



The Coleman Group, Inc.  
*Inspired Thinking... Intelligent Solutions.*

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# AUTOMATING GEOPROCESSING TASKS WITH MODEL BUILDER AND PYTHON

SMALL AREA HEALTH INSURANCE ESTIMATES PROJECT  
(SAHIE) 2014

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# Who we are and what we do

## **The Coleman Group, Inc.**

- **IT/Cyber Security Service provider to Federal Agencies**

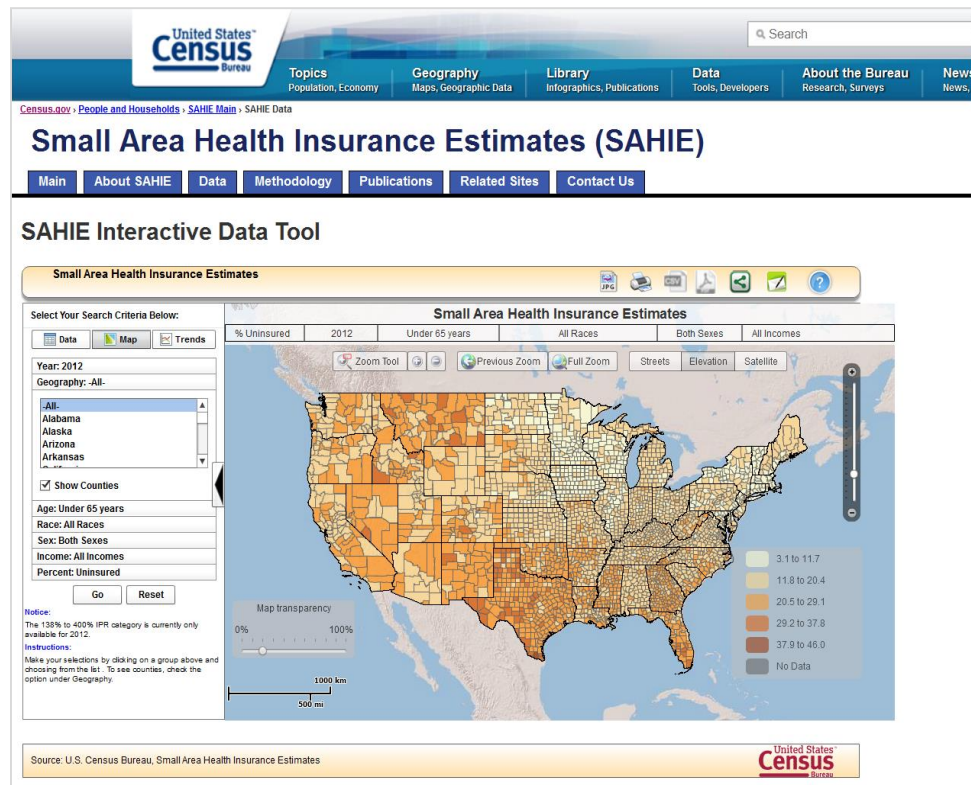
## **My current assignment : U.S. Census Bureau (DC)**

- **Demographic Survey Division**
  - **Dissemination and Internet Services (DIS)**
- **Dissemination of Public Data Products**



# Small Area Health Insurance Estimates (SAHIE)

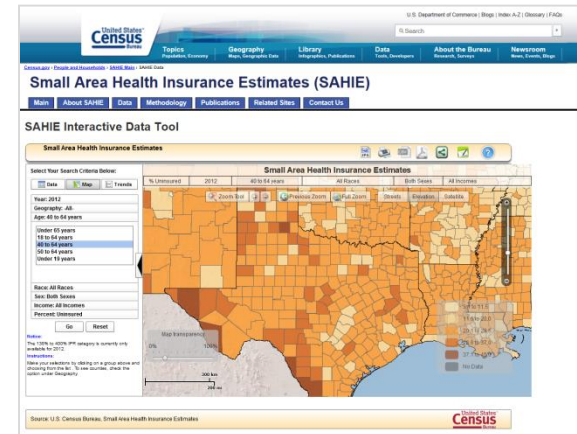
Automating the process by which the mapping services are created through a series of geoprocessing tasks, and results are consumed by the SAHIE interactive mapping tool (API)



# About Small Area Health Insurance Estimates (SAHIE)

- Produces timely estimates of health insurance coverage for all counties and states by detailed demographic and income groups.

More info: <https://www.census.gov/did/www/sahie>



The screenshot shows the SAHIE Interactive Data Tool interface with a data table. The table has columns for Year, ID, Name, Demographic Group, Uninsured (Number, %), and Insured (Number, %). The data is filtered for the year 2012 and the state of Alabama. The table lists various counties and their corresponding demographic groups and insurance status.

Year	ID	Name	Demographic Group	Uninsured	Insured						
			Number	%	Number	%					
2012	01000	Alabama		24,082	7,665	83	2,227,898	7,665	83		
2012	01001	Adelphi County, AL		16,252	2,440	304	113	17	15,912	304	87
2012	01002	Baldwin County, AL		65,950	18,150	1,008	18.8	1.8	55,015	1,008	84.4
2012	01005	Barbour County, AL		9,399	1,394	174	2.2	2.2	6,705	174	82.8
2012	01007	Bibb County, AL		7,995	1,098	141	19.0	2.0	6,898	141	89.0
2012	01008	Blount County, AL		19,450	3,520	360	11.1	2.9	15,932	360	89.9
2012	01011	Bolton County, AL		2,890	309	79	27.6	2.4	2,381	79	82.4
2012	01012	Bullock County, AL		9,794	1,123	148	19.5	2.2	8,670	148	85.5
2012	01015	Calhoun County, AL		28,815	6,015	625	18.2	1.8	22,308	625	88.8
2012	01017	Chambers County, AL		11,855	1,969	250	15.6	2.1	8,886	250	83.4
2012	01019	Cherokee County, AL		8,930	1,528	204	19.9	2.1	6,901	204	81.1
2012	01021	Chickasaw County, AL		14,440	2,591	294	17.4	2.0	11,921	294	85.2
2012	01023	Chickosa County, AL		4,826	719	89	19.9	2.1	4,057	89	84.1
2012	01025	Choctaw County, AL		8,389	1,442	180	17.0	2.1	7,127	180	83.0
2012	01027	Chocoma County, AL		4,755	641	105	17.9	2.2	3,984	105	82.1
2012	01029	Candler County, AL		5,110	618	107	19.0	2.1	4,282	107	84.0
2012	01031	Carroll County, AL		16,910	3,580	380	18.4	1.7	13,060	380	84.8
2012	01033	Colbert County, AL		16,942	2,738	334	14.4	1.8	14,206	334	85.6
2012	01035	Crenshaw County, AL		4,527	795	105	17.6	2.3	3,732	105	82.4
2012	01037	Crawford County, AL		4,233	688	91	18.8	2.1	3,348	91	84.2
2012	01039	Covadonga County, AL		12,844	2,246	265	17.8	2.1	10,598	265	82.5



# SAHIE AUTOMATION

## Our Goal

To automate GIS workflow in order to process data, create mapping documents, and publish mapping services for SAHIE interactive web mapping tool (API)

## Our (geo)Process

The process of creating map services had been in place for a few years. It involves data edits and transformation, and several (~14) geoprocessing tasks, including creating map services. All tasks are currently performed manually, and last nearly 2 days to complete. The lengthy and repetitive nature of geoprocessing tasks compelled us to automate our workflow so that we can increase process efficiency and reduce human errors.

## Our Approach

1. Use ModelBuilder to test and document our workflow; and
2. Use Python scripting to complete automating the process.

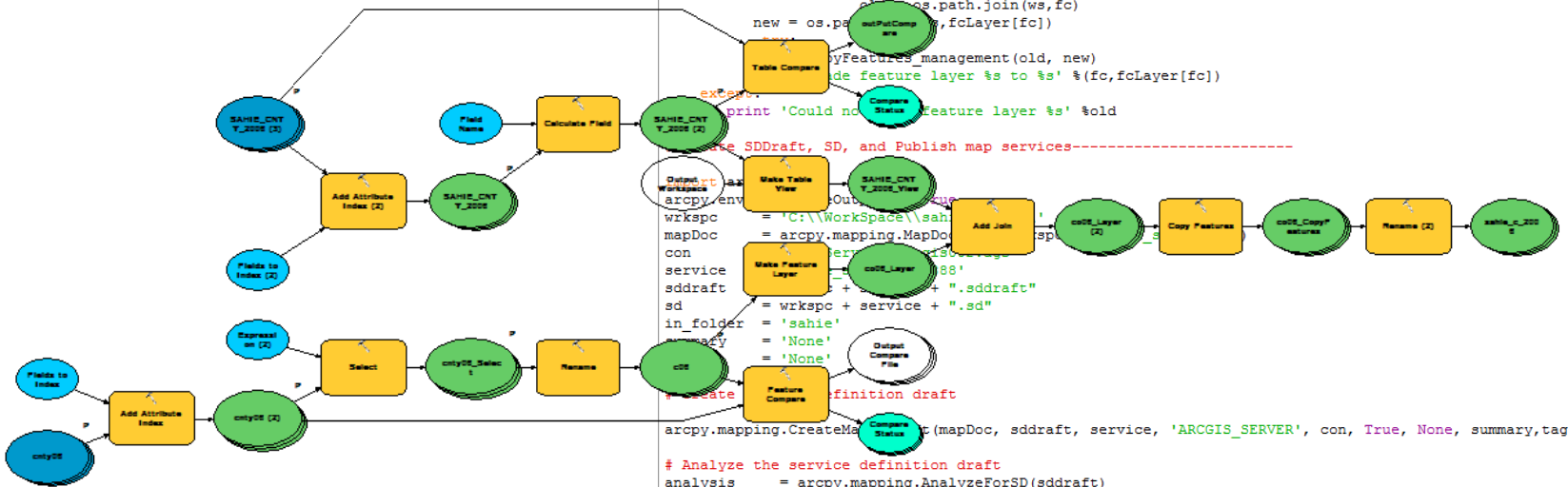


# Work Environment

1. **SAS** native data format
2. **Excel**(tab delimited .txt)
3. **ArcGIS for desktop/Server 10.1**
4. **Python 2.7.2**



# Tools: ModelBuilder and Python



```

File Edit Format Run Options Windows Help
import arcpy
from arcpy import env
env.workspace = ws = 'C:\\Workspace\\sahie_saiepe\\sahie_saiepe.gdb'

pairList = [['cnty06_Layer', 'SAHIE_CNTY_2006'], ['cnty07_Layer', 'SAHIE_CNTY_2007'], ['cnty08_Layer', 'SA
for pair in pairList:
    inLayer = r"%s\\%s" % (ws, pair[0])
    inTable = r"%s\\%s" % (ws, pair[1])
    Lyr = pair[0]
    outTable = r"%s\\%s" % (inLayer, "_joined")
    # arcpy.MakeFeatureLayer_management(inLayer, Lyr)
    arcpy.AddJoin_management(inLayer, "GEO_ID", inTable, "stccou", "KEEP_ALL")
    if arcpy.Exists(outTable):
        arcpy.Delete_management(outTable)
    arcpy.CopyFeatures_management(Lyr, outTable)
    print "done!"
# Copy Feature Layers
env.workspace = ws = 'C:\\workspace\\sahie_saiepe\\sahie_saiepe.gdb'
fcLayer = ('cnty06_Layer:co06 ', 'cnty07_Layer:co07', 'cnty08_Layer:co08', 'cnty09_Layer:co09', 'cnty10_La
for fc in ListFeatureClasses():
    if fc in fcLayer:
        old = os.path.join(ws, fc)
        new = os.path.join(ws, fc)
        arcpy.CopyFeatures_management(old, new)
        arcpy.Delete_management(outTable)
        arcpy.AddJoin_management(inLayer, "GEO_ID", inTable, "stccou", "KEEP_ALL")
        print "Could not find feature layer %s" % old

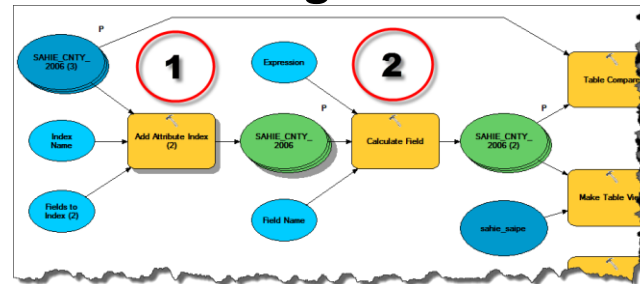
-----
# Create SDDraft, SD, and Publish map services-----
# Create SDDraft
env.workspace = ws = 'C:\\workspace\\sahie_saiepe\\sahie_saiepe.gdb'
wrkspc = 'C:\\Workspace\\sahie_saiepe\\sahie_saiepe.gdb'
mapDoc = arcpy.mapping.MapDocument("CURRENT")
con = 'ServiceName = "SAHIE_CNTY_2008"'
service = "SAHIE_CNTY_2008"
sddraft = "SAHIE_CNTY_2008" + ".sddraft"
sd = wrkspc + service + ".sd"
in_folder = 'sahie'
summary = 'None'
arcpy.CreateServiceDefinitionDraft("SAHIE_CNTY_2008", sddraft, sd, con, service, in_folder, summary)
arcpy.mapping.CreateMapServiceDefinitionDraft(mapDoc, sddraft, service, 'ARCGIS_SERVER', con, True, None, summary, tags)

# Analyze the service definition draft
analysis = arcpy.mapping.AnalyzeForSD(sddraft)
# Stage the service definition if the sddraft analysis did not contain errors
if analysis["errors"] == {}:
    # Execute StageService
    arcpy.StageService_server(sddraft, sd)
    # Execute UploadServiceDefinition
    arcpy.UploadServiceDefinition_server(sd, con, service, "default", "EXISTING", in_folder)
else:
    # If the sddraft analysis contained errors, display them
    print analysis["errors"]
    
```

# Why ModelBuilder?

## ModelBuilder: Workflow easily understood through visualization

- Simplifies modeling process
  - “visual programming”
  - WYSIWYG –
  - drag-and-drop
- Proof of concept/test hypothesis: show and tell for non-tech staff
- Maintaining institutional memory – pass it on...
- Documentation: document and share your process
- Start a Python script with a model
- Build your own tools – no coding





# Why Python?

## **More capabilities and flexibilities = fits our needs**

- Run script in ArcGIS or stand-alone
- Easy to edit vs. opening ModelBuilder in ArcGIS
- Do more with scripting
- Excellent support community
- Plays nicely with ModelBuilder
- Build customized tools



# Our Workflow

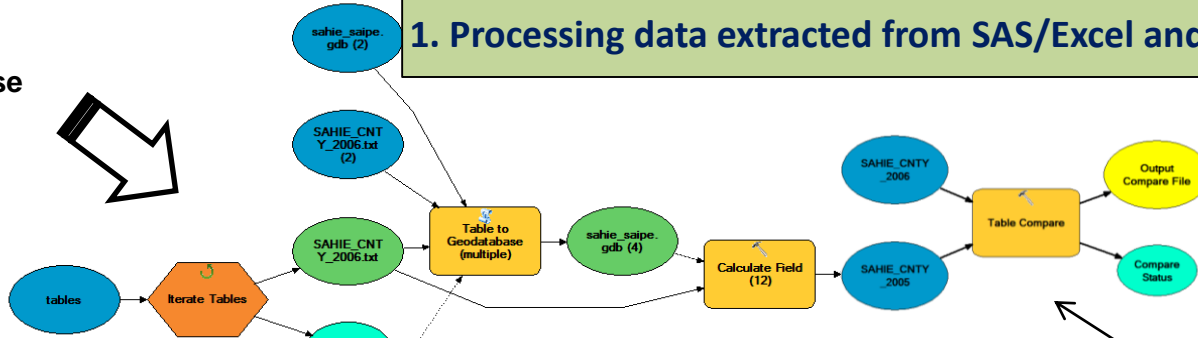


# Workflow Model

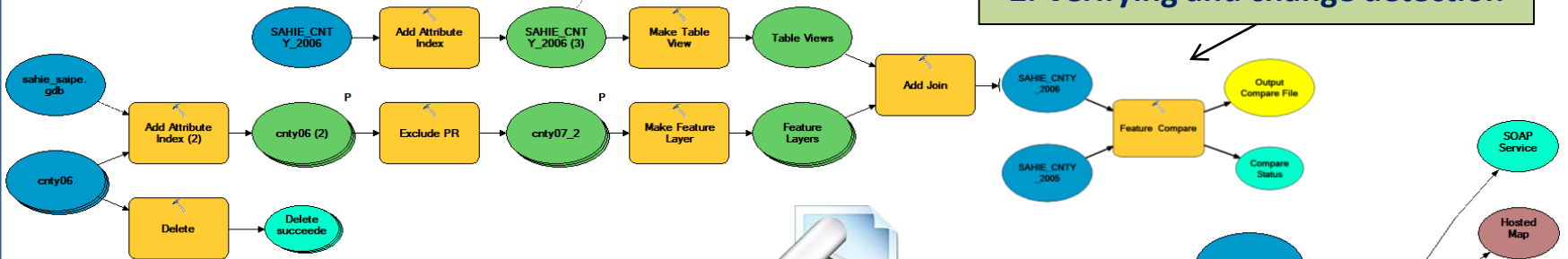


File Geodatabase

**1. Processing data extracted from SAS/Excel and exported to fGDB**



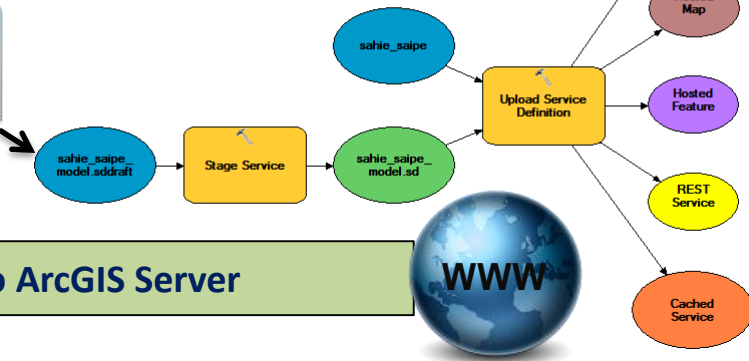
**2. Verifying and change detection**



**3. Geoprocessing feature classes**



**4. Publishing map services to ArcGIS Server**



# Taking the first Python step

```
File Edit Format Run Options Windows Help
# Name: sahie_compiled.py
# Created on: 2014-01-17 12:52:24.00000
# Usage:
# Description: This is a compiled version of 7 Python tools
# -----

import arcpy

# -----
# Set workspace
# -----

from arcpy import env
env.workspace = "C:\\Workspace\\sahie\\sahie.gdb"

# -----
# Process: ETL.py extracts, transforms and loads tab delimited text
# tables from XLSX to geodatabase tables.
# -----

# Extract Script arguments
SAHIE_CNTY_2006_txt = arcpy.GetParameterAsText(0)
if SAHIE_CNTY_2006_txt == "#" or not SAHIE_CNTY_2006_txt:
    SAHIE_CNTY_2006_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2006.txt"
# provide a default value if unspecified

SAHIE_CNTY_2007_txt = arcpy.GetParameterAsText(1)
if SAHIE_CNTY_2007_txt == "#" or not SAHIE_CNTY_2007_txt:
    SAHIE_CNTY_2007_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2007.txt"
# provide a default value if unspecified

SAHIE_CNTY_2008_txt = arcpy.GetParameterAsText(2)
if SAHIE_CNTY_2008_txt == "#" or not SAHIE_CNTY_2008_txt:
    SAHIE_CNTY_2008_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2008.txt"
# provide a default value if unspecified

SAHIE_CNTY_2009_txt = arcpy.GetParameterAsText(3)
if SAHIE_CNTY_2009_txt == "#" or not SAHIE_CNTY_2009_txt:
    SAHIE_CNTY_2009_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2009.txt"
# provide a default value if unspecified

SAHIE_CNTY_2010_txt = arcpy.GetParameterAsText(4)
if SAHIE_CNTY_2010_txt == "#" or not SAHIE_CNTY_2010_txt:
    SAHIE_CNTY_2010_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2010.txt"
# provide a default value if unspecified

SAHIE_CNTY_2011_txt = arcpy.GetParameterAsText(5)
if SAHIE_CNTY_2011_txt == "#" or not SAHIE_CNTY_2011_txt:
    SAHIE_CNTY_2011_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2011.txt"
# provide a default value if unspecified

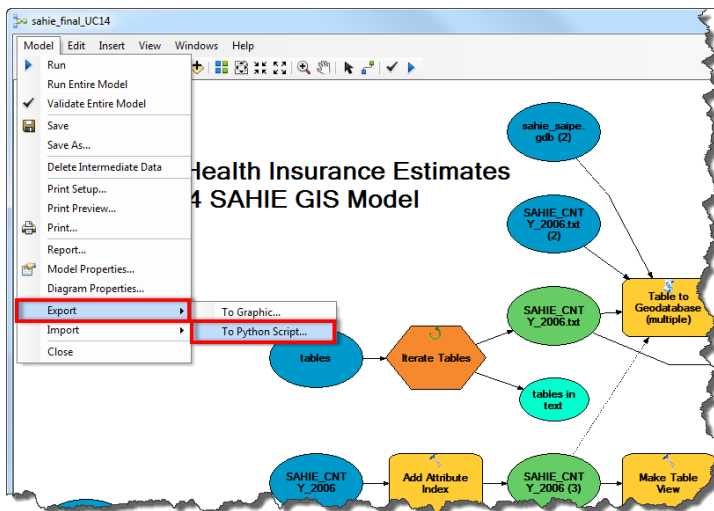
SAHIE_CNTY_2012_txt = arcpy.GetParameterAsText(6)
if SAHIE_CNTY_2012_txt == "#" or not SAHIE_CNTY_2012_txt:
    SAHIE_CNTY_2012_txt= "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2012.txt"
# provide a default value if unspecified

SAHIE_ST_2006_txt = arcpy.GetParameterAsText(7)
if SAHIE_ST_2006_txt == "#" or not SAHIE_ST_2006_txt:
    SAHIE_ST_2006_txt = "C:\\Workspace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2006.txt"
# provide a default value if unspecified
```



# From ModelBuilder to Python

1. Export your model from ModelBuilder to Python script
2. Review Python script in text editor
3. Can you run this script?



```
74 sahieModelBuilder.py - C:\Workspace\sahie_saige\sahie_saige_script\sahie_saige_final\sahieModelBuilder.py
File Edit Format Run Options Windows Help
# -----
# sahieModel.py
# Created on: 2014-04-11 09:13:50.00000
# (generated by ArcGIS/ModelBuilder)
# Usage: sahieModel
# Description:
# -----

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("H:/Workspace/sahie/Model/gp/sahie_tools.tbx")

# Script arguments
st_2 = arcpy.GetParameterAsText(0)
if st_2 == '#' or not st_2:
    st_2 = "H:\\Workspace\\sahie\\sahie.gdb\\st" # provide a default value if unspecified

st_3 = arcpy.GetParameterAsText(1)
if st_3 == '#' or not st_3:
    st_3 = "H:\\Workspace\\sahie\\sahie.gdb\\st" # provide a default value if unspecified

st_5 = arcpy.GetParameterAsText(2)
if st_5 == '#' or not st_5:
    st_5 = "in_memory\\(4EB22EF7-02D0-430C-BBB6-E1D8A4580861)" # provide a default value if unspecified

st_4 = arcpy.GetParameterAsText(3)
if st_4 == '#' or not st_4:
    st_4 = "in_memory\\(4EB22EF7-02D0-430C-BBB6-E1D8A4580861)" # provide a default value if unspecified

st_6 = arcpy.GetParameterAsText(4)
if st_6 == '#' or not st_6:
    st_6 = "in_memory\\(4EB22EF7-02D0-430C-BBB6-E1D8A4580861)" # provide a default value if unspecified

st_7 = arcpy.GetParameterAsText(5)
if st_7 == '#' or not st_7:
    st_7 = "in_memory\\(4EB22EF7-02D0-430C-BBB6-E1D8A4580861)" # provide a default value if unspecified
```



# Review your script in text editor

Can you run your script from ModelBuilder? It depends!

1. If you are processing a series of fcs using several tools, the ModelBuilder repeats the same script over and over – in this case over 450 lines of code were generated by the ModelBuilder.
2. **“iterators” do not work as Python script (from ModelBuilder)**
3. If you have imported tools from Toolbox, the script may have difficulty locating and running it!
4. Change the name to default toolbox name(run from within ArcGIS)
5. Check the paths to your workspace (gdb, etc.)

```
12 #-----
13
14 from arcpy import env
15 env.workspace = "C:\\WorkSpace\\sahie\\sahie.gdb"
16
17 #-----
18 # Process: ETL.py extracts, transforms and loads tab delimited text
19 # tables from XLSX to geodatabase tables.
20 #-----
21
22 # Extract Script arguments
23 SAHIE_CNTY_2006_txt = arcpy.GetParameterAsText(0)
24 if SAHIE_CNTY_2006_txt == "#" or not SAHIE_CNTY_2006_txt:
25     SAHIE_CNTY_2006_txt= "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_
26 # provide a default value if unspecified
27
28 SAHIE_CNTY_2007_txt = arcpy.GetParameterAsText(1)
29 if SAHIE_CNTY_2007_txt == "#" or not SAHIE_CNTY_2007_txt:
30     SAHIE_CNTY_2007_txt= "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_
31 # provide a default value if unspecified
32
33 SAHIE_CNTY_2008_txt = arcpy.GetParameterAsText(2)
34 if SAHIE_CNTY_2008_txt == "#" or not SAHIE_CNTY_2008_txt:
35     SAHIE_CNTY_2008_txt= "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_
36 # provide a default value if unspecified
37
38 SAHIE_CNTY_2009_txt = arcpy.GetParameterAsText(3)
39 if SAHIE_CNTY_2009_txt == "#" or not SAHIE_CNTY_2009_txt:
40     SAHIE_CNTY_2009_txt= "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_
41 # provide a default value if unspecified
42
43 SAHIE_CNTY_2010_txt = arcpy.GetParameterAsText(4)
44 if SAHIE_CNTY_2010_txt == "#" or not SAHIE_CNTY_2010_txt:
45     SAHIE_CNTY_2010_txt= "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_
46 # provide a default value if unspecified
47
48 SAHIE_CNTY_2011_txt = arcpy.GetParameterAsText(5)
```



# Review/test ModelBuilder Script in ArcMap

1. Copy/paste or load your script into ArcMap/ArcCatalog Python window
2. Use Geoprocessing results to monitor progress and review errors
3. Error No. or syntax error
4. Use ArcGIS Help to identify and correct your errors
5. Use Forums to ask for help



# Do you know Python?

## Rewrite/edit ModelBuilder script

Script imported from ModelBuilder ~ 43 lines

Edited in Python < 10 lines

```
from arcpy import env
env.workspace = "C:\\WorkSpace\\sahie\\sahie.gdb"
SAHIE_CNTY_2006_txt = arcpy.GetParameterAsText(0)
if SAHIE_CNTY_2006_txt == "#" or not SAHIE_CNTY_2006_txt:
    SAHIE_CNTY_2006_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2006.txt"
SAHIE_CNTY_2007_txt = arcpy.GetParameterAsText(1)
if SAHIE_CNTY_2007_txt == "#" or not SAHIE_CNTY_2007_txt:
    SAHIE_CNTY_2007_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2007.txt"
SAHIE_CNTY_2008_txt = arcpy.GetParameterAsText(2)
if SAHIE_CNTY_2008_txt == "#" or not SAHIE_CNTY_2008_txt:
    SAHIE_CNTY_2008_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2008.txt"
SAHIE_CNTY_2009_txt = arcpy.GetParameterAsText(3)
if SAHIE_CNTY_2009_txt == "#" or not SAHIE_CNTY_2009_txt:
    SAHIE_CNTY_2009_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2009.txt"
SAHIE_CNTY_2010_txt = arcpy.GetParameterAsText(4)
if SAHIE_CNTY_2010_txt == "#" or not SAHIE_CNTY_2010_txt:
    SAHIE_CNTY_2010_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2010.txt"
SAHIE_CNTY_2011_txt = arcpy.GetParameterAsText(5)
if SAHIE_CNTY_2011_txt == "#" or not SAHIE_CNTY_2011_txt:
    SAHIE_CNTY_2011_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2011.txt"
SAHIE_CNTY_2012_txt = arcpy.GetParameterAsText(6)
if SAHIE_CNTY_2012_txt == "#" or not SAHIE_CNTY_2012_txt:
    SAHIE_CNTY_2012_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_CNTY_2012.txt"
SAHIE_ST_2006_txt = arcpy.GetParameterAsText(7)
if SAHIE_ST_2006_txt == "#" or not SAHIE_ST_2006_txt:
    SAHIE_ST_2006_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2006.txt"
SAHIE_ST_2007_txt = arcpy.GetParameterAsText(8)
if SAHIE_ST_2007_txt == "#" or not SAHIE_ST_2007_txt:
    SAHIE_ST_2007_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2007.txt"
SAHIE_ST_2008_txt = arcpy.GetParameterAsText(9)
if SAHIE_ST_2008_txt == "#" or not SAHIE_ST_2008_txt:
    SAHIE_ST_2008_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2008.txt"
SAHIE_ST_2009_txt = arcpy.GetParameterAsText(10)
if SAHIE_ST_2009_txt == "#" or not SAHIE_ST_2009_txt:
    SAHIE_ST_2009_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2009.txt"
SAHIE_ST_2010_txt = arcpy.GetParameterAsText(11)
if SAHIE_ST_2010_txt == "#" or not SAHIE_ST_2010_txt:
    SAHIE_ST_2010_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2010.txt"
SAHIE_ST_2011_txt = arcpy.GetParameterAsText(12)
if SAHIE_ST_2011_txt == "#" or not SAHIE_ST_2011_txt:
    SAHIE_ST_2011_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2011.txt"
SAHIE_ST_2012_txt = arcpy.GetParameterAsText(13)
if SAHIE_ST_2012_txt == "#" or not SAHIE_ST_2012_txt:
    SAHIE_ST_2012_txt = "C:\\WorkSpace\\sahie\\tables\\sahie_2006-2012_xlsx\\SAHIE_ST_2012.txt"
```



```
import arcpy
import os
from arcpy import env
env.workspace = u'C:\\WorkSpace\\sahie_saiepe\\tables'
tables = arcpy.ListTables()
outLocation = u'C:\\WorkSpace\\sahie_saiepe\\sahie_saiepe.gdb'
try:
    print "Importing tables to gdb: " + outLocation
    arcpy.TableToGeodatabase_conversion(tables,outLocation)
except:
    print arcpy.GetMessages()
```

Example: importing data tables





# ModelBuilder tips that worked for me

1. Set your work environment from geoprocessing menu (ArcMap/Catalog)
2. Use relative path
3. Start with smaller models
4. Integrate smaller models (nesting) to create, or expand to a larger model
5. Use Geoprocessing menu to review and monitor your model



# Rewriting ModelBuilder Python scripts tips that worked for me

1. Use ModelBuilder to create your first Python script
2. Rewrite ModelBuilder Python script by using Toolbox examples in tool's Help:
3. Iterating over a list or a string using *for* loop statement
  - a. Dictionary
  - b. List
4. overwriteOutput (arcpy.env.overwriteOutput = True)
5. Use online Python resources: ArcGIS Resources, GIS StackExchange... enhance your script (450 lines → 150 lines)



# Lessons learned

## ModelBuilder/Python

1. ModelBuilder, a powerful and capable tool: automation made easy
2. Know what's in your system tool box before writing a new tool script! – most likely, there is already a tool for it
3. Use existing tools to create new tools specific for your needs
4. Build and integrate smaller models to create a larger model
  - If computing resources are limited, you can run smaller models to complete your tasks
5. Convert your model to an interactive Python tool for future use



# Questions

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