    'myStream.Close()
        End If
    End Sub


    Private Function BinArcon(ByVal input() As Single) As Byte

        'This function is a generalisation of the second part of the
Bayes alghorithm, it is designed to solve a problem of
        'compatibility between arrays and bmp files, basically we need
a conversion from single to byte
        'The main difficulty is that this conversion has to represent
probability in a scale of 255 colors.
```

```
        'Casting of single withought rescaling will likely reduce all
the array values to 0. Therfore it is useful to
        'firstly define the minimum value of the array then multiply
for an appropriate scaling factor to
        'obtain a range of values large than delta255
        'We need a string to save the name of each output file


        Dim ad As Integer


        Dim postprobByte(input.Length - 1) As Byte
        Dim rescale(input.Length - 1) As Single

        Array.Copy(input, rescale, input.Length)
        Array.Sort(rescale)

        Dim min As Single = rescale(0)
        Dim max As Single = rescale(rescale.Length - 1)

        My.Computer.FileSystem.WriteAllText("c:\wofe\scale_M.txt",
"min = " & min.ToString & "max = " & max.ToString, False)

        For ad = 0 To input.Length - 1

            ' we shift or translate the scale to get a minimum of 0
            'min must become firslty equal to 1 so if min*x=1
            Dim alfa As Single = (1 / min)
            input(ad) = input(ad) * alfa
            input(ad) = (input(ad) - (min * alfa))
            input(ad) = (input(ad) * 255) / ((max * alfa) - (min *
alfa))
            postprobByte(ad) = CByte((input(ad)))
            input(ad) = (input(ad) * ((max * alfa) - (min * alfa))) /
255
            input(ad) = (input(ad) + (min * alfa))
            input(ad) = input(ad) / alfa
        Next


        Dim response As MsgBoxResult = MsgBox("Binary conversion
completed, would you like to save the file?", MsgBoxStyle.YesNo)

        If response = MsgBoxResult.Yes Then

            Dim saveFileDialog1 As New SaveFileDialog()

            saveFileDialog1.InitialDirectory = "c:\wofe\"
            saveFileDialog1.Filter = "bin files (*.bin)|*.bin|All
files (*.*)|*.*"
            saveFileDialog1.FilterIndex = 2
            saveFileDialog1.RestoreDirectory = True
```

```
            If saveFileDialog1.ShowDialog() = DialogResult.OK Then

My.Computer.FileSystem.WriteAllBytes((saveFileDialog1.FileName),
postprobByte, False)
            End If
        Else

My.Computer.FileSystem.WriteAllBytes("c:\wofe\arraybin.bin",
postprobByte, False)
        End If

    End Function

    Private Sub Button11_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button11.Click

        'This function save a bmp file of an array of posteriror
probability
        'Dim myStream As Stream
        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "c:\wofe\"
        selectFileDialog1.Filter = "bin files (*.bin)|*.bin|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True
        'first dialog fpr selection of binary array to map
        If selectFileDialog1.ShowDialog() = DialogResult.OK Then

            Dim name As String = selectFileDialog1.FileName


            Dim postprobByte() As Byte =
My.Computer.FileSystem.ReadAllBytes(name)
            MsgBox("Please select reference (rows*column bmp file)",
MsgBoxStyle.OKOnly)
            'Array.Reverse(postprobByte)

            'second dialogue box for selection of a bmp as reference
            Dim selectFileDialog2 As New OpenFileDialog()

            selectFileDialog2.InitialDirectory = "c:\wofe\"
            selectFileDialog2.Filter = "bmp files (*.bmp)|*.bmp|All
files (*.*)|*.*"
            selectFileDialog2.FilterIndex = 2
            selectFileDialog2.RestoreDirectory = True

            If selectFileDialog2.ShowDialog() = DialogResult.OK Then

                'There might be a problem with loading this binary
file in term of header
                bayesmap = Bitmap.FromFile(selectFileDialog2.FileName)
                Dim x As Integer
```

```
                Dim y As Integer
                Dim count As Integer = 0

                '(bayesmap.Width - 1) - inverted also y with x


                For y = 0 To bayesmap.Height - 1
                    For x = 0 To bayesmap.Width - 1
                        bayesmap.SetPixel(x, y,
Color.FromArgb(postprobByte(count), postprobByte(count),
postprobByte(count)))
                        count = count + 1
                    Next
                Next

                File.Delete(name & ".bmp")
                bayesmap.Save(name & ".bmp")

                MsgBox("Map completed and saved in " & name & ".bmp")
            End If
        End If
    End Sub

    Private Sub Button14_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button14.Click
        'This routine is compiled to solve the problem of calculating
the additional error seen as variance of the posterior
        'probability. The objective is to create a function that input
info from the datagrid view
        'in particular the weights and the relative missing patterns,
in term of number and area

        'Here we select the patterns with missing evidence
        'start new ot ot

        Try
            cell = Me.TextBox9.Text
        Catch ex As Exception
            MsgBox("Please provide cell size")
            Exit Sub
        End Try

        d = Nothing
        PkD = Nothing
        PDx = Nothing

        SigmaSQm = Nothing
        s2Pk = Nothing
        s2Pkf = Nothing
        s2Pkf_miss = Nothing
        Dep = Nothing
        bmpsizepub = Nothing
        AD_w = Nothing
```

```
        AI_w = Nothing
        AG_w = Nothing
        AT_w = Nothing 'shared variables expressing areas as cell
numbers; they work in all sub routines

        Dim a As Integer
        'Dim b As Integer

        Dim FileName(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As String
        Dim Wplus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim Wminus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim sWplus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim sWminus(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim MissEv(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
String

        Dim FileName_r(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As String
        Dim Wplus_r(Bayes_Data_Source_ModelDataGridView.Rows.Count) As
Single
        Dim Wminus_r(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As Single
        Dim sWplus_r(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As Single
        Dim sWminus_r(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As Single
        Dim MissEv_r(Bayes_Data_Source_ModelDataGridView.Rows.Count)
As String


        For a = 0 To Bayes_Data_Source_ModelDataGridView.Rows.Count
            'DBnull
            Try
                If
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(3).Value Is
System.DBNull.Value Then
                    Exit Try
                End If
                FileName(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(6).Value
                Wplus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(1).Value
                Wminus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(2).Value
                sWplus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(4).Value
```

```
                sWminus(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(5).Value
                MissEv(a) =
Bayes_Data_Source_ModelDataGridView.Rows(a).Cells(3).Value

            Catch : Exit For

            End Try

        Next

        Dim b As Integer
        For a = 0 To FileName.Length - 1
            If FileName(a) <> Nothing Then
                FileName_r(b) = FileName(a)
                Wplus_r(b) = Wplus(a)
                Wminus_r(b) = Wminus(a)
                sWplus_r(b) = sWplus(a)
                sWminus_r(b) = sWminus(a)
                MissEv_r(b) = MissEv(a)

                b = b + 1
            Else



            End If
        Next
        ' we need to reduce FileName to just the layer with missing
evidence in it
        missing_evidence(FileName_r, Wplus_r, Wminus_r, MissEv_r)


    End Sub

    Private Function missing_evidence(ByVal FileName_r() As String,
ByVal Wplus_r() As Single, ByVal Wminus_r() As Single, ByVal
MissEv_r() As String) As Integer

        'looks fine
        'here we use the first part of bayes to get the value of
posterior probability
        'we have to use the postlogit array as prior probability when
we calculate P(d:x)
        'and P(d)
        'weights are automatically picked from the data grid view, but
the arrays with final summation of weights
        'has to be stripped of values that are not included within
deposits and missing evidence ???
        'we need to input a layer representing the area of missing
evidence = bmp indexed image then perform a boolean with
        'deposit and this layer to get only values useful for the
calculation, we consider only missing evidence as we are
```

```
        'using it to calculate the posterior probability resulting
when missing evidence is intersected
        'therefore a cumulative area obtained combining all the
missing evidence on a single layer positively defines
        'the pixel where this calculation is meaningfull
        'in any case we cannot calculate sigma^2(p) for missing
eveidence if there is no missing evidence
        Dim Form5Inst As New Form5
        Dim SigmaSQ2(imagesize.Height * imagesize.Width - 1) As Double
        Dep = Form5Inst.AD(TextBox8.Text)
        imagesize = Bitmap.FromFile(FileName_r(0))

        'Static header() As Byte 'on



        'four
        'six necessary to weight step
        ' Static rescale((imagesize.Height * imagesize.Width) - 1) As
Single 'seven

        Dim ab As Integer
        For ab = 0 To FileName_r.Length - 1
            Dim weightedArray((imagesize.Height * imagesize.Width) -
1) As Single
            Dim postlogit((imagesize.Height * imagesize.Width) - 1) As
Single
            Dim postlogit_miss((imagesize.Height * imagesize.Width) -
1) As Single
            Dim postlogit_wplus((imagesize.Height * imagesize.Width) -
1) As Single
            Dim postlogit_wminus((imagesize.Height * imagesize.Width)
- 1) As Single


            Try
                ' imagesize = Bitmap.FromFile(FileName(ab))
                myfile =
My.Computer.FileSystem.ReadAllBytes(FileName_r(ab)) 'may need to
string -- 'three
            Catch : Exit Try
            End Try

            'need to strip the header
            ' Dim headerfile() As Byte =
My.Computer.FileSystem.ReadAllBytes("c:\wofe\imageheader.bmp")
            'header = headerfile
            'Array.Resize(header, (headerfile.Length -
(imagesize.Height * imagesize.Width)))
            Array.Reverse(myfile)
            Array.Resize(myfile, (imagesize.Height * imagesize.Width))
            'Array.Reverse(myfile)
```

```
            'here we start looping the different layers

            'Dim x As Integer
            'Dim y As Integer
            Dim value As Byte
            Dim ard As Integer

            If FileName_r(ab) Is Nothing Then 'solves issue of final
(0)
                Exit For
            Else


                'here we convert the image in evdence layer using the
weights
                For ard = 0 To myfile.Length - 1

                    value = myfile(ard)

                    If value = 0 Then
                        weightedArray(ard) = Wminus_r(ab)
                    Else
                        weightedArray(ard) = Wplus_r(ab)
                    End If
                Next



                'For y = 0 To imagesize.Height - 1
                '    For x = 0 To imagesize.Width - 1
                '        'value = imagesize(a)


                '        If imagesize.GetPixel(x, y) =
Color.FromArgb(0, 0, 0) Then
                '            weightedArray(x * y) = Wminus(ab)
                '        Else
                '            weightedArray(x * y) = Wplus(ab)
                '        End If

                '    Next
                'Next


            End If

            'now we need to add the evidence layer created to the
prior probability
            'prilogit should be calculated as the ratio D/T the
conversion in ODDS and
```

```
            'ln function gives prilogit value
            'I need the deposit layer and the tot number of pixels


            ' Dep = Form5Inst.AD(TextBox8.Text)
            ' Dim Dep_conv As Single = Dep * 0.000269
            Dim priprob As Single = (Dep / (imagesize.Height *
imagesize.Width))
            Dim priOdd As Single = priprob / (1 - priprob)
            Dim con As Single
            con = Math.Log(Double.Parse(priOdd))


            Dim ac As Integer
            Dim priorlogit((imagesize.Height * imagesize.Width) - 1)
As Single 'five

            ' con = Single.Parse(TextBox6.Text)
            For ac = 0 To ((imagesize.Height * imagesize.Width) - 1)
                priorlogit(ac) = con
            Next

            'For ac = 0 To postlogit.Length - 1
            '    If ab = 0 Then
            '        postlogit(ac) = postlogit(ac) + priorlogit(ac) +
weightedArray(ac)
            '    Else
            '        postlogit(ac) = postlogit(ac) + weightedArray(ac)
            '    End If
            '    'we get a postlogit value that is the sum of all
images- as postlogit is declared
            '    'outside the For "ab" loop, each cycle updates its
value

            'Next



''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
''''''''''''''''''''''''''''''''''''''''''''''
            'From this point we introduce new code that considers the
missing eveidence
            'the code loads the missing eveidence layer a boolean
image
            'where pixel columns contain missing information the
weights are turned to (0)

            Dim MissingEv As String
            Dim MEArray() As Byte
            '  Dim test As String =
Bayes_Data_Source_ModelDataGridView.Rows(ab).Cells(3).Value.ToString
```

```
            MissingEv = MissEv_r(ab)
            MEArray = My.Computer.FileSystem.ReadAllBytes(MissingEv)
            Array.Reverse(MEArray)
            Array.Resize(MEArray, imagesize.Height * imagesize.Width)
            'Array.Reverse(MEArray) changed as all others were not
reversed to original like bayes to display purpose

            Dim a As Integer
            For a = 0 To MEArray.Length - 1
                If Not MEArray(a) = 0 Then
                    'seems that here we turn to 0 all the pixels that
has at least one layer with missing evidence in it
                    'the weightedArray is computed multiple times for
each j layer so we put 0 in each layer with missing
                    'evidence
                    weightedArray(a) = 0

                End If
            Next


''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
''''''''''''''''''''''''''''''''''''''''
            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit_miss(ac) = postlogit_miss(ac) +
priorlogit(ac) + weightedArray(ac)
                Else
                    postlogit_miss(ac) = postlogit_miss(ac) +
weightedArray(ac)
                End If
                'we get a postlogit value that is the sum of all
images- as postlogit is declared
                'outside the For "ab" loop, each cycle updates its
value

            Next


            'LOOP to change to W+


            For a = 0 To MEArray.Length - 1
                If Not MEArray(a) = 0 Then
                    'seems that here we turn to 0 all the pixels that
has at least one layer with missing evidence in it
                    'the weightedArray is computed multiple times for
each j layer so we put 0 in each layer with missing
                    'evidence
                    weightedArray(a) = Wplus_r(ab)
```

```
                End If
            Next


'''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
'''''''''''''''''''''''''''''''''''''''
            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit_wplus(ac) = postlogit_wplus(ac) +
priorlogit(ac) + weightedArray(ac)
                Else
                    postlogit_wplus(ac) = postlogit_wplus(ac) +
weightedArray(ac)
                End If
                'we get a postlogit value that is the sum of all
images- as postlogit is declared
                'outside the For "ab" loop, each cycle updates its
value

            Next


            'LOOP to change to W-


            For a = 0 To MEArray.Length - 1
                If Not MEArray(a) = 0 Then
                    'seems that here we turn to 0 all the pixels that
has at least one layer with missing evidence in it
                    'the weightedArray is computed multiple times for
each j layer so we put 0 in each layer with missing
                    'evidence
                    weightedArray(a) = Wminus_r(ab)
                End If
            Next


'''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
'''''''''''''''''''''''''''''''''''''''
            For ac = 0 To postlogit.Length - 1
                If ab = 0 Then
                    postlogit_wminus(ac) = postlogit_wminus(ac) +
priorlogit(ac) + weightedArray(ac)
                Else
                    postlogit_wminus(ac) = postlogit_wminus(ac) +
weightedArray(ac)
                End If
                'we get a postlogit value that is the sum of all
images- as postlogit is declared
                'outside the For "ab" loop, each cycle updates its
value
```

```
            Next

            'now we have all three Pprob we need for the calculation
the area where the jth layer with Pattern Bj has 1 and the area with 0
value
            'which is negBj

            'Calculation of AreaBj
            'For this we need the file path we call the binary file
and use a bit counter to find out the number of 0 and 1



            Dim r As Integer
            'Here we need some code that cleans up the bitmaps for us,
we declare 2 new myarrays that will be locally storing
            'the original BMP in binary format. Then we get the data
out of them and feed SumArray
            Dim PatternBj() As Byte =
My.Computer.FileSystem.ReadAllBytes(FileName_r(ab)) 'we call the file
with missing evidence




            r = (imagesize.Height * imagesize.Width) ' the number of
cells needed to get the number of good data pixels




            'tronca arrays con remove command

            Array.Reverse(PatternBj)
            Array.Resize(PatternBj, r)
            Array.Reverse(PatternBj)

            Dim b As Integer = 0
            Dim Sum As Single = 0

            ' algebric sum of array (PatternBj) we get just 1s not 0
counted, therfore the area of cells containing the pattern
            For b = 0 To PatternBj.Length - 1
                Sum = Sum + PatternBj(b) '-1 is inserted as the array
starts from 0
            Next b

            Dim AreaPattern As Single = Sum
```

```
            Dim Area_emptyPattern As Single = (r - AreaPattern)



            'estimation of postbrob for the 3 postlogits

            Dim aq As Integer

            Try

                weightedArray = Nothing

                Dim postprob_wminus(postlogit.Length - 1) As Single
                Dim postprob_miss(postlogit.Length - 1) As Single
                Dim postprob_wplus(postlogit.Length - 1) As Single


                '  Dim postprobByte(postlogit.Length - 1) As Byte
                For aq = 0 To postlogit.Length - 1
                    'we convert to probability
                    'postodds= exp(postlogit)
                    'postprob= postodds/(1+postodds)


                    'this post prob is Pk of Carranza 2004
                    postprob_wplus(aq) = Math.Exp(postlogit_wplus(aq))
/ (1 + Math.Exp(postlogit_wplus(aq)))
                    postprob_wminus(aq) =
Math.Exp(postlogit_wminus(aq)) / (1 + Math.Exp(postlogit_wminus(aq)))
                    postprob_miss(aq) = Math.Exp(postlogit_miss(aq)) /
(1 + Math.Exp(postlogit_miss(aq)))


                Next

                'sigmasq(Pk)= (P(DBj)-Pk)^2 * PBJ + (P(BnegBj)-Pk)^2 *
PnegBj


                cellsz = TextBox9.Text

                For a = 0 To postlogit.Length - 1
                    SigmaSQ2(a) = (Math.Pow((postprob_wplus(a) -
postprob_miss(a)), 2) * ((AreaPattern * cellsz) / (imagesize.Height *
imagesize.Width)) + (Math.Pow((postprob_wminus(a) - postprob_miss(a)),
2) * (Area_emptyPattern * cellsz) / ((imagesize.Height *
imagesize.Width))))
                Next
            Catch ex As Exception
                Exit Function
            End Try
```

```
        Next

        SigmaSQ_missingev = SigmaSQ2
        MsgBox("missing evidence calculated!")
    End Function


End Class
'remember that inside the buttons we have the code that defines the
order of use of such functionalities
#End Region
```

C.2. Spatial Analyser

Compiled in VB 2005 (Express Edition)

```
Software used to compute minimum Euclidean distances (Chapter 6)

Imports System.IO
Imports System.Text
Imports System
Imports System.Drawing
Imports System.Drawing.Printing
Imports System.Collections
Imports System.ComponentModel
Imports System.Windows.Forms

Public Class Form1

    Dim breccia() As Double
    Dim faults() As Double
    Dim deltaMin() As Double

    'Array gen
    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button1.Click
        'the button is used to convert a txt file to an array of data
in double format
        'we need a the initialisation of the butto to get access to
the hard drive and select the file

        Dim selectFileDialog1 As New OpenFileDialog()

        selectFileDialog1.InitialDirectory = "C:\Documents and
Settings\Leonardo\My Documents"
```

```
        selectFileDialog1.Filter = "txt files (*.txt)|*.txt|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() =
Windows.Forms.DialogResult.OK Then
            TextBox1.Text = selectFileDialog1.FileName

            'we need a call to the file that we host in a string
            Dim mystring As String =
My.Computer.FileSystem.ReadAllText(TextBox1.Text)
            'This command split the string in an array of string
containing xyz separated by space
            Dim mystring2() As String = Split(mystring,
Environment.NewLine)

            Dim a As Integer
            Dim b As Integer
            Dim mystring4((mystring2.Length) * 3) As Double
            'the loop is used to split more all data are charging a
single array
            For a = 0 To ((mystring2.Length - 1) * 3)
                Dim mystring3() As String = Split(mystring2(b), " ")
                mystring4(a) = Double.Parse(mystring3(0))
                mystring4(a + 1) = Double.Parse(mystring3(1))
                mystring4(a + 2) = Double.Parse(mystring3(2))
                a = a + 2
                'as b is always very small compared to a then it is
reasonable the use of b in the same loop
                'the problem would be that the loop is based on a
therefore if a ends earlier than b then
                b = b + 1
                If mystring2(b) = "" Then Exit For
            Next
            breccia = mystring4
            While breccia(breccia.Length - 1) = 0
                Array.Resize(breccia, breccia.Length - 1)
            End While

        End If
    End Sub
    'Array gen
    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button2.Click
        'the button is used to convert a txt file to an array of data
in double format
        'we need a the initialisation of the butto to get access to
the hard drive and select the file

        Dim selectFileDialog1 As New OpenFileDialog()
```

```
        selectFileDialog1.InitialDirectory = "C:\Documents and
Settings\Leonardo\My Documents"
        selectFileDialog1.Filter = "txt files (*.txt)|*.txt|All files
(*.*)|*.*"
        selectFileDialog1.FilterIndex = 2
        selectFileDialog1.RestoreDirectory = True

        If selectFileDialog1.ShowDialog() =
Windows.Forms.DialogResult.OK Then
            TextBox2.Text = selectFileDialog1.FileName

            'we need a call to the file that we host in a string
            Dim mystring As String =
My.Computer.FileSystem.ReadAllText(TextBox2.Text)
            Dim mystring2() As String = Split(mystring,
Environment.NewLine)

            Dim a As Integer
            Dim b As Integer
            Dim mystring4(((mystring2.Length) * 5)) As Double
            'the loop is used to split more all data are charging a
single array
            For a = 0 To (mystring2.Length * 5)
                Dim mystring3() As String = Split(mystring2(b), " ")
                mystring4(a) = Double.Parse(mystring3(0))
                mystring4(a + 1) = Double.Parse(mystring3(1))
                mystring4(a + 2) = Double.Parse(mystring3(2))
                mystring4(a + 3) = Double.Parse(mystring3(3))
                mystring4(a + 4) = Double.Parse(mystring3(4))

                a = a + 4
                b = b + 1
                If b > mystring2.Length - 1 Then Exit For
                If mystring2(b) = "" Then Exit For
            Next
            faults = mystring4
            While faults(faults.Length - 1) = 0
                Array.Resize(faults, faults.Length - 1)
            End While


        End If


    End Sub
    'Algorithm to compute minimum distances between the two pointsets
    Private Sub MainAlgho()
        'variables
        Dim a As Integer

        Dim xb As Double
        Dim yb As Double
        Dim zb As Double
```

```
        Dim xf As Double
        Dim yf As Double
        Dim zf As Double
        'clear txt file
        Dim file As System.IO.StreamWriter
        file = My.Computer.FileSystem.OpenTextFileWriter("c:\spatial
data\results.txt", False)
        file.WriteLine("")
        file.Close()
        'loops to select the coordinates to compute distance, store
distances on delta

        For a = 0 To breccia.Length - 1
            xb = breccia(a)
            yb = breccia(a + 1)
            zb = breccia(a + 2)

            a = a + 2

            Dim b As Integer = 0
            Dim c As Integer = 0
            Dim delta(faults.Length - 1) As Double 'delta lasts only
inside the b loop
            Dim deltacopy(faults.Length - 1) As Double
            For b = 0 To faults.Length - 1

                xf = faults(b)
                yf = faults(b + 1)
                zf = faults(b + 2)
                b = b + 4
                'delta gets all the distances of a single cbx point
                delta(c) = distance(xb, yb, zb, xf, yf, zf)
                c = c + 1
            Next

            'copy delta for index search
            Array.Copy(delta, deltacopy, delta.Length - 1)
            'sort delta to get a minimum
            Array.Resize(delta, c - 1)
            Array.Sort(delta)

            'compute index and retrive d1 and d2 on faults array
            Dim index As Integer = Array.IndexOf(deltacopy, delta(0))

            Dim d1 As Double = faults((index * 5) + 3)
            Dim d2 As Double = faults((index * 5) + 4)


            'write halt instruction in case of 0 or multiple equal
minimum values
            If delta(0) = 0 Or delta(0) = delta(1) Then
                'export values on a file text that is progressively
updated for each breccia loop in case of 0 or multiple
```

```
                file =
My.Computer.FileSystem.OpenTextFileWriter("c:\spatial
data\results.txt", True)
                file.WriteLine(xb & "     " & yb & "     " & zb & "     "
& d1 & "     " & d2 & "     " & delta(0) & "   err")
                file.Close()

                'export values on a file text that is progressively
updated for each breccia loop
            Else
                file =
My.Computer.FileSystem.OpenTextFileWriter("c:\spatial
data\results.txt", True)
                file.WriteLine(xb & "     " & yb & "     " & zb & "     "
& d1 & "     " & d2 & "     " & delta(0))
                file.Close()
            End If



        Next
        MsgBox("Computation completed!")
    End Sub

    Function distance(ByVal xb As Double, ByVal yb As Double, ByVal zb
As Double, ByVal xf As Double, ByVal yf As Double, ByVal zf As Double)
        'Euclidean formula
        Dim dist As Double = Math.Sqrt((Math.Pow(xb - xf, 2)) +
(Math.Pow(yb - yf, 2)) + (Math.Pow(zb - zf, 2)))
        Return dist
    End Function

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e
As System.EventArgs) Handles Button3.Click
        Me.mainAlgho()
    End Sub
End Class
```

APPENDIX D

Table D.1. Summary of rock specimens used in this thesis, illustrating their relative location, age, lithology and stratigraphic collocation.

Specimen ID	*Location*	*Easting**	*Northing*	*Age***	*Lithotype*	*Stratigraphic Unit*	*Chapter*	*Figure*
CDH 114	PCM 338(171.41 m)	47132.61	27873.7	MP	Siltstone/Shale	Pmh4s	3	5a
CDH83	PCM325(271.17 m)	46849.8	27850.56	MP	Siltstone/Shale	Pmh4s	3	5b
CDH85	PCM325(235.20 m)	46849.8	27850.56	MP	Shale	Pmh4s	3	5c
HSCM103	Century Mine (St4)	47430	27460	MP	Shale	Pmh4s	3	5d
HSCMT	Century Mine (St4)	47400	27550	MP	Mudstone/Siltstone	Pmh4s	3	5e
RLWL01	Watson's Lode	246462	7916970	MP	Qtz/Sid vein	Pmh3	3	6c
RLWL02	Watson's Lode	246301	7916930	MP	Qtz vein	Pmh3	3	6d
RLSK-BC35786	Silver King	245470	7925470	MP	Qtz/Sulph. infill	Pmh2	3	6e
RLWL-BC35780	Watson's Lode	246211	7916340	MP	Siltstone/Qtz vein	Pmh3	3	6f
HSCM32	Century Mine (St4)	47320	27500	MP	Siltstone/Shale	Pmh4s	5	2a
HSCM106	Century Mine (St4)	47410	27590	MP	Siltstone/Shale	Pmh4s	5	2b
HSCM109	Century Mine (St4)	47460	27510	MP	Siltstone/Shale	Pmh4s	5	2c
HSCM111	Century Mine (St4)	47340	25530	MP	Siltstone/Shale	Pmh4s	5	2e
HSCM33	Century Mine (St4)	47560	27313	MP	Siltstone/Shale	Pmh4s	5	2f
HSCML69	Century Mine (St4)	46920	28220	MC	CBX breccia	Thorntonia Limestones	6	11a
HSCML63	Century Mine (St4)	47070	28260	MC	MB Marl breccia	Thorntonia Limestones	6	11b
CDH55	PCM302(168 m)	47070	28250	MC	CLS nodular limestone	Thorntonia Limestones	6	11d
HSLHA67	Lawn Hill Annulus	251460	7928439	MC	Sandstone	Thorntonia Limestones	6	11e
HSCML64	Century Mine (St4)	46980	28240	MC	Karst breccia	Thorntonia Limestones	6	11f
LHCSO1	Lawn Hill Annulus	251049	7933520	MP	Siltstone	Pmh4s	6	25b

* Easting and Northing expressed either as AMG84 coordinates or Mine Grid coordinates.
** MP = Mesoproterozoic, MC = Middle Cambrian.

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A Visual Basic Express tool to perform 3D Weights of Evidence Modelling

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Numerical Models of Extensional Deformation, Heat Transfer, and Fluid Flow across Basement-Cover Interfaces during Basin-Related Mineralization

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