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ProjectMaker for Space-Time Analysis of Regional Systems

How to Create STARS Projects with ProjectMaker

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Building STARS Projects

1.1 Creating and Managing STARS Projects

1.1.1 Overview of Changes

The **Project Maker** utility has gone through a major overhaul since the last release. A series of python scripts were created to surplant the *ShapeLib* utility that was formerly required to manage mapping files. In short, this means that the program is entirely independent of any additional binaries. This occured behind the scenes, so for many users this change will go unnoticed.

After the first release it became evident that most of the problems associated with our program had to do with confusion surrounding the creation of STARS projects. As such, we drastically improved the capabilities of **Project Maker** and made it easier for the common user to employ.

The following sections serve as a tutorial for creating STARS projects. We use a real data set that comes standard in this release. Please feel free to walk through the steps both in this document and in the **Project Maker** environment.

1.2 Project Maker: Tutorial

We believe the easiest way to instruct the user on creating a new STARS project is to provide a step-by-step tutorial with "real" data. The example contains data for the counties of California. The files are located in the "data" directory that is included in the STARS binary. Upon installation you should have copied "data" to a directory that has write permissions.[1] For this example we will assume you copied "data" to a directory named "myDataDir". So the path to the data is: "myDataDir/data".

In this example we want to create a STARS project from an ArcView shapefile that contains several cross-sectional variables. Furthermore, we have additional data on per capita incomes and population from 1969–2001 that we want to augment our new project with. The following sections will guide you through this procedure.

[1] See the README file included in the STARS download.

1.2.1 Launch Project Maker

To launch **Project Maker** double click on the "ProjectMaker" application.[2] You will encounter the main screen for **Project Maker** which contains four main menus: **File, Data, Tables, Plot**.

1.2.2 Create a New Project: California Example

1. Click **File-Create New STARS Project**

   a You will be prompted to choose which type of file is going to be used as the *base data* for the new project. Your two choices are **ArcView** and **CSV**. If your project has a map, you must choose the **ArcView** option. You can always add data from comma delimited files later in the project making process. The steps that follow are identical for the CSV option, but the plotting feature will be nullified. For this example choose: **ArcView**.

   b You will then be prompted to choose a file that contains your base data. Base data for **ArcView** projects are found in ***.dbf** files. Navigate to the "myDataDir/data" data directory and choose the file: "california.dbf". Click "OK".

   c This is your first chance to name your new project. You will encounter an empty entry field. If you leave this entry blank, the prefix of the base data file will be the name of your project (i.e. california in this case). For this example we are going to name the project CA. So type "CA" in entry field for Project Prefix. Click "OK".

   d Now you will have to declare the time series information for your project. First you will be prompted for the *type* of series. The California example we are working with contains annual data as shown in Figure 1.2, so check the "Annual" button and click "OK". See Section 1.3.4 for a full explanation of the different time series types available for STARS.

   e Next, you must provide the start year and the end year for your time series. So place 1969 and 2001 in their corresponding entry spaces as shown in Figure 1.3, and click "OK".

   f You will now encounter a dialogue box (Figure 1.4) where you must choose a field from your original data to use as the names for your cross-sectional units. There are four empty fields in this view. In the case of California, you only need to select "NAME" for the "Unique Field" and click "OK". This will associate any shape in your shapefile with its corresponding name. Futher information on this procedure can be found in section 1.3.5.

   g The next step involves selecting what type (if any) weights matrices you would like to create based on the shape files. Select the type you want as shown in Figure 1.5 and click "OK".

   h You have just finished the initial stage of creating a STARS Project. Now it is time to add some data!

[2] For those of you running STARS from the source code you should navigate to the "stars/src" directory and enter "python ProjectMaker.py" at the command line.

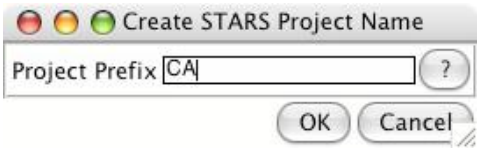


Figure 1.1: Name your Project

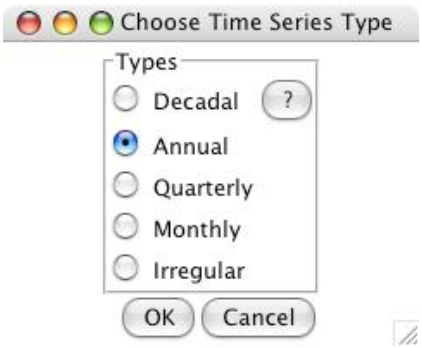


Figure 1.2: Choose the Time-Series Type

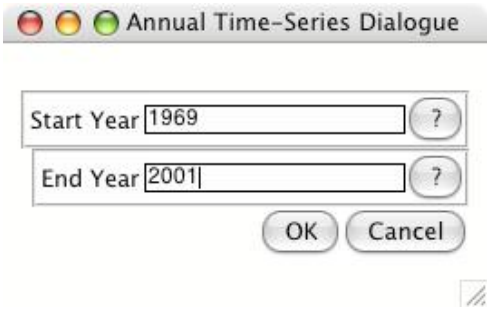


Figure 1.3: Enter the Start and End Periods

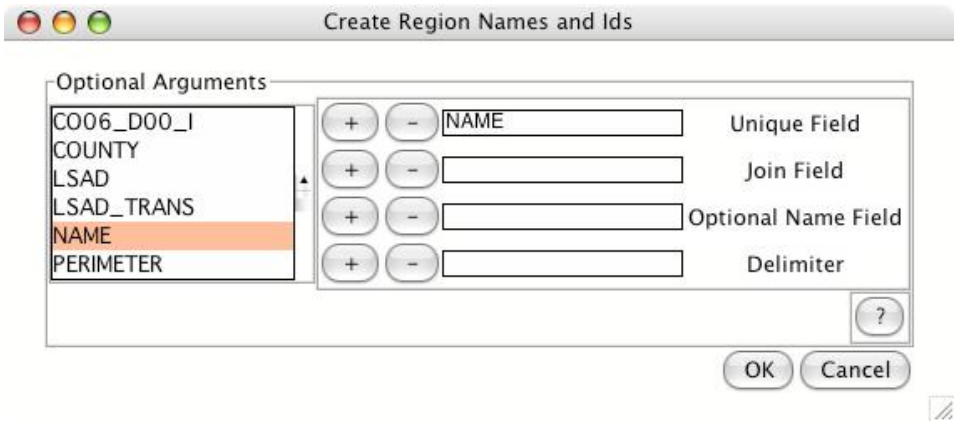


Figure 1.4: Choose the Cross-Sectional Names Field (California)

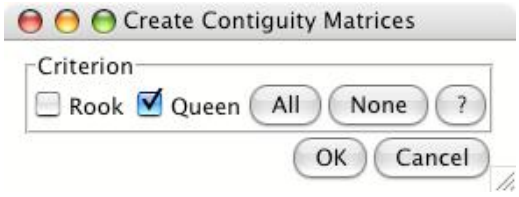
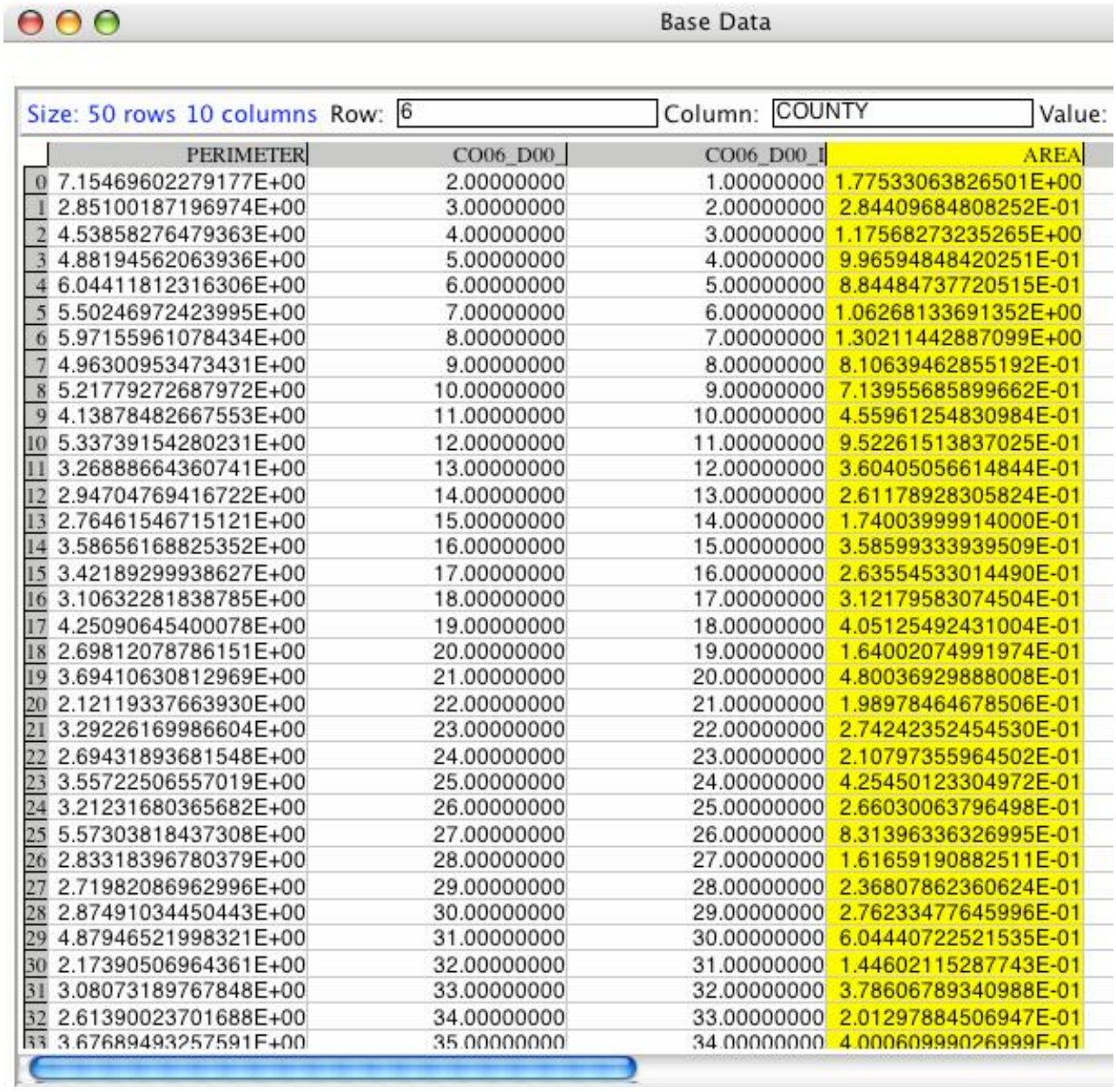


Figure 1.5: Choose the Types of Weights Matrices



	PERIMETER	CO06_D00_	CO06_D00_I	AREA
0	7.15469602279177E+00	2.00000000	1.00000000	1.77533063826501E+00
1	2.85100187196974E+00	3.00000000	2.00000000	2.84409684808252E-01
2	4.53858276479363E+00	4.00000000	3.00000000	1.17568273235265E+00
3	4.88194562063936E+00	5.00000000	4.00000000	9.96594848420251E-01
4	6.04411812316306E+00	6.00000000	5.00000000	8.84484737720515E-01
5	5.50246972423995E+00	7.00000000	6.00000000	1.06268133691352E+00
6	5.97155961078434E+00	8.00000000	7.00000000	1.30211442887099E+00
7	4.96300953473431E+00	9.00000000	8.00000000	8.10639462855192E-01
8	5.21779272687972E+00	10.00000000	9.00000000	7.13955685899662E-01
9	4.13878482667553E+00	11.00000000	10.00000000	4.55961254830984E-01
10	5.33739154280231E+00	12.00000000	11.00000000	9.52261513837025E-01
11	3.26888664360741E+00	13.00000000	12.00000000	3.60405056614844E-01
12	2.94704769416722E+00	14.00000000	13.00000000	2.61178928305824E-01
13	2.76461546715121E+00	15.00000000	14.00000000	1.74003999914000E-01
14	3.58656168825352E+00	16.00000000	15.00000000	3.58599333939509E-01
15	3.42189299938627E+00	17.00000000	16.00000000	2.63554533014490E-01
16	3.10632281838785E+00	18.00000000	17.00000000	3.12179583074504E-01
17	4.25090645400078E+00	19.00000000	18.00000000	4.05125492431004E-01
18	2.69812078786151E+00	20.00000000	19.00000000	1.64002074991974E-01
19	3.69410630812969E+00	21.00000000	20.00000000	4.80036929888008E-01
20	2.12119337663930E+00	22.00000000	21.00000000	1.98978464678506E-01
21	3.29226169986604E+00	23.00000000	22.00000000	2.74242352454530E-01
22	2.69431893681548E+00	24.00000000	23.00000000	2.10797355964502E-01
23	3.55722506557019E+00	25.00000000	24.00000000	4.25450123304972E-01
24	3.21231680365682E+00	26.00000000	25.00000000	2.66030063796498E-01
25	5.57303818437308E+00	27.00000000	26.00000000	8.31396336326995E-01
26	2.83318396780379E+00	28.00000000	27.00000000	1.61659190882511E-01
27	2.71982086962996E+00	29.00000000	28.00000000	2.36807862360624E-01
28	2.87491034450443E+00	30.00000000	29.00000000	2.76233477645996E-01
29	4.87946521998321E+00	31.00000000	30.00000000	6.04440722521535E-01
30	2.17390506964361E+00	32.00000000	31.00000000	1.44602115287743E-01
31	3.08073189767848E+00	33.00000000	32.00000000	3.78606789340988E-01
32	2.61390023701688E+00	34.00000000	33.00000000	2.01297884506947E-01
33	3.67689493257591E+00	35.00000000	34.00000000	4.00060999026999E-01

Figure 1.6: Base Data for California

1.2.3 Working With Data

There are several methods that can be used to place data in STARS projects. They fall under the follwing categories: Convert, Merge, Join. There are also three different types of data:

CS Cross-Sectional Data

TS Time-Series Data

CSTS Cross-Sectional/Time-Series (Panel) Data.

Convert Data: California Example

You will notice that when you finished the initial stage of creating a project you were left with a table containing your base data.[3] As of right now, none of these fields have been added to our STARS project. Usually the first stage in adding data to a project involves **converting** these fields into STARS variables. Let's get our feet wet by continuing with the California example.

1. Click **Data-Variable-Convert-Base Data to CS**

   - You will encounter a dialogue box with all of the base data *Fields* in one listbox, and a series of *Optional Arguments* in the other.
   - Let's choose "AREA" as a variable we would like to add to our STARS project. To do so, highlight "AREA" in the listbox and click the "+" button.[4]
   - Highlight "Sum" as your *Optional Argument*, and click "OK". (See Figure 1.7)[5]
   - You have just create a new "CS" variable for your STARS project. To view your results you can use the appropriate table.

For a complete explanation of all the **Convert Data** methods see section 1.3.8.

Merge Data: California Example

Suppose you want to add some data to your project that was not included in your base datafile. The Merge and Join methods will allow you to augment your project appropriately. We are going to start with **Merging Data**. For a complete explanation of merging data see Section 1.3.9.

1. Click **Data-Variable-Merge-CSTS Data**

   - You will encounter a directory/file browser that should identify only files with a ***.csv** extension.
   - Navigate to the "myDataDir/data" directory. You will notice several files available.
   - The file "caPCR.csv" contains per capita income data from 1969–2001.[6] Select this file and click "Open". (See Figure 1.8)

[3] Please note that the data tables are limited to contain 50 rows. This prevents the package from slowing down when the number of observations increases.

[4] You could choose more than one variable to convert at the same time.

[5] A complete explanation of the *Optional Arguments* can be found in 1.3.6.

[6] Standardized to be relative to the California average across time periods.

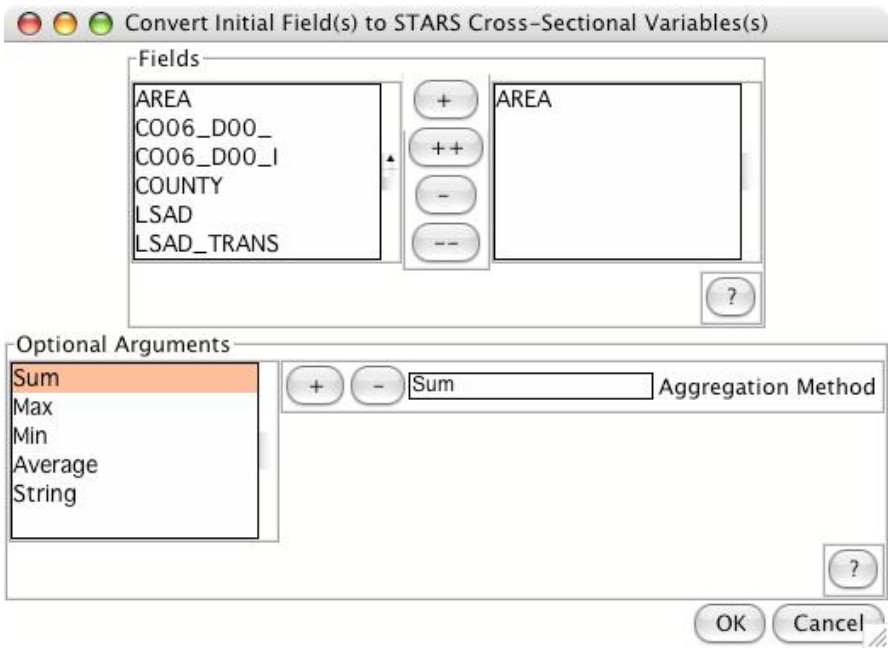


Figure 1.7: Convert CS Data (California)

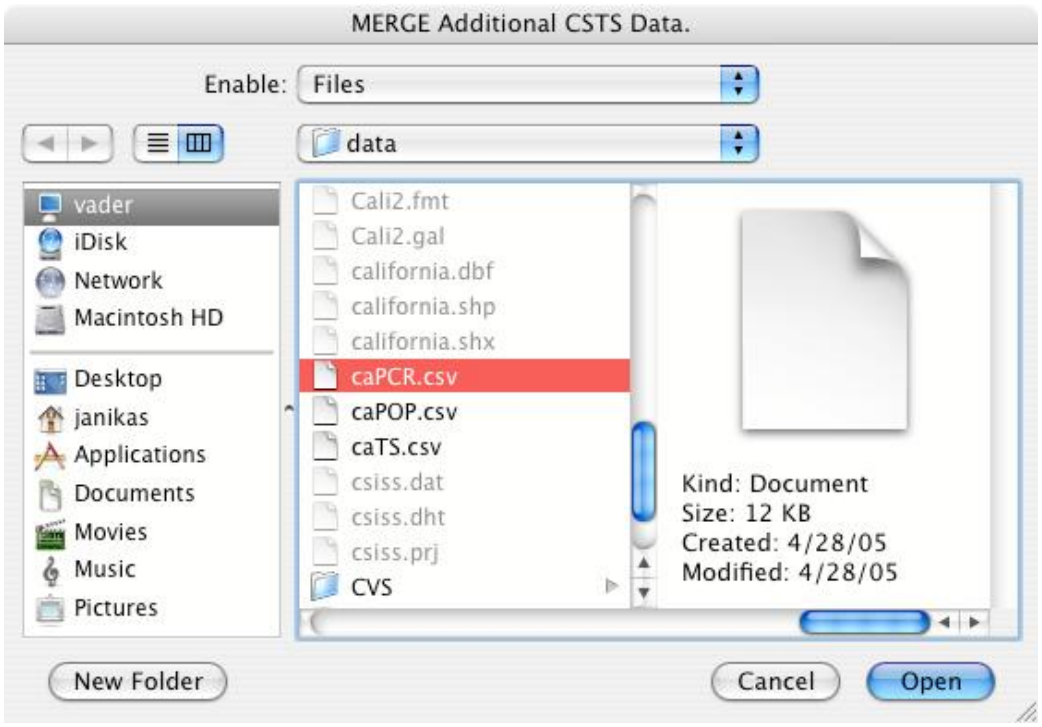


Figure 1.8: Merging CSTS Data (California)

Thats it! That is all there is to it! Merging data is easy on the front end, but requires that the data is ordered in the same way as the project you just created. How do you do that? See Section 1.3.9 for a complete explanation.

You could take this opportunity to repeat this process for the file "caPOP.csv", which contains population values for the CA counties over the time series. Furthermore, merging TS and CS data is just as easy. You can click **Data-Variable-Merge-TS Data** and add the file "caTS.csv" to see an example. This data contains the population and per capita income values for California as a whole over the time period.

Join Data: California Example

Joining data is similar to merging data, but the data does not have to be in a specific order. The data must be correctly matched through the use of a common field; one of which is in your *base data*, the other is in the new data file itself. See Section 1.3.10 for a full description. Let's try an example with California.

1. Click **Data-Variable-Join-CS Data**
    - You will encounter a directory/file browser that should identify only files with a ***.csv** extension.
    - Navigate to the "myDataDir/data" directory. You will notice several files available.
    - Choose the file "caJoinCS.csv".
    - You will encounter a dialogue box where you must choose the appropriate fields to match.
    - The **Master Field** contains CS variables that have already been created. We are going to choose "csnames" as our **master**. The "COUNTY" field is the **slave** in this instance. The master and the slave fields have the same values in them, but the order is different. Behind the scenes your new data will be matched accordingly. Figure 1.9 demonstrates the correct way to join this data file. Select "OK".

The steps for joining CSTS data are practically identical.[7]. Try clicking: **Data-Variable-Join-CSTS Data** and select "caJoinCSTS.csv". Again, use "csnames" as the master and "COUNTY" as the slave.

Adding a GAL Matrix: California Example

Often users have GAL (Geographic Algorithim Library) matrix files already created and want to add them to the project. It is important to note that the cross-sectional "ids" within the "*.gal" file, must be *identical* to those in your new project.[8] Again, anytime a user would like a print-out of the cross-sectional order of their project they can use the Write Cross-Section Names menu option.

To continue with the California example:

1. Click **Data-Matrix-Import GAL Binary**
    - You will encounter a directory/file browser that should identify only files with a ***.gal** extension.

[7] Again, see Section 1.3.10 for a full explanation.

[8] The "ids" of your cross-sectional units are the CS variable *csids* in your project.

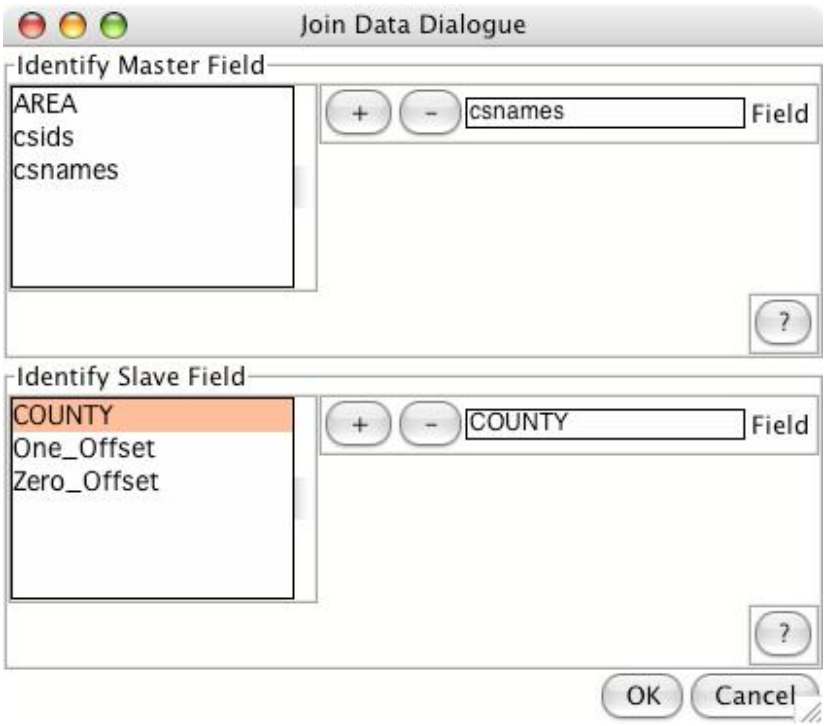


Figure 1.9: Joining CS Data (California)

- Navigate to the "myDataDir/data" directory. You will notice several files available (some of them might have been created in the initial stages of the project.).
- Choose the file "Cali1.gal".[9]
- Select "OK".

1.2.4 Finishing Up: California Example

Once you have added all of the data and matrices you want in your new STARS project, it will be time to write the files. If your project has a shapefile, you must plot your map first before you can proceed. In the case of California:

1. Click **Plot-Plot Map**
   - You will be prompted to choose the type of projection you want for your map.
   - Figure 1.14 contains the dialogue box with your choices.
   - Choose a type and select "OK".

Figure 1.10 contains the plotted map with the "Mercator" projection. If you decide you do not like the projection you initially chose, you can go back and change it before you save your data. Just repeat the steps until you find a projection that suits you.

[9]This GAL file is identical to the "Queen Contiguity Matrix" created in the initial stage.

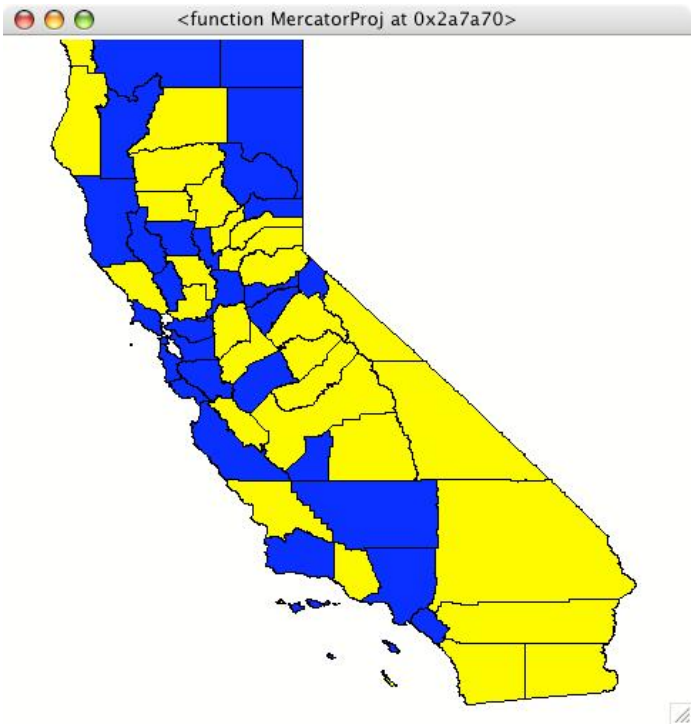


Figure 1.10: Mercator Projection for California

Now you can save your project and quit the **Project Maker** environment. Thats it! Your all done! Now you can open your "CA.prj" file in the STARS environment and start your exploration!

1.3 Project Maker: General

The following sections provide a more general explanation of the inner workings of the **Project Maker** utility.

1.3.1 Write Cross-Section Names

When a user wants to merge data or import a matrix, the order of the cross-sections must match with the current project. Most of the times this order is not known initially. One can obtain a file with the appropriate order by clicking **File-Write Cross-Section Names**. It is important to note that this file can only be created for a **new project** after the initial base data has been read and organized.

1.3.2 Saving Your Project

There are two ways to save your STARS Project:

1. **File-Save Project** Use this option if you are content with the name you have given your new project. It will write all of the appropriate files.

2. **File-Save Project As** Use this option if you want to either change the name of your project, or if you want to save your project to a new directory.

Rememeber that you must plot you map first if a shapefile is involved in your project.

1.3.3 CSV Projects

STARS does not require that your project contain a map. A comma-delimited file ***.csv** can be used to create a project. There are limitations however, as all of the mapping utilities in STARS will be nullified. For those interested in this type of case, you can proceed through the California Example again, but with the **CSV** option. The *base data* file for California is: "myDataDir/data/california.csv". The remaining steps are the same, save the plotting feature.

1.3.4 Time-Series Types

There are several canned types of time-series projects in STARS. Here is a brief description:

1. Decadal: Provide the start year and the end year when creating the project.
2. Annual: Provide the start year and the end year when creating the project.
3. Quarterly: Provide the start quarter, start year, end quarter, and end year.
4. Monthly: Provide the start month, start year, end month, and end year.
5. Irregular: For all other cases, it is best to use the irregular time-series. Just provide the number of time intervals in your project.

One Time Period

If your project only has one time period then you need to fake it. Try using **Irregular** as you time-series type and select 2 intervals. You wont be able to use the visualization techniques in STARS for time-series variables but you wont have any, so you should'nt miss it.

1.3.5 Creating Names and IDs

This is an extremely important stage in the creation of your project, because it serves as the accounting system between your maps and your data. There are four entry spaces in this view (See Figures 1.4): "Unique Field", "Join Field", "Optional Name Field", and "Delimiter". In most circumstances, your base data file (***.dbf, *.csv**) will have a unique name field (i.e. you will only see each name once down the column). In this case, you should always choose that field for "Unique Field" and leave the other entries blank.

Using the Join Field

Sometimes the base data file has more than one cross-section with the same name. For example, if your study area included the counties and municipios along the US/Mexico border you would find that that there are more than one cross-section with the name "Hidalgo". You could imagine quite a few repetitive names if you were to use all of the US counties as your study area. In this case, you can go two routes:

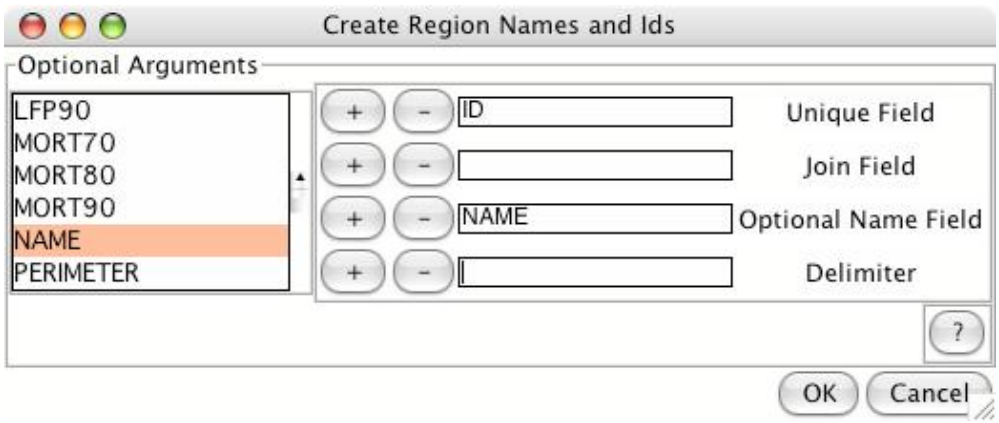


Figure 1.11: Joining with a Unique Field

1. In most cases there is another field that is unique to each cross-section. Identify this field and place it in the "Unique Field" entry space. If you want your cross-sections to be named as per this field, then you are done. However, you can select another field to be used as the names by placing it in the "Optional Name Field" entry space (i.e. your "Unique Field" will be used for matching, but the "Optional Name Field" will be used for actually naming your cross-sections.) In this case, you could have more than one cross-section with the same name in your completed STARS project. Figure 1.11 is an example where "ID" represents a unique field, and "NAMES" represents the cross-sectional names you want associated with your STARS project.

2. In some cases there is not a unique field for naming your cross-sections. When confronted with this situation you may want to combine two fields to make a unique one. For example, if one were to be using the US counties as their study area each cross-section could have a state (fips) code. While the name field is not unique, you can be certain that within each state their is no repetition of county names. To make unique names you could place the state codes in the "Unique Field" entry space, and the names in the "Join Field" entry space. The "Delimiter" field allows you to assign the string character you would like to use to combine the two. Figure 1.12 shows an example where "STATE" is the state code, "NAME" is the name field, and the string ":" is used to combine the two to make a unique cross-sectional name field. The result for a county named "Hidalgo" in state "01" would be: "01:Hidalgo".

Aggregation: The Case Of Islands

The last major circumstance one may confront in the creation of Names and IDs in **Project Maker** has to do with aggregation. Some shapefiles contain cross-sections that are made up of a series of islands. For example, Santa Barbara County in California is made up of a major land mass and several islands. In the accounting framework for California we used the "NAMES" field for a unique identifier. Behind the scenes, an aggregation method was employed to combine all shapes with the same "NAME" to form a single cross-sectional unit. In essence, the "NAME" field was not unique, but instead of joining fields or using a seperate unique field to keep all of the initial

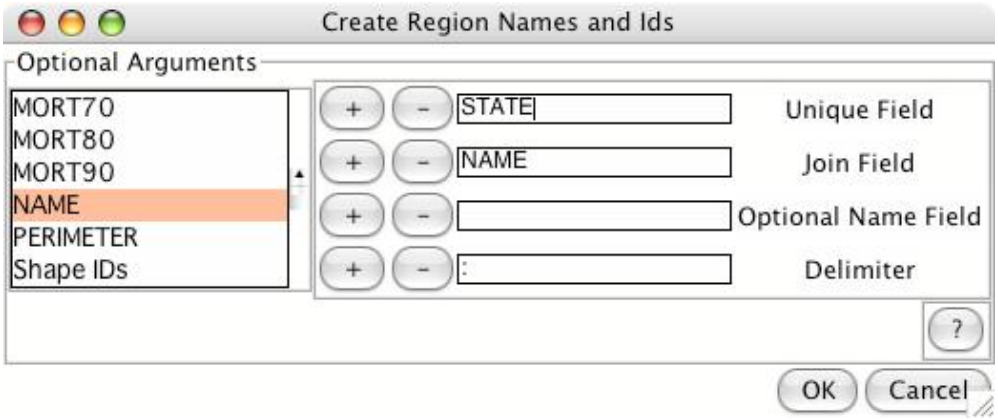


Figure 1.12: Joining without a Unique Field

shapes seperate, we *aggregated* to the number of unique values in the field. Hence, 68 shapes in the base data, became 58 unique cross-sections in the STARS project. We did this because there are 58 counties in California and the data corresponds to this number. In some cases, one would not want to aggregate, in which case they would look for a field in the base data that is truly unique.

The aggregation process is pretty straightforward, but it leads to several optional arguments that should be considered when confronted with this situation.

1.3.6 Optional Arguments

When an aggregation occurs in the base data it is necessary to provide optional arguments when converting base data to STARS variables. If a new cross-sectional unit is made up of a series of islands, each seperate shape will have attributes that need to be aggregated as well. Your choices include:

- Sum: Adds the values for all the shapes that make up each cross-section. We used this in the California Example for the field "AREA". This makes sense because we are aggregating several shapes into one, and we would probably want the total area for each cross-section.

- Max: Returns that maximum value for the variable in question for all shapes that make up each cross-section.

- Min: Returns that minimum value for the variable in question for all shapes that make up each cross-section.

- Average: Returns that average value for the variable in question for all shapes that make up each cross-section.

- String: Returns a string value for the aggregated cross-section. Users can use this for regime based variables, or to create a field with which to Join Data

1.3.7 Importing Weights Matrices

STARS has the ability to add GAL (Geographic Algorithim Library) matrix files to a project. See Section 1.2.3 for a an example.

1.3.8 Convert Data

This section provides a general description of converting data in the **Project Maker** environment.

- **Data-Variable-Convert-Base Data to CS**
  Creates a CS variable from your original base data. You will be prompted to select a field name from your original data and an optional argument.

- **Data-Variable-Convert-Base Data to CSTS**
  Creates a CSTS variable from your original base data. You will be prompted to select a series of fields from your original data and an optional argument. The number of fields you select must be identical to the number of time-periods in your study, and the fields should be selected in the correct order.

- **Data-Variable-Convert-Base Data to CSTS (Batch)**
  Creates a CSTS variable from your original base data on a Batch basis. **Project Maker** looks for base data field names with similar prefixes and lists them for the user to choose from. The user can select as many as they want. Figure 1.13 contains an example image. There are 5 variables that had similar prefixes in more than one field: "EDU", "FERT", "LFP", "MORT", "TFR". They also had similar suffixes: "70", "80", "90". In the ***.dbf** or ***.csv** base data file "EDU" would have 3 columns: "EDU70", "EDU80", "EDU90". In Figure 1.13 you will notice that we are going to create 3 new CSTS variables: "EDU", "FERT", "MORT". We use "70" and "90" as the start and end periods respectively. We then indicate that the increments between time periods is "10". Lastly, you have a choice of optional arguments. The batch method is a quick and effective way to create CSTS variables from more than one column in your original data file.

- **Data-Variable-Convert-Cross-Section to Panel**
  Creates a CSTS variable from CS variables you have already created. You must provide a name for your new CSTS variable. You can also choose whether you want to delete the CS variables you used to create the new CSTS variable.

- **Data-Variable-Convert-Panel to Cross-Section**
  Creates t = # of time periods CS variables from an existing CSTS variable. For example, if you had annual data for income (1970:1990), and the existing CSTS variable was named "income", the resulting CS variable would be "income1970"... "income1990". You can also choose whether you want to delete the CSTS variable you used to create the new CS variables.

1.3.9 Merge Data

Merging data to your new STARS project is rather easy within the **Project Maker** environment, but requires that the data is ordered in an appropriate manner. When a new Project is being made, the Cross-Sectional order is related to the order of the original base data. The user usually

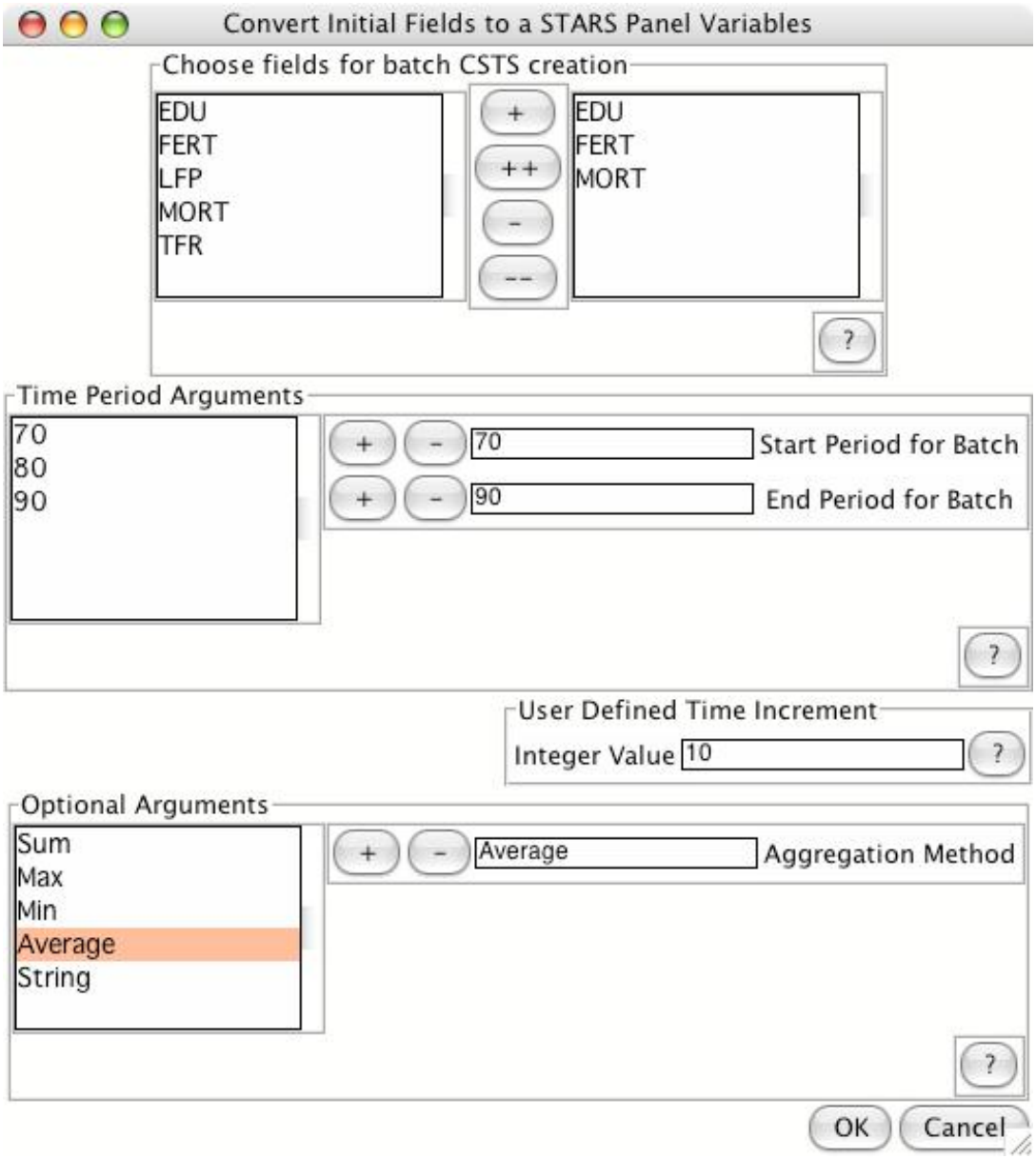


Figure 1.13: Creating Variables Via Batch

does not know this order to being with, so they often have to print the order to a file. If the data is ordered correctly then there are several options for merging data:

- **Data-Variable-Merge-CS Data**
  The user selects the ***.csv** file that contains CS variables in a column format. The first line in the ***.csv** contains the names of the new CS variables, and the remaining lines contain the values in the correct order. There should be $n + 1$ rows in the ***.csv**, one for the variable names, and n for the number of cross-sections.

- **Data-Variable-Merge-TS Data**
  The user selects the ***.csv** file that contains TS variables in a column format. The first row contains the names of the time-series variables, and the remaining lines contain the values. There should be $T + 1$ rows in the ***.csv**, one for the variable names, and T for the number of time periods.

- **Data-Variable-Merge-CSTS Data**
  The user selects the ***.csv** file that contains CSTS variable in a column format. You can only merge one CSTS variable per file. Therefore, the first line of the ***.csv** should only contain one variable name. The remaining lines contain the values in the correct order. There should be $n+1$ rows in the ***.csv**, one for the variable name, and n for the number of cross-sections. There should also be T columns in this file (the first row being the exception), one for each time period in the study.

1.3.10 Join Data

The join data method is different from merging because the data does not have to be in a pre-specified order. The join method uses a common field that exists in your new data file and in your new project to match the data appropriately. Often users will use "names" or "codes" to match their data. You can see an example in the California Tutorial. You can join data for CS or CSTS variables:

- **Data-Variable-Join-CS Data**
  The user selects the ***.csv** file that contains CS variables in a column format. The first line in the ***.csv** contains the names of the new CS variables as well as a name for a field that will be used for matching. There should be $n + 1$ rows in the ***.csv**, one for the variable names / matching field name, and n for the number of cross-sections. There should be $k + 1$ columns in the file: k for the number of new variables, and one extra for the matching field. The field for matching in your ***.csv** file is labeled as the "Slave". You will be prompted to match it with it's "Master" from the **Project Maker** environment. See Section 1.9 for an example.

- **Data-Variable-Join-CSTS Data**
  The user selects the ***.csv** file that contains CSTS variable in a column format. The first line in the ***.csv** contains the names of the new CSTS variable in order of T as well as a name for a field that will be used for matching. For example, the first row of your file may look like: "NAME", "VAR_1", "VAR2_" ... "VAR_T"
  There should be $n + 1$ rows in the ***.csv**, one for the variable names / matching field name, and n for the number of cross-sections. There should be $T + 1$ columns in the file: T for the

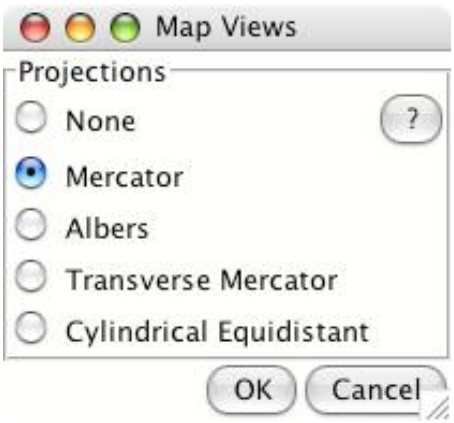


Figure 1.14: Possible Projections for Plotting

number of time periods, and one extra for the matching field. The field for matching in your ***.csv** file is labeled as the "Slave". You will be prompted to match it with it's "Master" from the **Project Maker** environment. See Section 1.9 for an example.

1.3.11 Tables

The **Tables** allows the user to view their data. The choices are as follows:

1. **Specific Variables:** Allows the use to select individual variables that have been added to the project for viewing.
2. **CS Variables:** Creates a table with all of the CS variables created so far.
3. **TS Variables:** Creates a table with all of the TS variables created so far.
4. **CSTS Variables:** Creates a table with all of the CSTS variables created so far.
5. **CS and CSTS Variables:** Creates a table with all of the CS and CSTS variables created so far.
6. **Base Data** Re-creates a table containing all your *base data*.

1.3.12 Plotting and Projections

All new projects that contain maps must be projected and plotted before the project can be completed. Figure 1.14 contains the possible projections for you STARS project map.

Resources

The project homepage for STARS is at http://stars-sf.py.

The STARS-User mailing list is at https://sourceforge.net/mailarchive/forum.php?forum_id=41297

The development page for STARS is at https://sourceforge.net/projects/stars-py/.

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