Analysis of Change in Polygon Distribution



These instructions enable you to analyze the change in polygon distribution between two time periods using ArcGIS 8.1 (*ArcInfo licensed*) software. The GIS processing used here is based on the following publication:

SADAHIRO, Yukio and Mitsuru UMEMURA (2001). "A Computational Approach for the Analysis of Changes in Polygon Distributions." *Journal of Geographical Systems*, to appear [CSIS Discussion Paper Series, 25, Center for Spatial Information Science, University of Tokyo]. <u>http://okabe.t.u-tokyo.ac.jp/okabelab/sada/docs/pdf-e.html</u>

In the publication, the change in polygon distribution is broken down into a combination of *primitive events*:

1) generation, 2) disappearance, 3) expansion, 4) shrinkage, 5) union, 6) division

These events are categorized according to topological relationships of the polygons between the two time periods. Using the resulting attribute tables, change can then be computed in a spreadsheet according to formulae presented in the publication.

The following sample files are used:

ORIGINAL DATA THEMES

Set1.shp	shapefile of single-class polygons at time 1 (t_1)
Set2.shp	shapefile of single-class polygons at time 2 (t_2)

CREATED DATA THEME

Union

polygon coverage resulting from the conversion and union overlay of the original shapefiles

Start the map document:

- 1. Open ARCMAP
- 2. ADD DATA: Set1.shp and Set2.shp
- 3. Choose VIEW → DATA FRAME PROPERTIES...
- 4. Set the Map and Display units under the GENERAL tab as appropriate
- 5. Click OK

Add unique identification fields to each shapefile attribute table.

- 6. In the table of contents, right-click on Set1.shp
- 7. Choose OPEN ATTRIBUTE TABLE
- 8. Click on the OPTIONS button
- 9. Choose ADD FIELD
- 10. Specify [ID1] as the name and Short Integer with a precision of 0 as the type

- 11. Right-click on the heading [ID1]
- 12. Choose CALCULATE VALUES
- 13. Enter the expression: 1 & [FID]
- 14. Repeat steps 6 through 13 for **Set2.shp**, except specify **[ID2]** as the name and use the expression: 2 & **[FID]** to calculate values
- 15. Save the map document, e.g. C:\Workspace\PolyDlst.mxd
- 16. Close ArcMap

Convert to coverages, build topology, and overlay union:

1. Open ARCTOOLBOX

Import the shapefiles to polygon coverages.

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- 2. Open CONVERSION TOOLS → IMPORT TO COVERAGE → SHAPEFILE TO COVERAGE
- 3. Select **Set1.shp** as the input shapefile
- 4. Accept Default mapping and Poly as the Output feature class
- 5. Specify **set1** as the output coverage name
- 6. Click on the BATCH button
- 7. Click on the ADD ROW button
- 8. Select **Set2.shp** as the input and specify **set2** as the output
- 9. Click OK

Build polygon and line topology for the new coverages.

- 10. Open DATA MANAGEMENT \rightarrow TOPOLOGY \rightarrow BUILD 11. Select **set1** as the input coverage and Poly
- as the feature class
- 12. Click on the BATCH button
- 13. Click on the ADD ROW button
- 14. Select **set2** as the input coverage and *Poly* as the feature class
- 15. Repeat steps 13 and 14 twice but select *Line* as the feature class for both coverages16. Click OK
- Perform a union overlay to combine the two sets. \square 17.Open ANALYSIS TOOLS \rightarrow OVERLAY \rightarrow UNION

Union			? X
Input coverage:	ChworkspaceAsel1	2	OK
Union coverage:	C:\workspace\set2	-	Cancel
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- 18. Select **set1** as the input coverage and **set2** as the union coverage
- 19. Accept defaults (or choose not to join tables modify the tolerance value)
- 20. Specify union as the output
- 21. Click OK

Build topology for the union coverage using the same tool as above.

- 22.Open DATA MANAGEMENT → TOPOLOGY → BUILD
- 23. Select union as the input coverage and Poly as the feature class
- 24. Batch and add row to repeat building for the Line feature class
- 25. Click OK
- 26. Close ArcToolbox

nput coverage: C \workspace\union	Cancel
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1 C:/workspace/union	1.90

Add fields, make selections, and calculate inferred variables:

- 1. Open ARCMAP and specify to open with the PolyDist.mxd map document
- 2. ADD DATA: Union polygon, Union arc, Set1 arc, and Set2 arc
- 3. Modify the symbology and change the drawing order of layers to make the various layers easier to interpret (see example below)



Add new fields to the **union** polygon and arc attribute tables.

- 4. Right-click on union polygon, OPEN ATTRIBUTE TABLE, and ADD FIELDS:
 - [S1] Text type of Width 2
 - [S2] Text type of Width 2
 - [S1S2] Text type of Width 4
- 5. Right-click on union arc, OPEN ATTRIBUTE TABLE, and ADD FIELDS:
 - [S1] Text type of Width 2
 - [S2] Text type of Width 2
 - [S1S2] Text type of Width 4
 - [A1] Text type of Width 2

- [A2] Text type of Width 2
- [A1A2] Text type of Width 4

Select by attributes and by location to calculate new values in the order presented:

- 6. Choose SELECT → SELECT BY ATTRIBUTES
- 7. Select Union polygon as the layer
- 8. Enter the first "Where:" expression from the table below
- 9. Click APPLY
- 10. Right-click on the appropriate heading and CALCULATE VALUE as specified 11. Click OK
- 12. Repeat steps 6 through 11 until you are finished with Table 1

Table 1. Union polygon: SELECT BY ATTRIBUTES

Select * from Layer	Where:	Calculate values for	Value
	"ID1" <> 0	Q1	E
onion polygon	"ID1" = 0 (OPTIONS \rightarrow SWITCH SELECTION)	51	0
	"ID2" <> 0	S 2	E
	"ID2" = 0 (OPTIONS \rightarrow SWITCH SELECTION)	54	0

Select By Altributes	Y X Select By Location	<u> </u>
Query Layer union polygon	Wizard Lets you select heatures from one or more in relation to the features in another layer. I reant to:	layers based on where they are located
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Fields: Unique val "UNION4D" ≜ - ↔ Lika 0 10 10	Jestset2 andset1 andset1 andset1 andset1 andset1 andset2 andset3 andse	4
"D1"And	that	
"SET2#" < <= Dr 13	share a line segment with	-
"ID2" 12 () New 15	the features in this layer:	_
"S1"	union polygon	-
"S152" SOL Info 112 SELECT * FRDM union polygon WHERE: "Dim"!	F Use selected features (16 features Apply a buffer to the features in union of [0.000000 [Meter	ues selected) n polygon s
	The red features represent the feature The highlighted open features are sale share a line segment with the red feature	e in union polygon. chad because they res.
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- 13. For Table 2, you must first choose to select by attributes according to the SELECT BY ATTRIBUTES expressions and layers indicated by (A).
- 14. Choose SELECT → SELECT BY ATTRIBUTES
- 15. Select Union polygon (or one of the set arcs) as the layer
- 16. Enter the "SELECT BY ATTRIBUTES (A)" expression
- 17. Click APPLY
- 18. Then choose SELECT \rightarrow SELECT BY LOCATION
- 19. Complete the selection expression according to Table 2 for each value

- 20. Right-click on the appropriate field heading and calculate the corresponding values for the selection
- 21. Repeat until you are finished with Table 2

Table 2. Union arc: SELECT BY LOCATION

Select features from	That	The features in this layer <mark>(A)</mark>	Use selected features	SELECT BY ATTRIBUTES <mark>(A)</mark>	Calculate values for	Value
Union arc	Share a line segment with	Union polygon	Υ	"ID1" <> 0	S1	Е
Union arc	Share a line segment with	Union polygon	Υ	"ID2" <> 0	S2	Е
Linion arc	Share a line	Set1 arc	Ν	"I POLV#" <> 1	A1	В
onion are	segment with	Octi alo	Y		A1	Р
Union arc	Share a line	Set2 arc	N	"I POI V#" <> 1	A2	В
Union alc	segment with		Υ		A2	Р

22. According to Table 3, make selections and calculate using the same methods as for the first table

Table 3. Union arc: SELECT BY ATTRIBUTES

Select * from Layer	Where:	Calculate values for	Value
Linion arc	"\$1" - ' '	S1	0
Onion are	01 -	A1	0
Linion are	"C2" _ ' '	S2	0
Official	52 -	A2	0
Union arc	"A1" = ' '	A1	Ι
Union arc	"A2" = ' '	A2	Ι

Calculate the final variables for [S1S2] in both tables and [A1A2] in the arc table. 23. Right-click on the appropriate table heading and choose CALCULATE VALUES

24. Enter the expression that correspond with the heading you clicked:

- [S1S2] = Trim ([S1] & [S2]), or
- [A1A2] = Trim ([A1] & [A2])

25. Click OK

26. Visually inspect and manually recode if **[A1A2] = "II**"

This error may be due to the fuzzy tolerance used when building topology.

27. Export the union arc and polygon attribute tables to dBase for use in a spreadsheet by clicking OPTIONS → EXPORT...

Refer to the Sadahiro and Umemura (2001) publication to:

- categorize primitive events as defined by [S1S2] and [A1A2]
- compute change using the formulae

KEY to the VARIABLE Values:				
Inferre S1S2	ed <i>Polygon</i> Variables S1 = state at t_1 S2 = state at t_2	E = existing O = not-existing		
Inferre S1S2	ed Arc Variables S1 = state at t_1 S2 = state at t_2	E = existing O = not-existing		
A1A2	A1 = value at t_1 A2 = value at t_2	B = boundary P = partition I = interior O = absent		