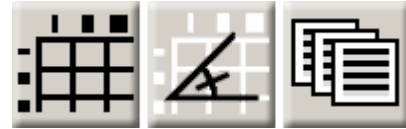


**NAME:** Distance and Azimuth Matrix v. 2

**Aka:** dist\_mat\_jen.avx

**Last modified:** February 7, 2005



**TOPICS:** Distance, Azimuth, Matrix, Array, dBASE, Excel, delimited, delimiter, text, comma, tab, space

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**DESCRIPTION:** This extension produces a matrix of values showing the distances between pairs of features, and/or azimuths between pairs of points. You can generate distances and azimuths between features in a single theme or between features in two separate themes.

**Output:** Matrices can be saved to dBASE tables, Excel spreadsheets, or text-delimited files (using commas, tabs or spaces as the delimiters). Text-delimited files can hold many more columns of data than either dBASE tables or Excel spreadsheets.

**All or only selected records:** You can either use all the features in your themes for the analysis or only a selected subset of features. If any features in your themes are selected, then only those selected features will be used in the analysis. If no features are selected, then all features will be used in the analysis.

**Projected vs. Unprojected Views:** If your original data are in Lat/Long coordinates (the Geographic Projection) and your View has been projected, then you have the option of calculating distances or azimuths based on either the Geographic Projection or your View Projection. The choice of projections can dramatically affect the distance and azimuth values. If your data are unprojected points (regardless of your View projection), then you have the option to use geodesic curves for the most accurate measures possible.

**Requires:** This extension requires that the file "avdlog.dll" be present in the ArcView/BIN32 directory (or \$AVBIN/avdlog.dll) and that the Dialog Designer extension be located in your ArcView/ext32 directory, which they usually are if you're running AV 3.1 or better. The Dialog Designer doesn't have to be loaded; it just has to be available. If you are running AV 3.0a, you can download the appropriate files for free from ESRI at

<http://support.esri.com/index.cfm?fa=downloads.patchesServicePacks.viewPatch&PID=25&MetalD=483>

**Recommended Citation Format:** For those who wish to cite this extension, the author recommends something similar to:

Jenness, J. 2005. Distance Matrix (dist\_mat\_jen.avx) extension for ArcView 3.x, v. 2. Jenness Enterprises. Available at: [http://www.jennessent.com/arcview/dist\\_matrix.htm](http://www.jennessent.com/arcview/dist_matrix.htm).

Please let me know if you cite this extension in a publication ([jeffj@jennessent.com](mailto:jeffj@jennessent.com)). I will update the citation list to include any publications that I am told about.

**Updates:** Version 1.3 (Feb. 17, 2004) adds the option to calculate great circle (geodesic) distances if both Row and Column themes are Point themes. Version 1.4 (May 25, 2004) adds the option to generate an azimuth matrix for point features.

Version 2 (Feb. 7, 2005) adds the option to export to text-delimited files or Microsoft Excel tables.



Version 2.1 (February 24, 2005) incorporates internal changes to make it run faster on very large matrices.

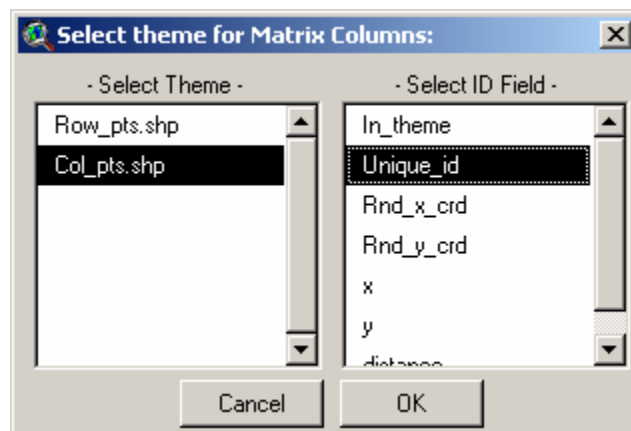
**Acknowledgments:** The author thanks Dr. Evelyn J. Peters (Associate Professor) and Oksana Starchenko (Ph.D. Candidate), from the Department of Geography, University of Saskatchewan, and the Canadian Foundation for Innovation, for suggestions and financial support leading to Version 2 of this extension.

### General Instructions:

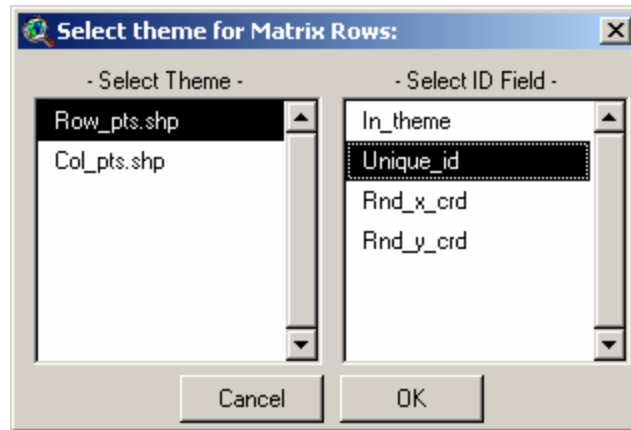
- 1) Begin by placing the "**dist\_mat\_jen.avx**" file into the ArcView extensions directory (../Av\_gis30/Arcview/ext32/).
- 2) After starting ArcView, load the extension by clicking on **File --> Extensions...**, scrolling down through the list of available extensions, and then clicking on the checkbox next to the extension called "**Distance Matrix, v. 2.**"

### Generating a Distance or Azimuth Matrix:

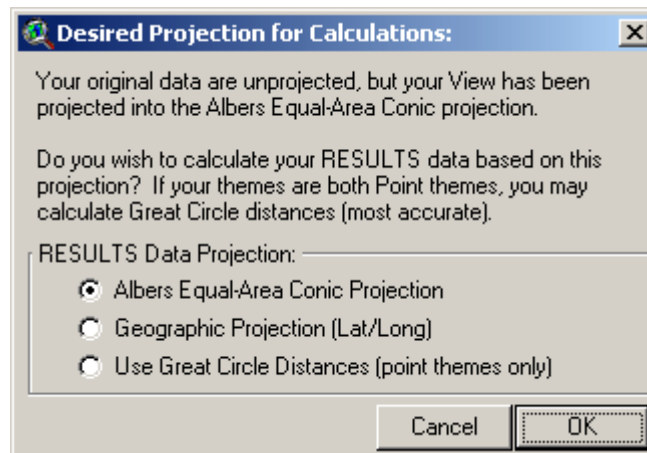
- 1) Click the  button to generate a Distance matrix, or the  button to generate an Azimuth matrix. The Azimuth matrix can only be developed for a point theme because of the complications involved with determining which portions of polygons or polylines to calculate an azimuth from.
- 2) You will first be asked to identify your Column theme. Each feature in this theme will be represented by a field (column) in your output file. The fields will be named according to the ID values in the ID Field you choose:



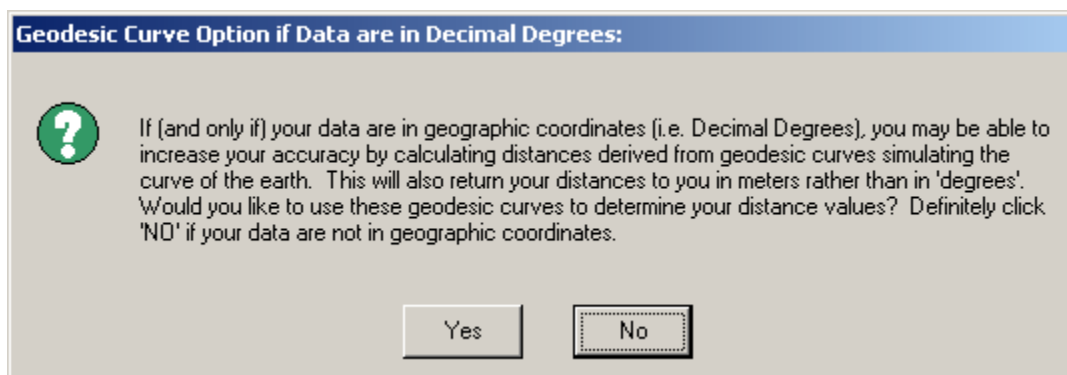
- 3) Next you will be asked to identify your Row theme. Each feature in this theme will be represented by a row in your output file. The output file will also contain an ID field containing ID values drawn from the ID field you choose:



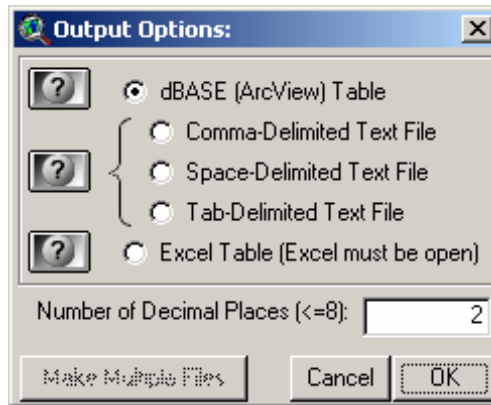
- 4) If your view is projected, then the extension will assume that your actual data are in Latitude/Longitude coordinates. If so, then distances between them will likely be very inaccurate because Decimal Degrees make poor distance units. In this case the extension will ask you whether you would prefer to calculate distance values according to the coordinate system of the View projection. If both your Row and Column themes are Point themes, then you will also have the option to calculate distances based on geodesic curves (also known as great circle distances).



- 5) If your view is not projected, and if both your Row and Column themes are Point themes, then you will still have the option to calculate distances based on geodesic curves. You will be asked if you would like to use geodesic curves in the following window:



- 6) Next, specify your output format and the number of decimal places to record:



**IMPORTANT: Notes Regarding Output Formats –**

- a. *dBASE Tables:* This function will generate a dBASE table of distance or azimuth values and open that table in ArcView. dBASE is ArcView's native database format so ArcView will have no trouble reading the file.

HOWEVER, there is a limit on the number of fields that a dBASE table can hold. The ArcView documentation says that dBASE tables are limited to 255 fields (see 'Are there any limitations when I work with tables?' in the ArcView help files). This is clearly incorrect because the author has generated many tables with more fields than that. There is certainly some limit on the number of fields, however, and the author is not aware of what the true limit is.

If you encounter problems, and if you have some other software you would like to use to analyze the matrix (i.e. S-Plus or SPSS), you might try saving the matrix to a text-delimited file (see below) and then importing it into your other software.

- b. *Excel Spreadsheets:* This function will generate a new Excel Spreadsheet of distance or azimuth values. Microsoft Excel must be installed and open on your computer, and this extension will write the values directly to the spreadsheet as it calculates them. If you open your spreadsheet while ArcView is generating the matrix, you can even watch the values appear in the spreadsheet as they are calculated.

HOWEVER, there is a limit to the number of fields that can be written to the Excel spreadsheet. The author has found that only the first 256 columns of data will be written, which limits this analysis to 255 columns of data and 1 column of ID values.

ALSO, this is a relatively slow operation. ArcView maintains a DDE (Dynamic Data Exchange) conversation with Microsoft Excel as it generates the values, and this conversation is surprisingly slow. The author has found that writing to an Excel spreadsheet takes 3-4 times longer than writing to a dBASE table or text file.

If you encounter problems, and if you have some other software you would like to use to analyze the matrix (i.e. S-Plus or SPSS), you might try saving the matrix to a text-delimited file (see below) and then importing it into your other software.

- c. *Text-Delimited Files:* This extension can generate comma-delimited, tab-delimited and space-delimited text files, which can then be imported into other software packages. In this case, all values are written directly to a basic text file and all values are separated by the delimitation character (comma, space or tab).

**IMPORTANT:** With very large matrices, ArcView may slow down considerably as it writes to the file. The author was unable to determine why this occurs and was unable to create a work-around for it. One possible solution was to create the matrix in several smaller files and then combine them afterward. Unfortunately this solution did not lead to a noticeable increase in speed.

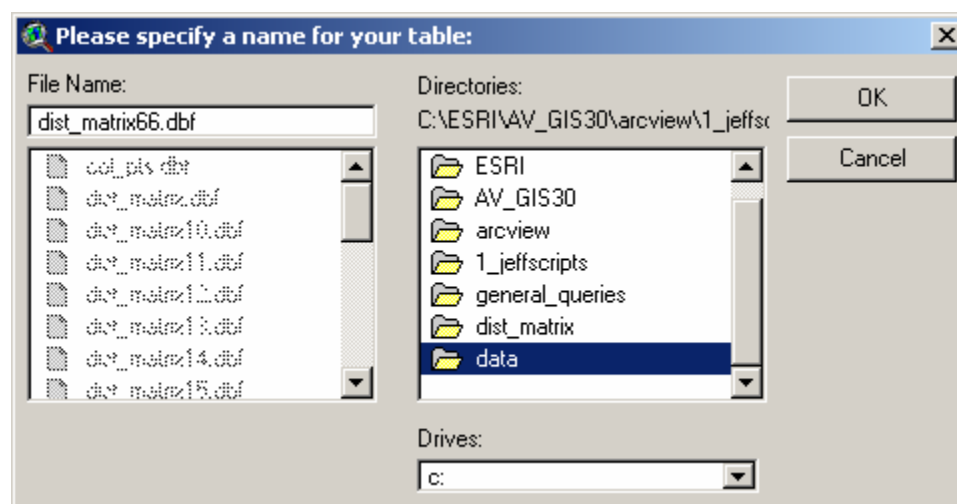
However, the author decided to leave the option to create the matrix in multiple files in case anyone wanted to use that option, either to try to increase speed or to conserve computer memory as the analysis progressed. Therefore, this extension will allow you to generate your matrix in multiple files and combine them afterwards. In this case, each file will contain a fraction of the total matrix. Each file will contain all the columns, but only a portion of the rows. Each file will contain complete rows, so no row will be broken in the middle. Therefore the files can be easily appended to each other using functions in this extension or with a standard text editor.

If you choose this option, you will be asked to specify a single filename for your text file. Each file will then have the name you specify, plus a numeral indicating where it falls in the order.

Regarding importing text-delimited files into MICROSOFT ACCESS and EXCEL: The author has tried and failed to import large text-delimited files into Microsoft Access 2002 because Access would only import the first 254 fields. The author has also tried and failed to import a text file with 7048 columns of data into Microsoft Excel. Excel imported differing numbers of values into each row, varying between 1369 to 1410, and left all remaining values empty. Interestingly, it did import all the field names, and the 'Data Preview' window in the 'Text Import Wizard' showed all the 7048 columns of data and field names, but the actual import operation failed.

The author was able to successfully import all 7048 columns of data into S-Plus 6.0, and users of SPSS 12 have reported success at importing the table into that software.

- 7) If your output option is either a dBASE table or a text-delimited file, you will next be asked to provide a name and location for the file:



- 8) Click OK to produce the distance or azimuth matrix:

Row_ID	z0	z1	
2	23091.583422	6956.466521	22
4	8384.453851	10892.554193	10
6	8658.258324	14650.149724	14
7	7061.551065	16255.421887	14
9	25302.371377	7165.889886	22
14	24619.706896	5571.557797	20
20	21796.478263	6493.306352	27
21	26281.884573	10779.792753	25
24	11581.158287	11735.663967	15
31	22191.199718	3223.734994	18
35	10513.957387	12055.206435	14
36	10711.100126	1064.004071	16

**REGARDING AZIMUTH MATRICES:** Azimuth matrices differ from distance matrices in that the azimuth from X to Y is different than the azimuth from Y to X, while the distances are the same. The azimuth matrices generated with this extension will display the azimuth from the Row value to the Column value.

- 9) The tool will also produce a report describing several relevant details about the distance or azimuth matrix, including the number of rows, columns and cells, and the hard drive location of the table:

**Column Field Name Key:**

**DISTANCE MATRIX REPORT:**

Column Theme: col\_points.shp, 25 records  
Row Theme: row\_points.shp, 22 records

Distance Matrix: 25 columns X 22 rows = 550 cells

Analysis Begun: February 17, 2004 - 13:45:08  
Analysis Completed: February 17, 2004 - 13:45:09

File Save to c:\esri\av\_gis30\arcview\1\_jeffscripts\general\_queries\dist\_matrix\data\dist\_matrix51.dbf

Distance Calculations Based on Geodesic Curves, using Geographic coordinates projected on to the 'WGS 84' Spheroid...

Your Column theme 'col\_points.shp' ID values appear as field names in the distance matrix. The field names correspond with the ID values as follows:



[ID Value -> 1] = [Field Name -> z1]  
[ID Value -> 2] = [Field Name -> z2]  
[ID Value -> 3] = [Field Name -> z3]  
[ID Value -> 4] = [Field Name -> z4]  
[ID Value -> 5] = [Field Name -> z5]  
[ID Value -> 6] = [Field Name -> z6]  
[ID Value -> 7] = [Field Name -> z7]  
[ID Value -> 8] = [Field Name -> z8]  
[ID Value -> 9] = [Field Name -> z9]  
[ID Value -> 10] = [Field Name -> z10]  
[ID Value -> 11] = [Field Name -> z11]  
[ID Value -> 12] = [Field Name -> z12]  
[ID Value -> 13] = [Field Name -> z13]  
[ID Value -> 14] = [Field Name -> z14]  
[ID Value -> 15] = [Field Name -> z15]

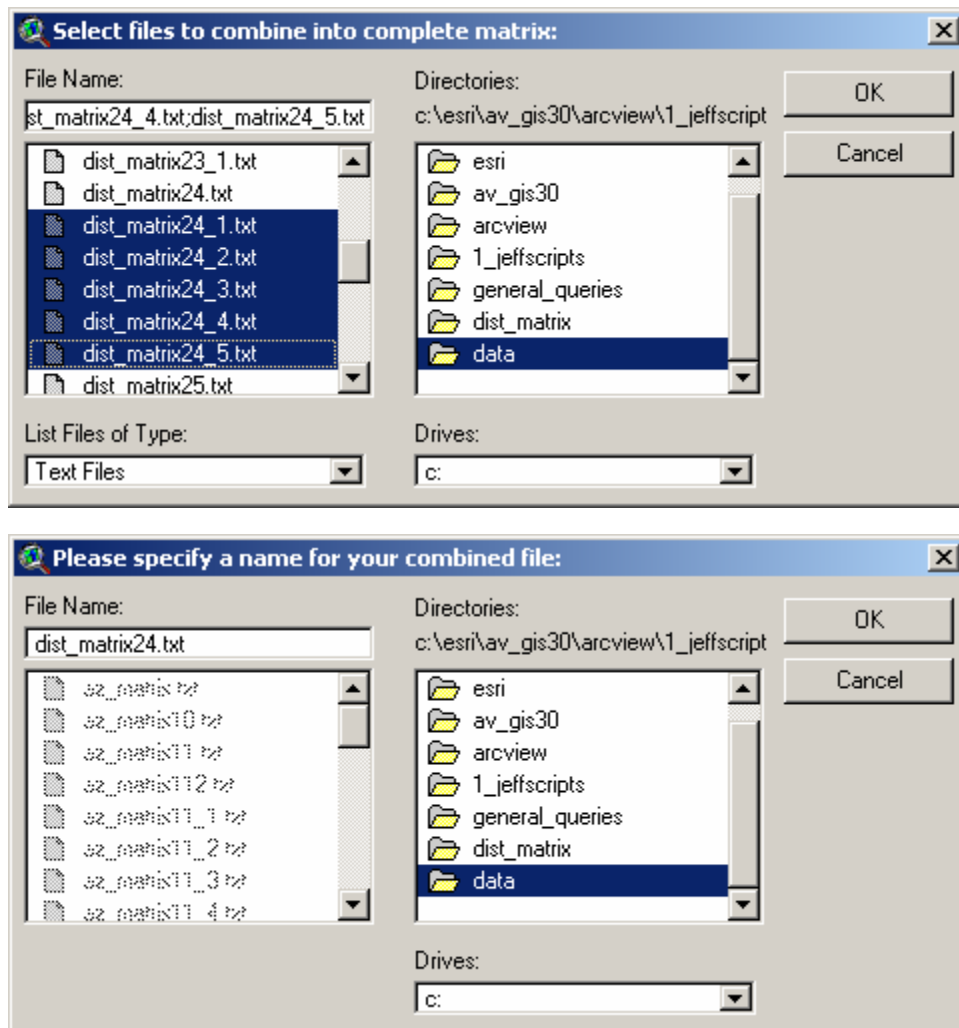
Copy to Clipboard    Copy and Close    Close

- 10) Notice that in this example we are generating a distance matrix between two themes. We could have chosen the same theme for both the Columns and Rows, in which case the final

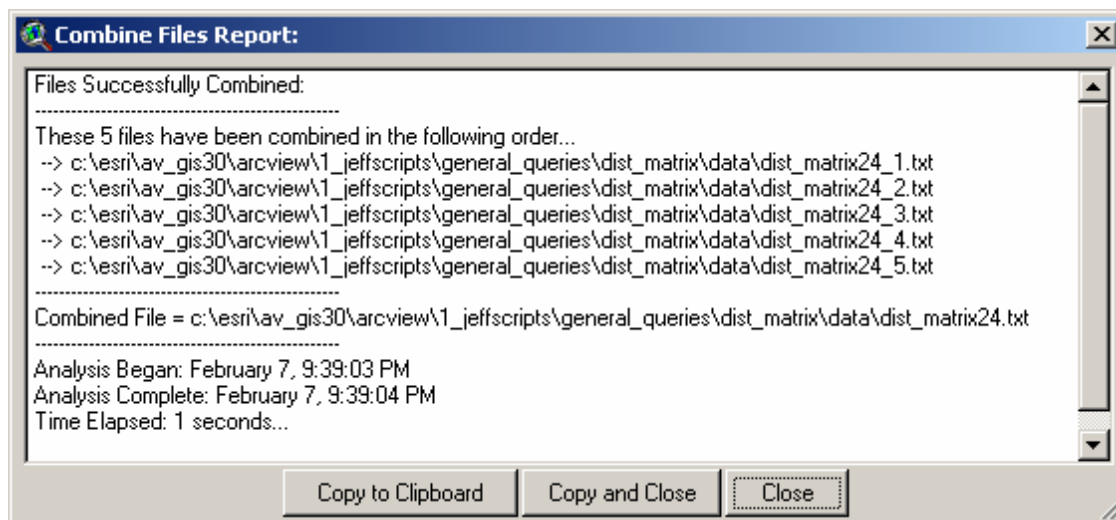
matrix would have Zero values along the diagonal. The diagonal would represent the distance from a feature to itself.

### Combining Multiple Text Files into a Single Complete Text-Delimited Matrix:

If you have generated your matrix in several sub-files, you can combine them into a single file using either the  button in your View button bar or using a standard text editor. If you use the  button, you will first be asked which files to combine. Be sure to only select files that combine into a single matrix. These should all have the same name, with a number appended at the end. The extension will sort them according to the number and compile them into a single file, and ask you what you want to name the combined file.



When it finishes, it will produce a report describing the outcome:



### Adding Record Numbers to Table:

This option provides a simple way to add a field of record numbers to your table. Many types of analysis require that you have some kind of unique ID value in your attribute table, and record numbers usually make good ID values when no other option exists. This extension uses unique ID values to identify exactly which features are being compared in the distance and azimuth matrices.

All you need to do is open your table, click the “Edit” menu, and then click “Create Record Number Field”. The table does NOT need to be set to Editable prior to this. The tool will add a field named [rec\_num] and populate it with record number values. If a field named [rec\_num] already exists in your table, the tool will append an index number to the name until it finds a name that does not exist in your table (i.e. [rec\_num\_1], [rec\_num\_2], etc.)



Enjoy! Please contact the author if you have problems or find bugs.



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Updates to this extension and an on-line version of this manual are available at

[http://www.jennessent.com/arcview/dist\\_matrix.htm](http://www.jennessent.com/arcview/dist_matrix.htm)

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