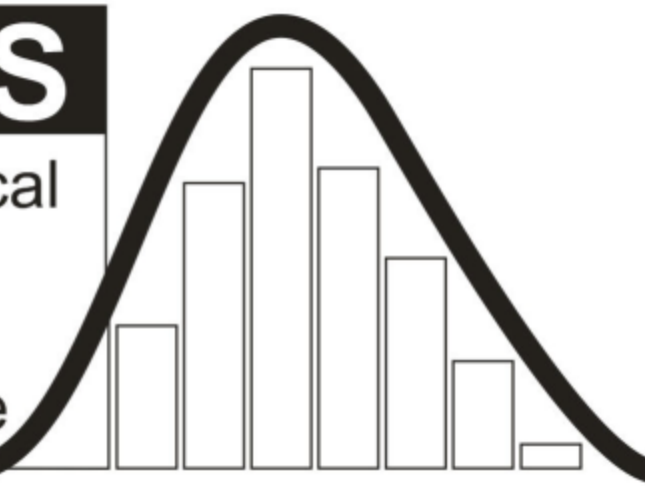


# GIAS

Geological  
Image  
Analysis  
Software



## ***GIAS version 2***

*Geological Image Analysis Software*  
How to use it

© Ciaran Beggan and Christopher Hamilton  
March 2012  
[www.geoanalysis.org](http://www.geoanalysis.org)

# Running the application

- In MATLAB
  - Add the GIAS directory and sub-directories to your path (along with the *Mcode* and *skdata* directories)
  - On the command line type: `GIAS_v2`
  - You should see the GIAS GUI appear within a few seconds


# Panels/Tabs (1)

- Input panel:
  - Open files, select processing parameters and options
- Image Analysis Tab:
  - Used for image processing statistics
- Nearest Neighbor Analysis Tab:
  - Used for nearest neighbor statistics
- Planetary NN Tab:
  - Used for analysis of planetary-scale datasets

# Panels/Tabs (2)

Inputs panel

Geological Image Analysis Software



Load Data

Process >>

Save Results ...

Quit

**Input Parameters**

☐ Invert Input Image

☐ NN Input Image

☐ NN Centroid List

☐ Planetary Data

**Detection Parameters**

Minimum Object Area: 10

Maximum Object Area: Max

Black / White Threshold Level: 0 Low / High 250

Normalized Poisson Threshold: 0

**Spatial Parameters**

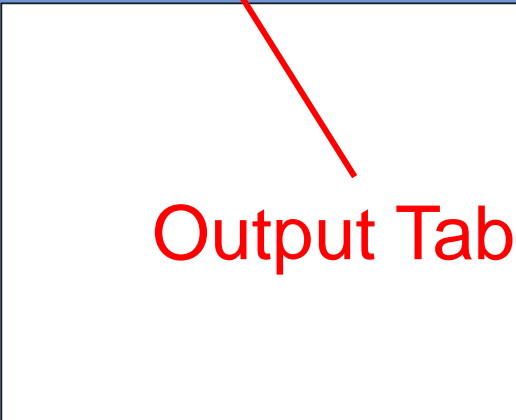
Pixel Size: 1 m Pixel Units

☒ Ignore Hull Boundary Objects

☐ Enter Hull Area in units

Image Analysis | **Nearest Neighbor Analysis** | Planetary NN

**Nearest Neighbor Frequency Distribution**



**R statistic plot**

R Threshold (1  $\sigma$ ):

R Threshold (2  $\sigma$ ):

**C statistic plot**

C Threshold (1  $\sigma$ ):

C Threshold (2  $\sigma$ ):

**Model Selection (Re)**

☒ Poisson ☐ Scavanged k = 1

☐ Normalised Poisson ☐ Scavanged k = 2

**Nearest Neighbor Results (Ra)**

Total: Std (data): Re:

Minimum: Std:

Maximum: Skewness: R:

Mean (Ra): Kurtosis: C:

**Skew vs Kurtosis plot**

Skew:

Kurtosis:

Bin Size: ☒ Default ☐ Custom 5 mm

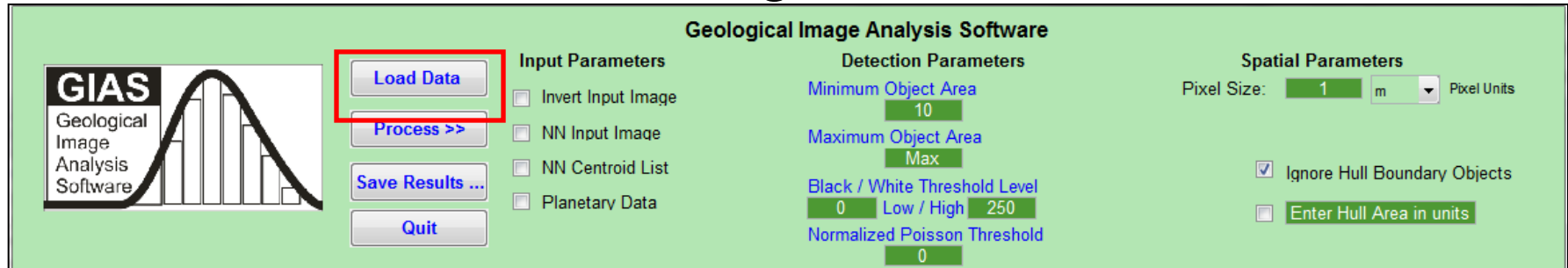
X Axis: ☒ Default ☐ Custom Min mm Max mm

Y Axis: ☒ Linear ☐ Log ☐ Cust... Max

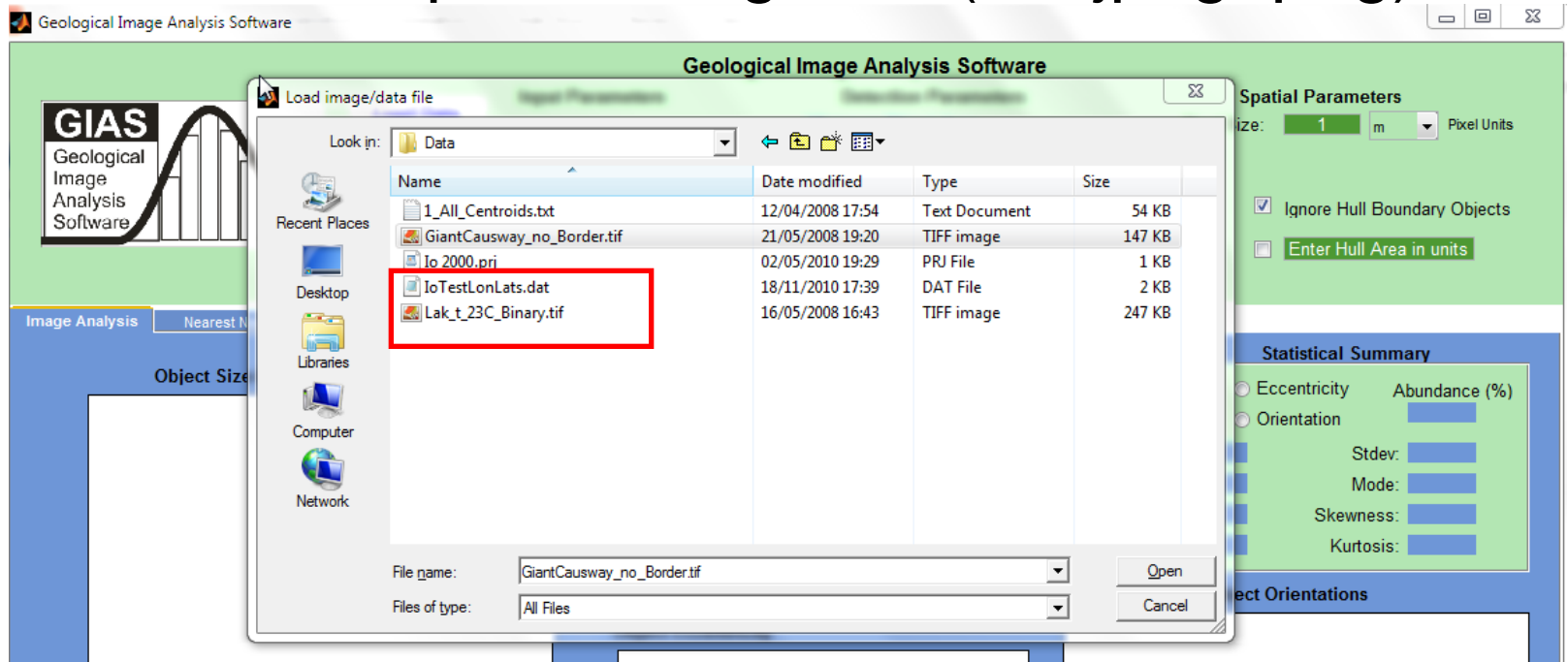
Output Tabs

# Opening an image

- Click on the 'Load Image' button

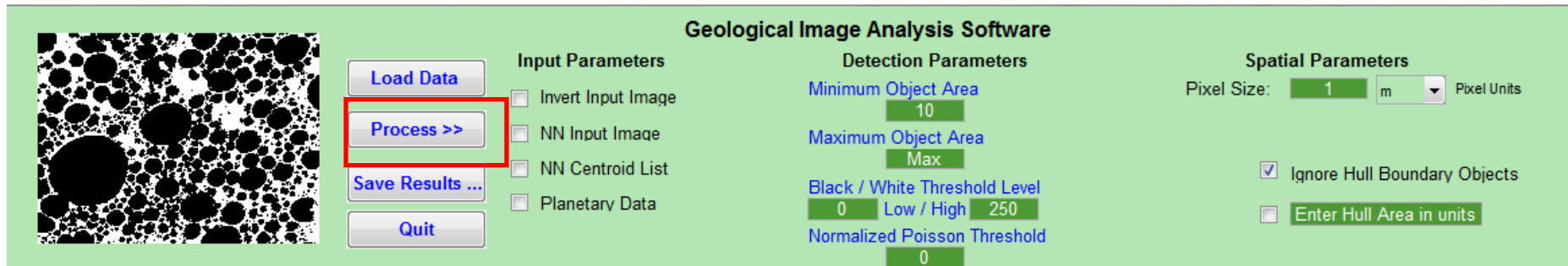


- Select the required image file (tiff, jpeg, png)



# Processing the Image

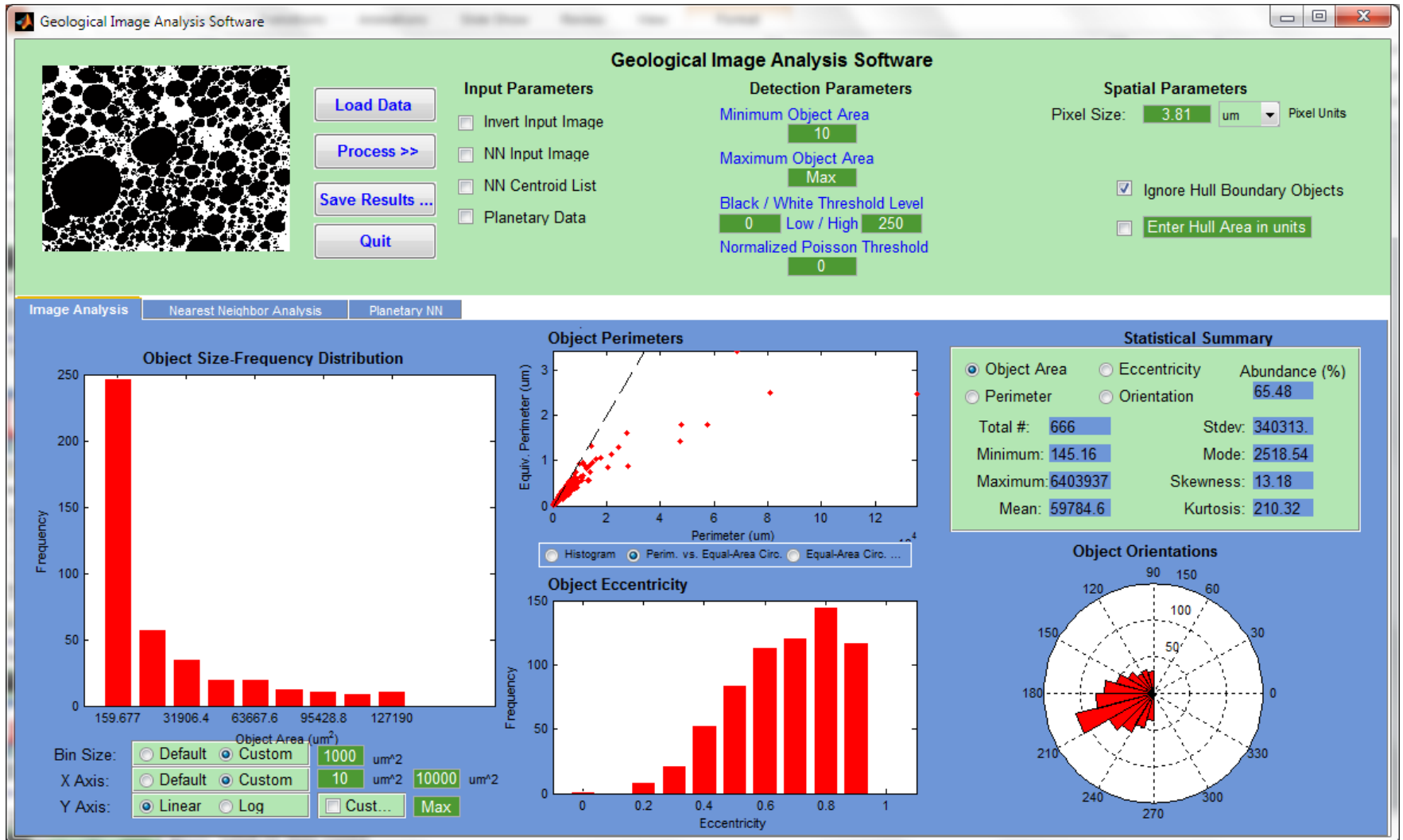
- Select the relevant detection parameters and output parameters (e.g. pixel size)
- See the Help files for information on the options
- Click on the 'Process' button



- It takes less than 15 seconds to process test image LAK\_t\_23c on an Intel i5 core

# Results: Image Analysis Tab

- These are the results for the Image Analysis



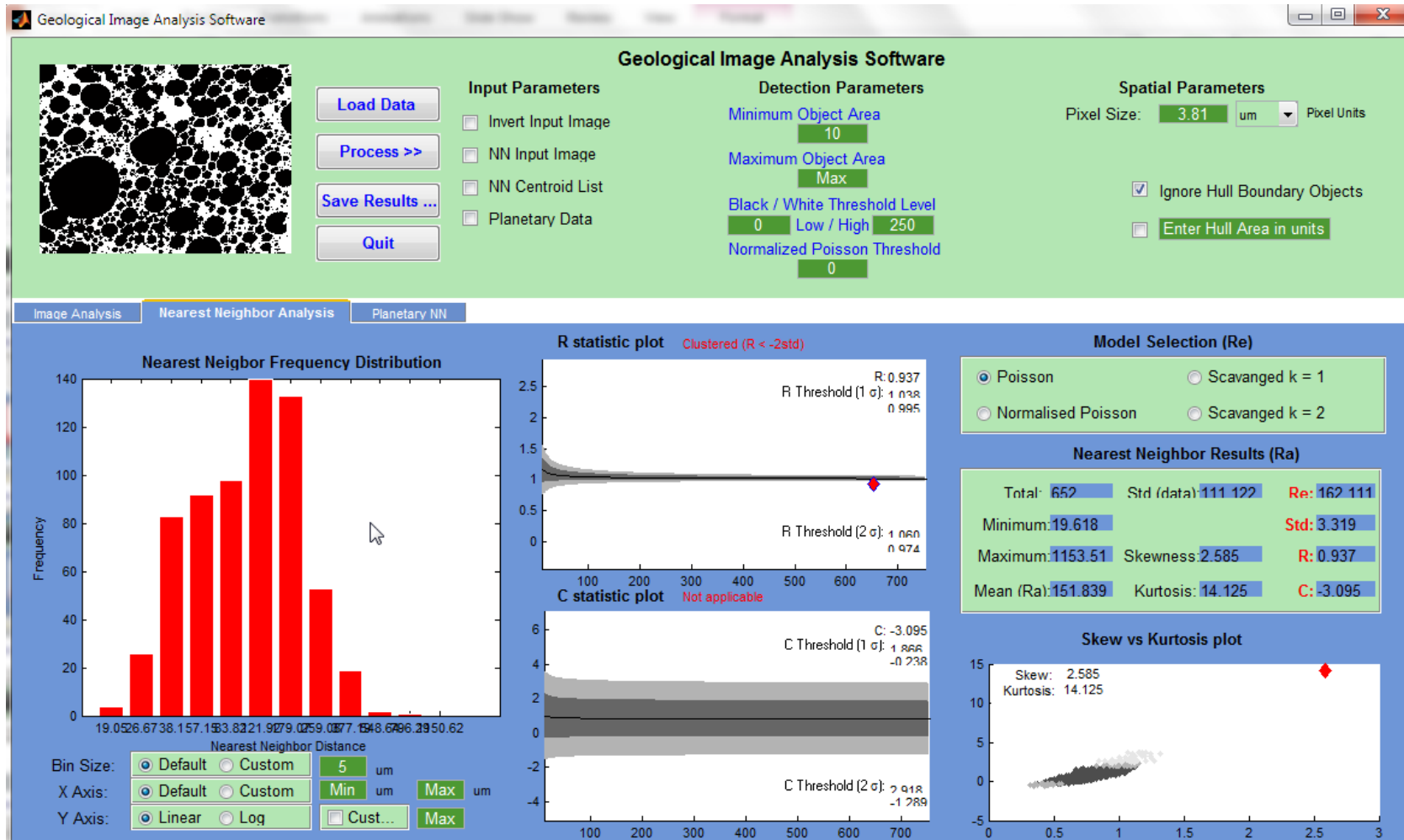
# Notes on the Image Analysis Tab

- The histograms and graphs are intended for quickly looking for dominant features only
  - The object-size histogram shows the size distribution of the objects
  - The object perimeters shows how circular the objects are compared to an equal-area circle (e.g. what about crenulations?)
  - The eccentricity histograms shows the elongation of the objects (0 = circular -> 1 = flattened ellipse)
  - The rose diagram indicates the direction of the sample fabric
  - The information box displays the statistics of the chosen radio button (e.g. Perimeter length)
- Save the data to file to build and customise your own figures



# Results: Nearest Neighbor Tab

- These are the results for the Nearest Neighbor Tab

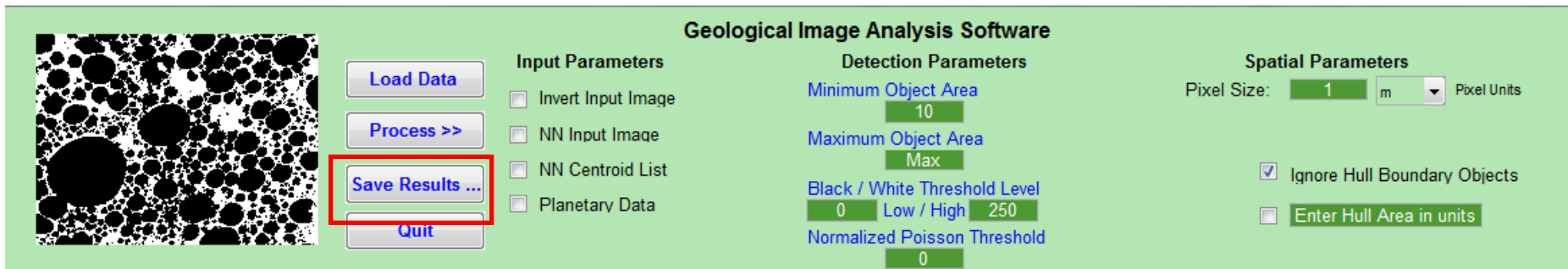


# Notes of the NN Analysis Tab

- The histograms and graphs are intended for quick look only
  - The NN distance histogram indicates the spread of distances
  - The R and c plots give an idea of whether the NN distribution is compatible with the null hypothesis of Poisson distribution (i.e. randomly distributed)
  - Skew vs. kurtosis gives shows the bias versus peakedness of the distribution
  - If a different model selection is made (e.g Scavanged  $k=1$ ) the 'Process' button must be pressed again to update the figures, though the NN Results box will be refreshed without rerunning
- Save the data to file to build and customise your own figures

# Saving output (1)

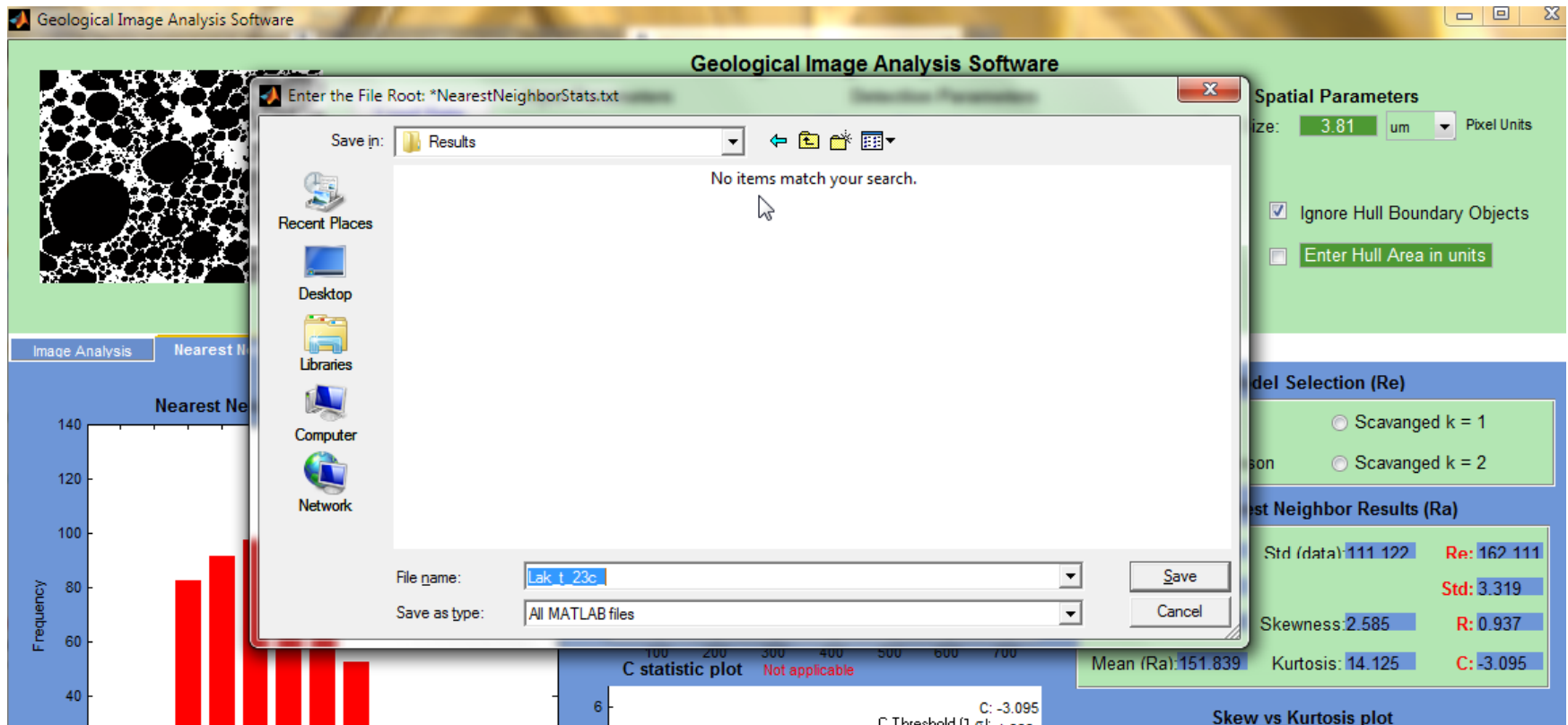
- You can save all the graph calculations using the 'Save Results' button



- This opens a GUI dialogue box with the default name of 'Output\_', saved into the current directory. Change the filename and directory as required

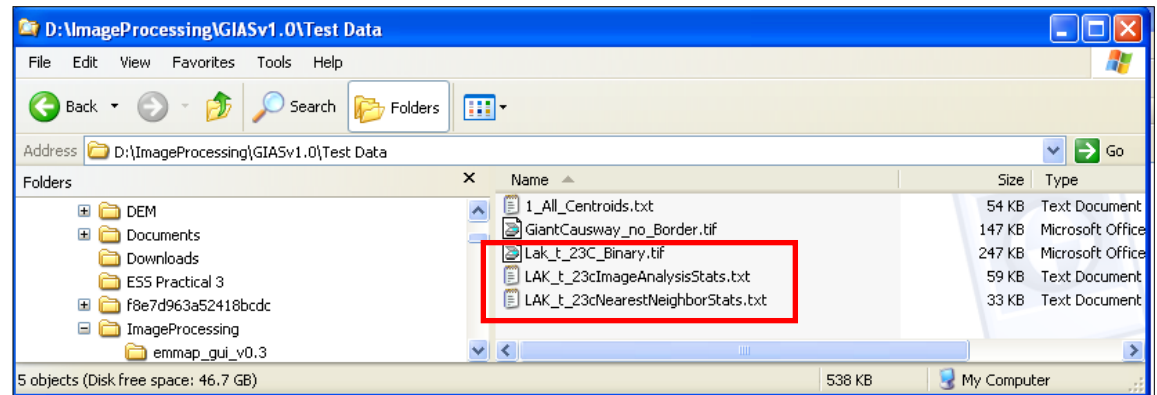
## Saving output (2)

- GIAS writes two Excel-readable tab-delimited files named from the output filename box: LAK\_t\_23c\_
- It also prints the R and c plots from the NN Analysis Tab



# Results in Excel

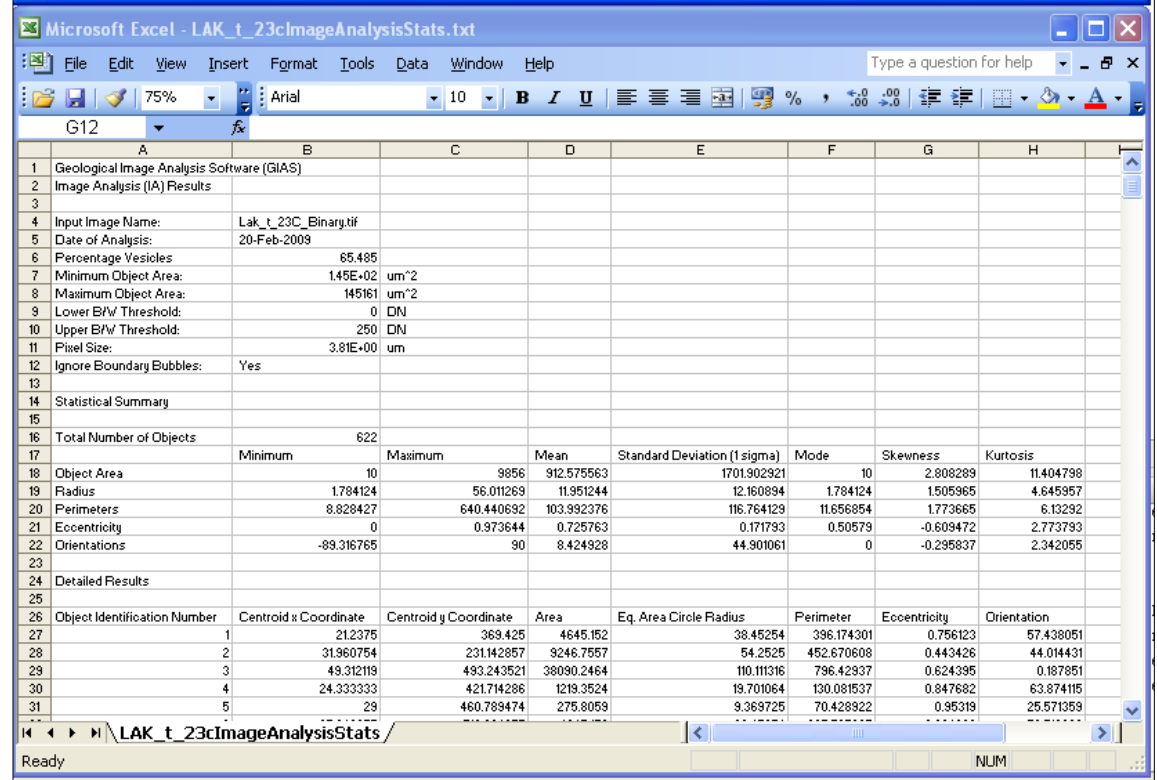
- You results are written to two separate files in the local working directory
- One is for *image analysis* statistics, the other for *nearest neighbor* statistics



Windows Explorer window showing the directory D:\ImageProcessing\GIASv1.0\Test Data. The files listed are:

Name	Size	Type
1_All_Centroids.txt	54 KB	Text Document
GiantCausway_no_Border.tif	147 KB	Microsoft Office
Lak_t_23C_Binary.tif	247 KB	Microsoft Office
LAK_t_23cImageAnalysisStats.txt	59 KB	Text Document
LAK_t_23cNearestNeighborStats.txt	33 KB	Text Document

5 objects (Disk free space: 46.7 GB) 538 KB My Computer

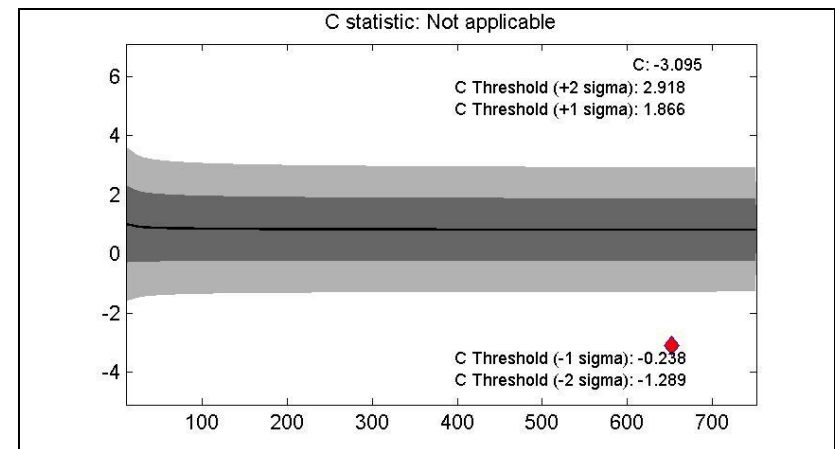
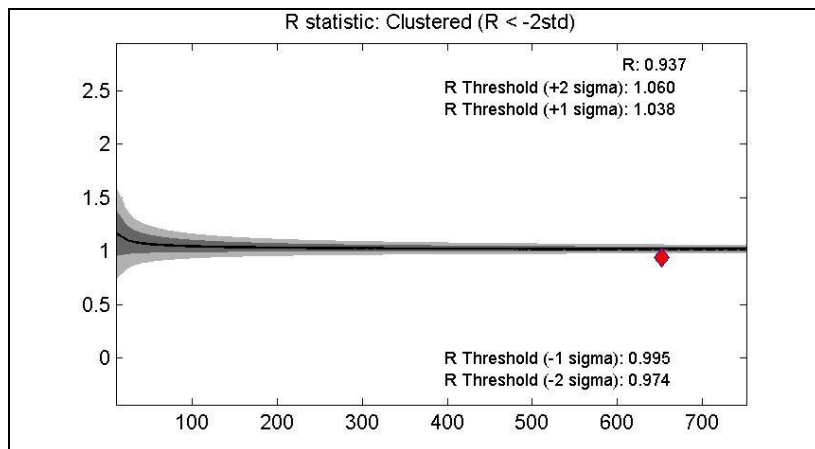
Microsoft Excel - LAK\_t\_23cImageAnalysisStats.txt

	A	B	C	D	E	F	G	H
1	Geological Image Analysis Software (GIAS)							
2	Image Analysis (IA) Results							
3								
4	Input Image Name:	Lak_t_23C_Binary.tif						
5	Date of Analysis:	20-Feb-2009						
6	Percentage Vesicles	65.485						
7	Minimum Object Area:	1.45E+02	um <sup>2</sup>					
8	Maximum Object Area:	145161	um <sup>2</sup>					
9	Lower B/W Threshold:	0	DN					
10	Upper B/W Threshold:	250	DN					
11	Pixel Size:	3.81E+00	um					
12	Ignore Boundary Bubbles:	Yes						
13	Statistical Summary							
14								
15								
16	Total Number of Objects	622						
17		Minimum	Maximum	Mean	Standard Deviation (1 sigma)	Mode	Skewness	Kurtosis
18	Object Area	10	9856	912.575563	1701.902321	10	2.808289	11.404798
19	Radius	1.784124	56.011269	11.951244	12.160894	1.784124	1.505365	4.645957
20	Perimeters	8.828427	640.440692	103.992376	116.764129	11.656854	1.773665	6.13292
21	Eccentricity	0	0.973644	0.725763	0.171793	0.50579	-0.609472	2.773793
22	Orientations	-89.316765	90	8.424928	44.901061	0	-0.295837	2.342055
23	Detailed Results							
24								
25								
26	Object Identification Number	Centroid x Coordinate	Centroid y Coordinate	Area	Eq. Area Circle Radius	Perimeter	Eccentricity	Orientation
27	1	21.2375	369.425	4645.152	38.45254	396.174301	0.756123	57.438051
28	2	31.960754	231.142857	9246.7557	54.2525	452.670608	0.443426	44.014431
29	3	49.312119	493.243521	38090.2464	110.111316	796.42937	0.624395	0.187851
30	4	24.333333	421.714286	1219.3524	19.701064	130.081537	0.847682	63.874115
31	5	29	460.789474	275.8059	9.369725	70.428922	0.95319	25.571359

Ready NUM

# Results of R and c

- R and c graphs are printed to jpg files, with relevant statistics and a suggested implication: random, clustered or uniform
- Again, these are for illustration purposes – use the data in the NN analysis data file for your own detailed figures
- The data for the bias/error envelopes are stored in the skdata folder as NNbias\_flat\_k\_0.dat for Poisson test



# Other options for NN analysis

- You can load data in as two other types of file
  - **NN Input image**: this is an image with single pixels representing the centroid or single points (within a landscape for example). Useful for ArcGIS exports
  - **NN Centroid List**: A list of X and Y coordinates (e.g. in UTM or another 'flat' coordinate system) assumed to be a two column .txt or .dat file
  - **Invert Input Image**: by default, GIAS assumes that the objects of interest (e.g vesicles) are the blackest pixels. Tick this box to invert the image colors (e.g white becomes black)

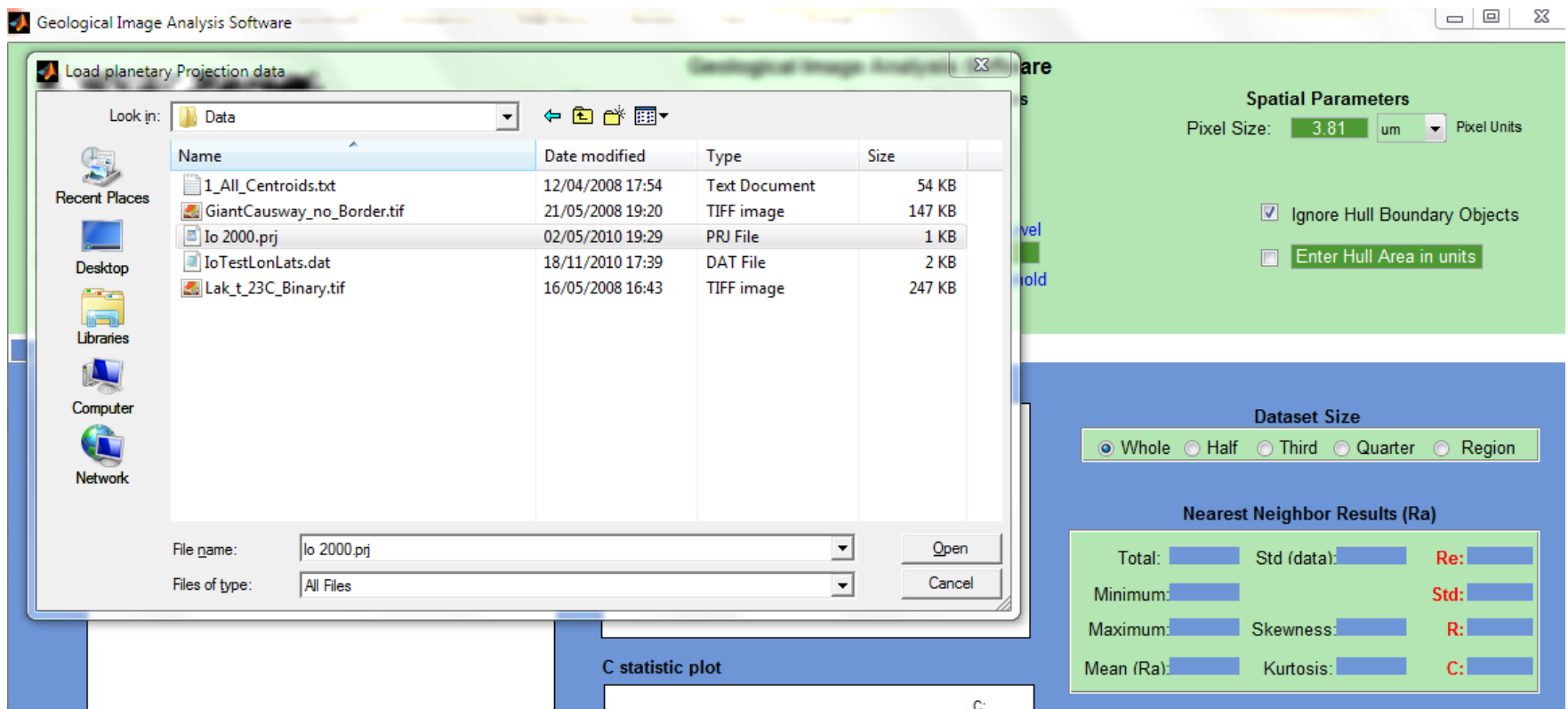
# Planetary analysis

- This new tab (in version 2) allows analysis of planetary-scale features or those measured on a spherical object given in degrees of longitude and latitude
  - Analyse NN distributions across the whole sphere, half, third or quarter sphere.
  - Compare to a 'flat' Region with size computed or input via the Hull Area box
- To use this Tab, select the Planetary Data tick box
  - An Open File GUI will appear prompting you for projection file, which gives the radius and flattening of the planet of interest.
  - Then load in a two column file consisting of longitude and latitudes for the points of interest
  - The following example is for hotspots on the Jupiter moon Io



# Planetary Tab: Load projection file

- Load the ArcGIS projection file (e.g. Io.prx)
- Then click 'Load Data' to load in a two column file of longitude and latitudes in degrees (e.g. IoTestLonLat.dat)



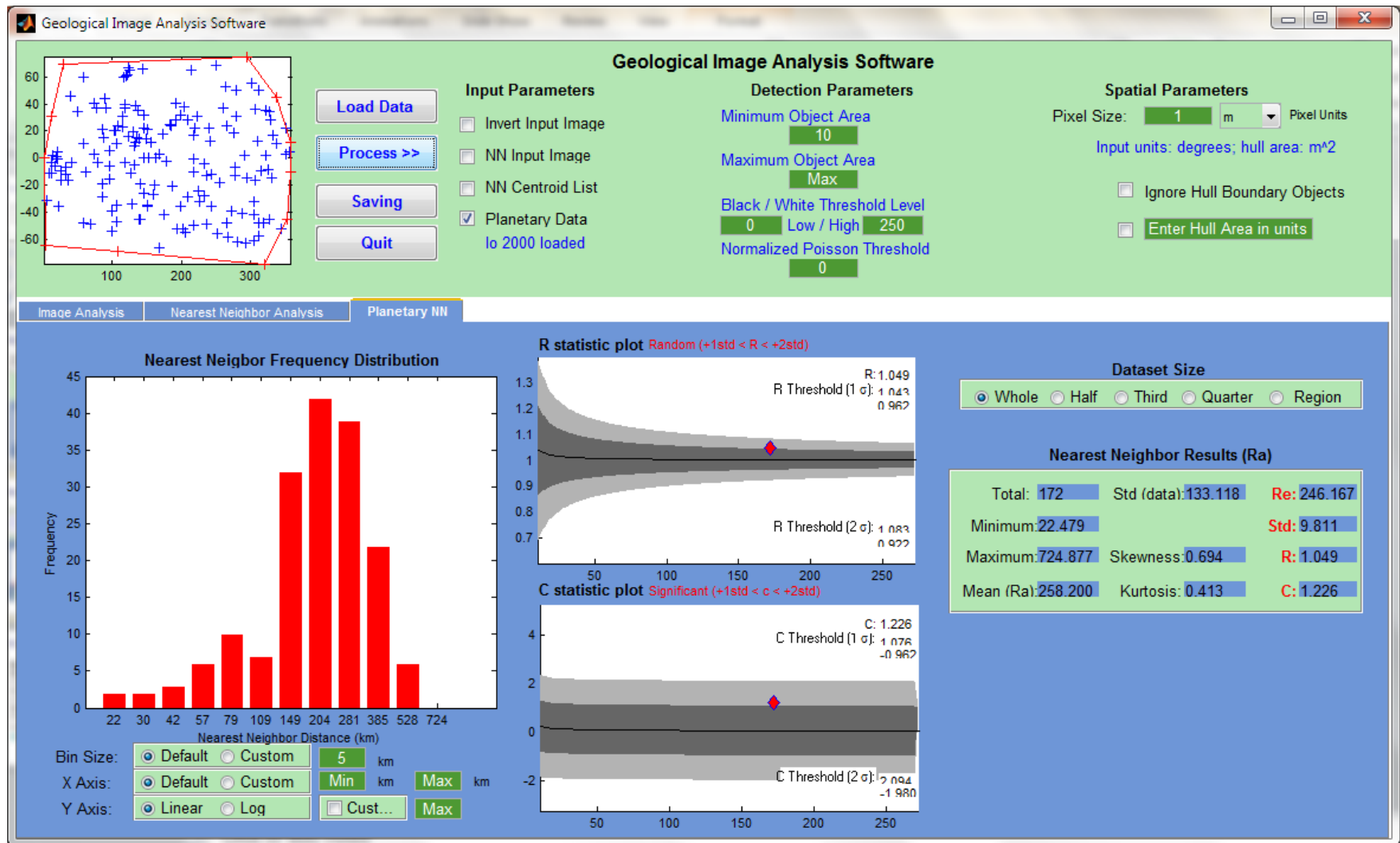
# Planetary Tab: Load data

- You should see the two columns of data displayed in the Input panel as a thin line (see upper left). Now hit 'Process'

The screenshot displays the 'Geological Image Analysis Software' interface. The top panel is green and contains three main sections: 'Input Parameters', 'Detection Parameters', and 'Spatial Parameters'. The 'Input Parameters' section on the left includes buttons for 'Load Data', 'Process >>', 'Saving', and 'Quit', along with checkboxes for 'Invert Input Image', 'NN Input Image', 'NN Centroid List', and 'Planetary Data' (which is checked and labeled 'Io 2000 loaded'). The 'Detection Parameters' section in the center includes input fields for 'Minimum Object Area' (10), 'Maximum Object Area' (Max), 'Black / White Threshold Level' (0 Low / High 250), and 'Normalized Poisson Threshold' (0). The 'Spatial Parameters' section on the right includes a 'Pixel Size' dropdown (1 m), 'Input units: degrees; hull area: m^2', and checkboxes for 'Ignore Hull Boundary Objects' (checked) and 'Enter Hull Area in units'. Below the top panel is a tabbed interface with three tabs: 'Image Analysis', 'Nearest Neighbor Analysis', and 'Planetary NN' (which is selected). The 'Planetary NN' tab is divided into three main areas. On the left is the 'Nearest Neighbor Frequency Distribution' plot, which is currently empty. At the bottom left are controls for 'Bin Size' (Default/Custom), 'X Axis' (Default/Custom), and 'Y Axis' (Linear/Log). In the center are two empty plots: the 'R statistic plot' with 'R Threshold (1 σ)' and 'R Threshold (2 σ)' labels, and the 'C statistic plot' with 'C Threshold (1 σ)' and 'C Threshold (2 σ)' labels. On the right is the 'Dataset Size' section with radio buttons for 'Whole', 'Half', 'Third', 'Quarter', and 'Region'. Below this is the 'Nearest Neighbor Results (Ra)' section, which displays a grid of input fields for 'Total', 'Std (data)', 'Re', 'Minimum', 'Maximum', 'Skewness', 'R', 'Mean (Ra)', 'Kurtosis', and 'C'.

# Results of hotspots on Io

- The hotspots are randomly distributed when compared against the whole moon's area - what about subsets of the data ...?



# Notes on Planetary Tab

- The Image Analysis and NN Analysis Tabs are ignored once the Planetary Data Tick box is enabled
  - Untick to start using the other two tabs
- Use the 'Normalized.prj' projection file if you are analysing items on the surface of a sphere. Assumes the radius of the sphere is equal to 1.
- The NN distances are also correctly computed with ellipsoidal planetary projections
- If using the whole sphere, untick the 'Ignore Hull Boundary Objects' box.
- Saving the data is similar to the other two tabs. A file with the NN data and two jpg images of R and c are written out with the XXX\_PlanetNearestNeighborStats.dat ending.

# Other options

- See the Help files for advice on how the other options work
- If the code stops working correctly, the best thing to do is to close the programme and restart it
- If it is persistently crashing, check the image format is correct and that you have set the path in Matlab correctly.
- If all else fails, contact us via the [www.geoanalysis.org](http://www.geoanalysis.org) website