The Field Calculator UNLEASHED

By Tom Neer, EDAW, Inc.

Understanding basic programming techniques allows the GIS user greater flexibility and expands the functionality of ArcGIS. Software developers no longer write every little utility a user might need but instead provide code-level access to the underpinnings of their software.

This article covers the basics of the Field Calculator in ArcMap. It explains the attribute table and describes how to use the simple field calculator. The Field Calculator is a tremendously useful but sometimes overlooked tool. It can eliminate the tedious process of manually entering values in a table or create new data from existing data in a table. Using the Field Calculator also provides nonprogrammers with a foundation for understanding programming in a nearly painless manner.

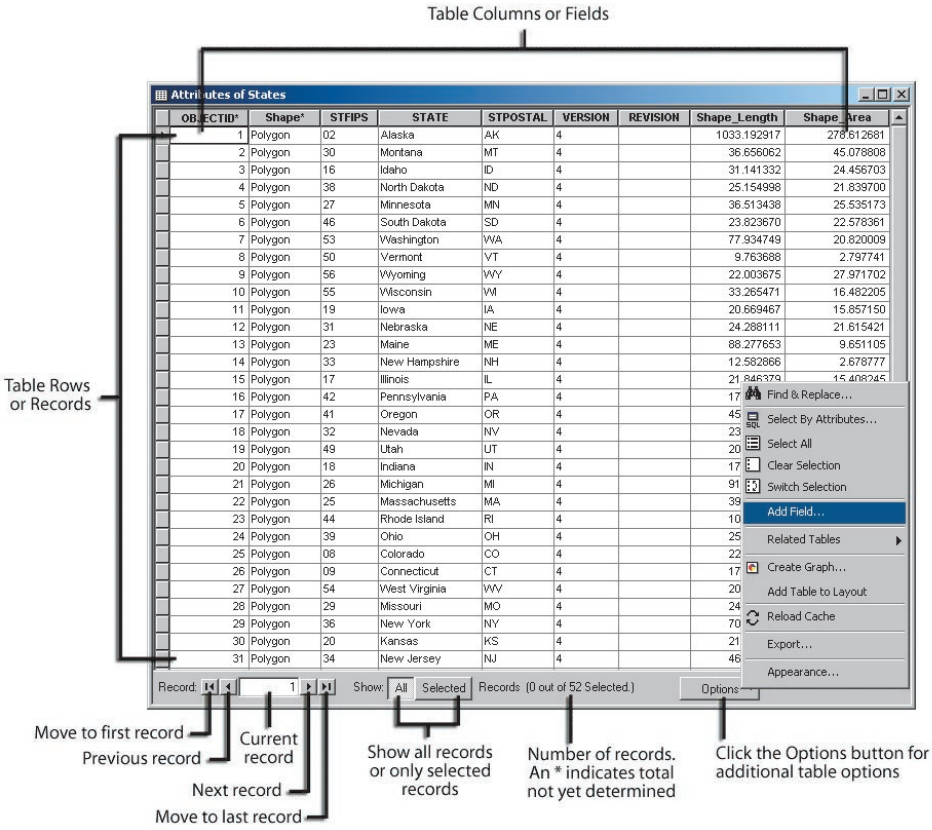
The operations described in this article are available in ArcMap at any license level (i.e., ArcView, ArcEditor, or ArcInfo). Not only will these examples save time but they can also provide a place to start developing your own uses for the field calculator.

Understanding and Modifying the Attribute Table

The attribute table is the database component of geographic datasets, whether that dataset is a shapefile, coverage, geodatabase, or something else. All attribute tables are stored in a database format. Shapefiles are stored in dBASE, personal geodatabases are stored in Microsoft Access, and ArcSDE geodatabases can be stored in a variety of relational database management systems (DBMS) such as IBM DB2, Informix, Microsoft SQL Server, and Oracle. There are differences between these databases, but the following examples and descriptions focus on the commonality between databases.

Attribute Table Elements

To open an attribute table in ArcMap, right-click on a feature dataset in the Table of Contents and choose Open Attribute Table. The attribute table contains the database attributes for the selected feature dataset. The attribute table is a flat file representation of the database that is similar to a spreadsheet. The table records, or rows, are the representation of each feature—a state, road, stream—whatever your data represents. The table fields, or columns, are the attributes contained by each feature—the shape, area, perimeter, or state name.



The anatomy of an attribute table.

The attribute table shows the elements in a states feature dataset stored in a geodatabase. Each state has an object ID [OBJECTID], which is automatically generated. The Shape field stores the graphic representation.

STFIPS, STATE, and STPOSTAL are field attributes commonly used to define a state. VERSION and REVISION are fields specific to this dataset from the Bureau of Transportation statistics. Shape_Length and Shape_Area are fields created by ArcGIS in geodatabases that store the shape's length or perimeter and area. The units in these fields are stored in the native units of the dataset—decimal degrees in this case.

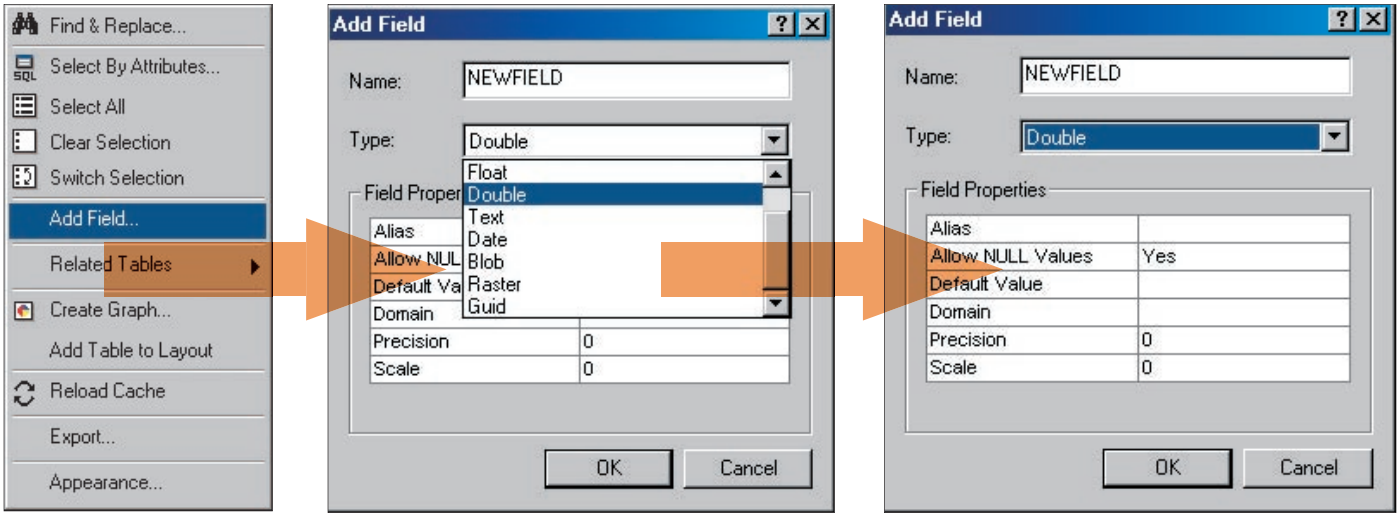
Adding Fields

The Field Calculator is often used to create a new field. To add a new field to an attribute table, open the table as previously described and click the Options button in the Attribute Table. Select Add Field. The Add Field dialog box will open. In this dialog box, give the field a name (Name), define the data type (Type), and set the precision and scale (if applicable). Alternative methods for adding fields to feature datasets can be found in the article "Adding Fields to a Shapefile Attribute Table in ArcGIS" in the October–December 2002 issue of *ArcUser*.

Creating Field Names

In shapefiles, field names are limited to 10 characters and can only use numbers, letters, hyphens, and underscores. A couple of other characters will work but are not recommended. No spaces or other special characters are allowed in shapefile field names. Shapefiles are one of the most common GIS datasets. Because of the character limit of field names, the user needs to be careful when naming fields.

In personal geodatabases, field names are constrained by Microsoft Access field naming



Adding a field to an attribute table.

Data Type	Size	Range	Description
Short Integer	2 bytes	+/- 32,768	Short integers are whole numbers, either positive or negative, that are typically used for coding. They are used for lists of short value such as land-use codes, vegetation types, and Booleans (i.e., true/false).
Long Integer	4 bytes	+/- 2.14 billion	Long integers are whole numbers, either positive or negative, that are typically used to store quantity values such as population figures.
Float	4 bytes	+/- 3.4 x 1,038	Float data types are single-precision floating-point numbers that can support numbers with an accuracy to 6 places past the decimal. A float can have a precision of 0–8 numbers with a scale of 0. Floats are used to store simple decimal numbers such as percentages.
Double	8 bytes	+/- 1.8 x 10,308	Double data types are double-precision floating point numbers that can support numbers with an accuracy to 15 places past the decimal. A float can have a precision of 6–19 numbers with a scale of 0. Doubles are used to store decimal numbers with a high level of detail such as latitude and longitude.
Date	8 bytes	Jan. 1, 100 to Dec. 31, 9999	Dates are stored in Coordinated Universal Time (UTC) format and are translated into the current day and time in the local time zone.
Text	1 byte per character	1–255 characters	The text data type stores any character string (names, abbreviations, alphanumeric codes, and numeric codes that begin with 0 such as ZIP Codes).

Figure 1: Six common data types supported by ArcGIS.

	100 Records	1,000 Records	10,000 Records	100,000 Records
Field Length of 2	0.20 KB	1.95 KB	19.53 KB	195.31 KB
Field Length of 50	4.88 KB	48.83 KB	488.28 KB	4882.81 KB

Figure 2: File size difference for text field with length of 2 compared to 50 characters.

restrictions. Fields can be up to 64 characters long and can include any combination of letters, numbers, spaces, and special characters except periods (.), exclamation points (!), accent graves (`), double quotation marks (“), and brackets ([ ]). Geodatabase field names cannot begin with leading spaces or include control characters (ASCII values 0 through 31).

ArcSDE geodatabases have the field name restrictions of the underlying DBMS. Objects such as feature classes or relationship classes are stored as tables in an RDBMS, so these restrictions affect more than just stand-alone tables.

Although personal geodatabases and ArcSDE geodatabases allow longer field names and special characters, bear in mind that this data may be exported as a shapefile. If exported, field names will be truncated to 10 characters and it may become difficult or impossible to tell the difference between fields called [POPULATION UNDER 21] and [POPULATION OVER 21] because they will be named [POPULATI_1] and [POPULATI_2] when exported as shapefiles.

Consequently, forethought should be used in naming fields. Use common or easily interpreted abbreviations for field names. Remember, you are not always the only user. If a field name is complex, create an alias and define it in the metadata. The ArcGIS Desktop Help has a good section on defining aliases for fields. Type Alias in the Index tab to locate this topic. In the box above are examples of truncated field names that are easily discerned.

Elevation in Meters	ELEV_M
Area in Acres	AREA_ACRES
Area in Square Feet	AREA_SQ_F
Population in 2000	POP_2000

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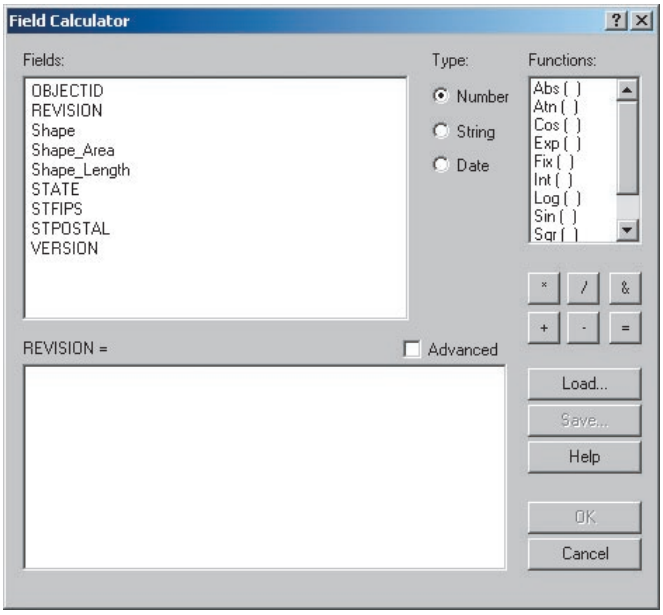
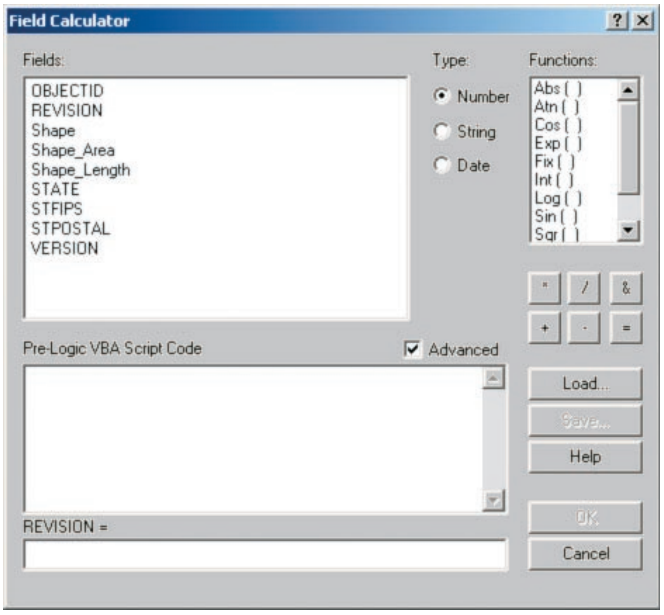


The simple Field Calculator is opened by right-clicking on a field name in a table.



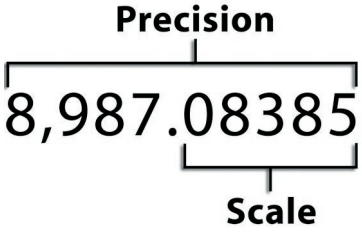
Checking the Advanced box on the simple Field Calculator invokes the advanced Field Calculator that performs advanced calculations using Visual Basic for Applications (VBA) statements that process the data before calculations are made on the selected field.

Setting Data Types

There are six common data types supported by ArcGIS. Figure 1 summarizes the characteristics for these basic data types and their uses. There are several others, but they are rarely used in the Field Calculator.

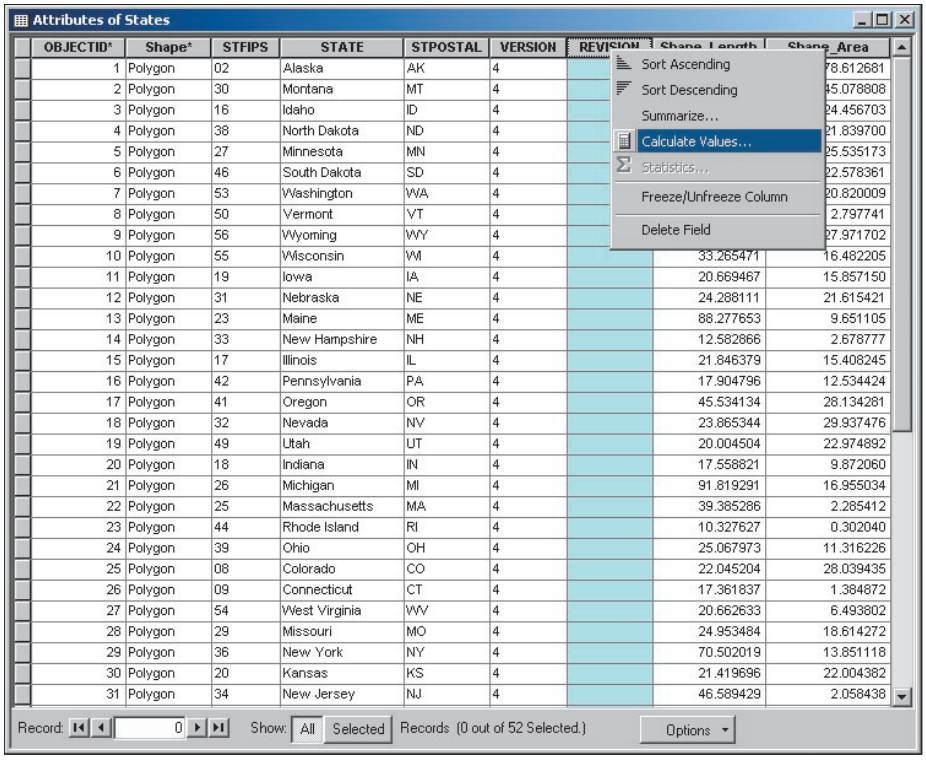
Data Type Field Properties

After selecting a field data type, the Add Field dialog box will display the Field Properties for that data type. For text fields, the Field Property is Length. This refers to the size or length of the text field. Length can be set between 1 and 255 characters, but ArcGIS defaults to 50 characters.



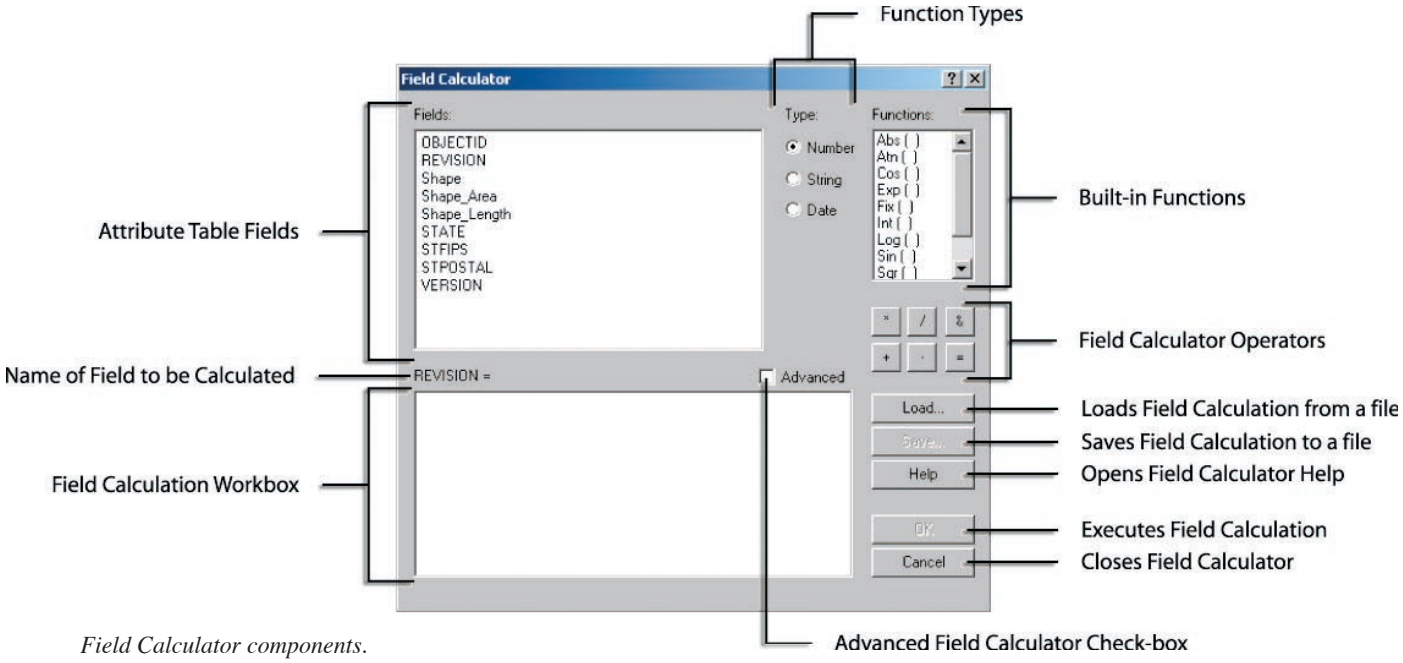
Precision and scale properties.

However, leaving the text length set to the default value and entering only a two-character abbreviation is an inefficient use of storage space. Unnecessarily large fields can add up quickly and affect field calculation speed. The effect of size on the performance of datasets containing only a couple hundred records is not noticeable, but it becomes an issue as feature datasets get larger. The table in Figure 2 shows the file size difference in kilobytes using a text field length of 50 versus 2 for state abbreviations. While you probably will not have a file with 100,000 states, with datasets such as contours and land use, this inefficient use of storage can be a problem.



Opening the Field Calculator to populate a new field.

For numeric data types of integer, float, and double must be set. Short and long integer data types have a precision field property. Float and double data types have precision and scale field properties. Precision refers to the number of digits used to store numbers. Scale refers to the number of decimal places to the right of the decimal point. See the ArcGIS Help topic "Setting an appropriate geodatabase spatial domain" for information on setting appropriate precision and scale properties. The Field Calculator can be used in a variety of ways to populate this newly created field.



Field Calculator components.

Using the Field Calculator

The Field Calculator can be used to set the field value of one, several, or all the records in a feature dataset. The Field Calculator is a useful tool for copying, concatenating, or creating new fields of information. The Field Calculator has two modes—simple and advanced. In simple mode, the Field Calculator is used for copying fields, concatenating (i.e., combining) strings, performing most mathematical calculations, and entering raw data. The advanced mode allows the Field Calculator to be used for conditional reclassification, complex mathematical calculations, and extracting geometric and geographic information.

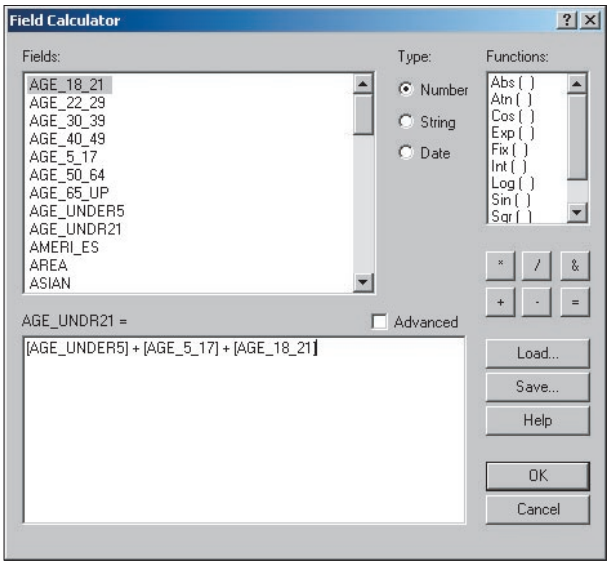
The Field Calculator can be used within an edit session or outside an edit session. Performing calculations within an edit session allows any field calculations to be undone. Calculating on fields outside an edit session is faster but commits those calculations without allowing them to be undone. However, fields can be recalculated. The general rule of thumb is when calculating on fields with data, calculate within an edit session. When calculating on a new empty field, calculate outside an edit session. For fields in a geodatabase feature class with topology or a network, the Calculates Values command will only be available within an edit session.

To open the Field Calculator, open an attribute table or other table in ArcMap. Right-click on the name of the field to be edited and select Calculate Values.

Exploiting the Simple Field Calculator

To calculate on all records in a table, do not select any records or select all records. To calculate only on one record, click on that record. To calculate on selected records, either control-click the records desired or use the Select by Attributes or Select by Location commands to highlight them.

One common use for the simple Field Calculator is copying the contents of one field to another field. With the Field Calculator open, click on a field under the Fields list. The field should appear in the field calculation workbox in brackets. Click OK. This will populate the new field with a copy of the data in the source field. This is useful for renaming fields or providing a more descriptive field name.



An example of a simple field calculation.

Use simple field calculations to perform most mathematical operations, simple string (text) functions, and raw data entry. Remember to use double quotes when calculating strings. For example, the Field Calculator can be used to calculate the total population under the age of 21 from Bureau of Census records. A table of demographic data was imported into ArcMap. A new field called [AGE_UNDR21] was created as a long integer. The fields [AGE_UNDER5], [AGE_5_17], and [AGE_18_21] were added by clicking on them in the field list and separated by the addition sign.

Additional examples of operations that can be performed in the simple Field Calculator are included in the table on page 54. There are far more functions in the simple Field Calculator available than are listed here. The VBScript Function page at www.w3schools.com/vbscript/vbscript_ref_functions.asp is a good source for additional function descriptions. For more information on this tutorial, contact

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About the Author

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MATHEMATICAL OPERATONS

Objective	Code	Example
Add two or more fields.	[numericField1] + [numericField2]	1 + 2
Subtract two or more fields.	[numericField1] - [numericField2]	2 - 1
Multiply two or more fields.	[numericField1] * [numericField2]	2 * 2
Divide two fields.	[numericField1] / [numericField2]	4 / 2
Find percentage of population.	[age_Field1] / [total Population]	[AGE_UNDR21] / [POP2000]
Find percentage of multiple populations.	([age_Field1] + [age_Field2] + [age_Field3]) / [total Population]	([AGE_UNDER5] + [AGE_5_17] + [AGE_18_21]) / [POP2000]
Convert units from meters to feet.	[meters] * 3.2808	30 * 3.2808 returns 98.4
Convert degrees minutes seconds to decimal degrees.	[DEG] + ([MIN] / 60) + ([SEC] / 3600)	[121] + ([8} / 60) + ([6] / 3600 returns 121.135

STRING OPERATIONS

Objective	Code	Example
Populate field with new text.	"Text"	"Text" = "Text"
Concatenate two text fields. The concatenate operator "&" binds two strings together.	[textField1] & [textField2] (without a space} [textField1] & " " & [textField2] (with a space)	"Joe" & "User" = "JoeUser" "Joe" & " " & "User" = "Joe User"
Concatenate new text with field.	"Text" & " " & [textField]	"Text" & " " & "Text2" = "Text Text2"
Convert numeric field to text.	Str([numericField])	Str(123) = "123"
Return the number of characters in a string (returns a long integer).	Len([Field])	Len("text") = 4
Return the leftmost n characters.	Left([textField], n) (where n is the number of characters)	Left("abcdefg", 3) = "abc"
Return the rightmost n characters.	Right([textField], n) (where n is the number of characters)	Right("abcdefg", 3) = "efg"
Convert all text to lowercase.	LCase([textField])	LCase("Text") = "text"
Convert all text to uppercase.	UCase([textField])	UCase("Text") = "TEXT"
Trim space(s) from beginning and end of text.	Trim([textField])	Trim(" Text ") = "Text"

DATE OPERATIONS

Objective	Code	Example
Enter today's date.	Now() or Date()	Date() = October 1, 2003
Add a year to the date.	DateAdd("yyyy", 1, [dateField])	DateAdd("yyyy", 1, October 1, 2003) = October 1, 2004
Find the difference between two dates (in months).	DateDiff("m", [dateField1], [dateField2])	Example: DateDiff("m", October 1, 2004, October 1, 2003) = 12
Find the day number.	DatePart("d", [dateField])	DatePart("d", October 1, 2003) = 1