

GeoDa Workshop

Part 2

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after July 1, 2016
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Acknowledgments

NSF OCI-1047916

AHRQ IR01HS021752-01AI



spatial weights

spatial autocorrelation

space-time exploration

averages tool (treatment effect analysis)

spatial regression



Spatial Weights



creating weights

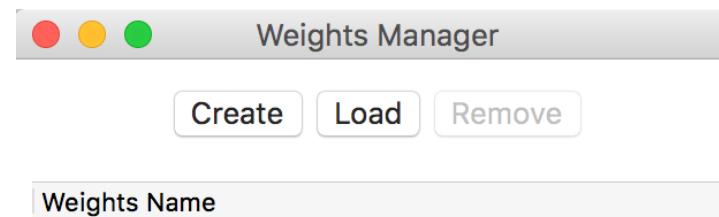
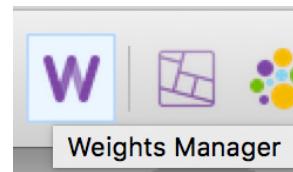
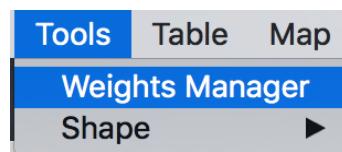
weights properties

project file



Creating Weights





Property	Value

[Histogram](#) [Connectivity Map](#)

weights manager



Weights File Creation

Weights File ID Variable

Contiguity Weight

Queen contiguity Order of contiguity

Rook contiguity Include lower orders

Precision threshold

Distance Weight

Distance metric

X-coordinate variable

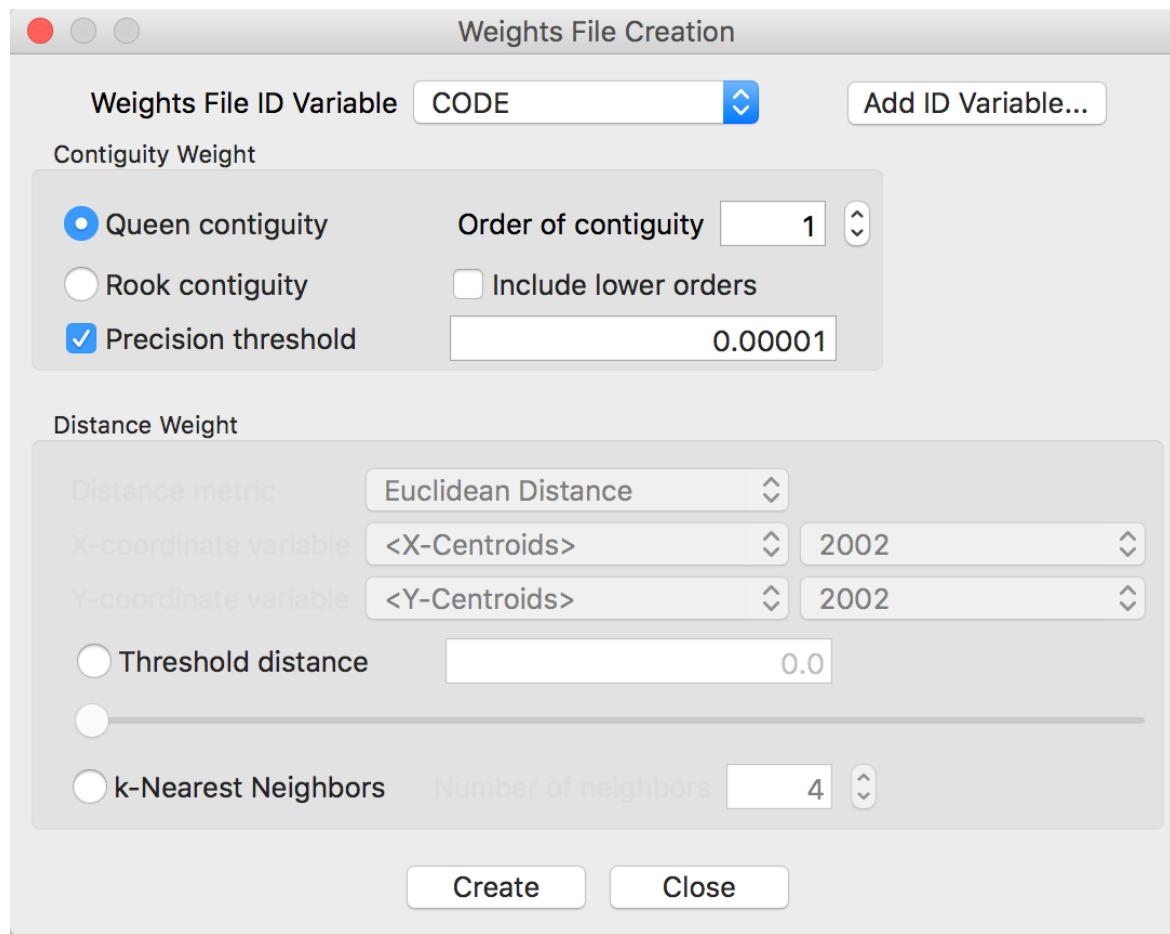
Y-coordinate variable

Threshold distance

k-Nearest Neighbors Number of neighbors

contiguity weights





precision threshold (NYC example)





Create Load Remove

Weights Name
Nepal_q

Property	Value
type	queen
symmetry	symmetric
file	Nepal_q.gal
id variable	OID_
order	1

Histogram Connectivity Map

weights in weights manager



Weights File Creation

Weights File ID Variable **OID_**

Contiguity Weight

- Queen contiguity Order of contiguity
- Rook contiguity Include lower orders
- Precision threshold

Distance Weight

- Distance metric
- X-coordinate variable
- Y-coordinate variable
- Threshold distance
- k-Nearest Neighbors Number of neighbors

Weights File Creation

Weights File ID Variable **OID_**

Contiguity Weight

- Queen contiguity Order of contiguity
- Rook contiguity Include lower orders
- Precision threshold

Distance Weight

- Distance metric
- X-coordinate variable
- Y-coordinate variable
- Threshold distance
- k-Nearest Neighbors Number of neighbors

distance-based weights





Create Load Remove

Weights Name

Nepal_q

Nepal_k6

Property	Value
type	k-NN
symmetry	asymmetric
file	Nepal_k6.gwt
id variable	OID_
distance metric	Euclidean
distance vars	centroids
neighbors	6

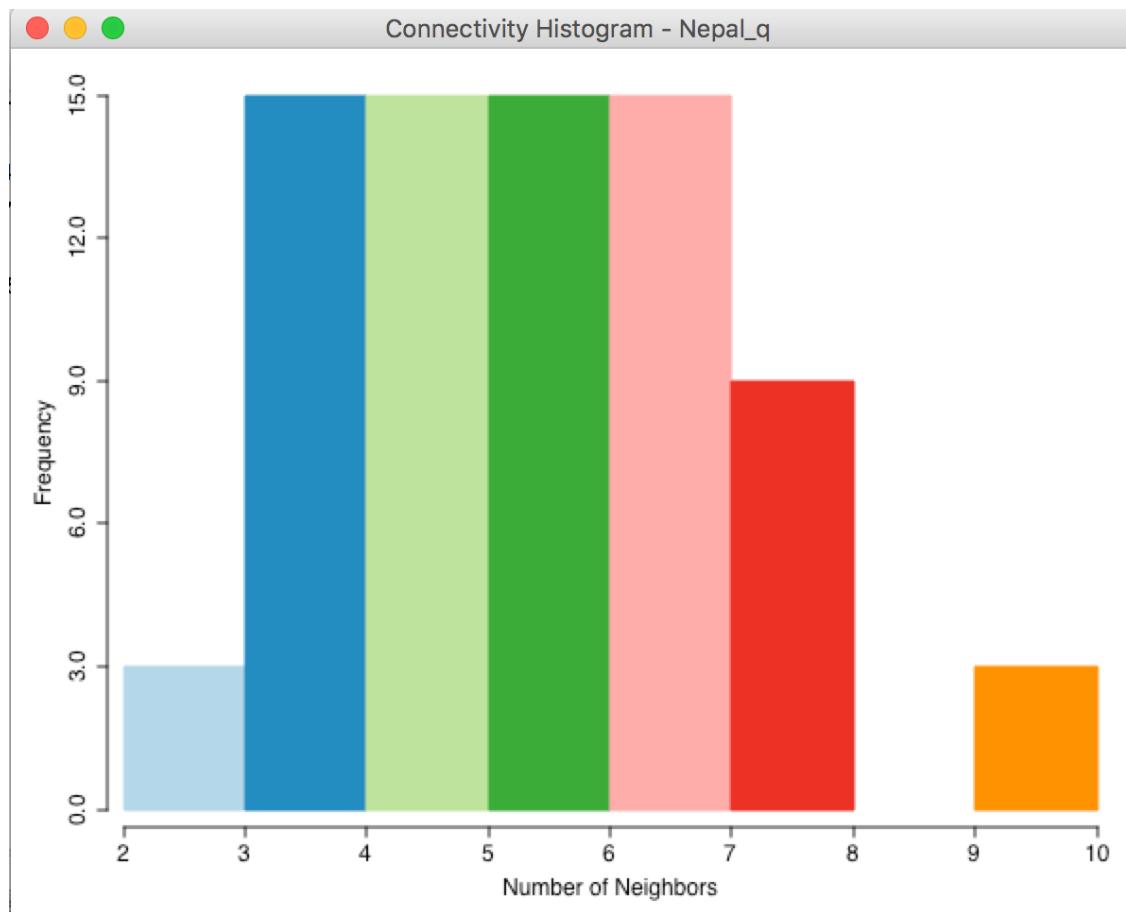
Histogram Connectivity Map

multiple weights in weights manager



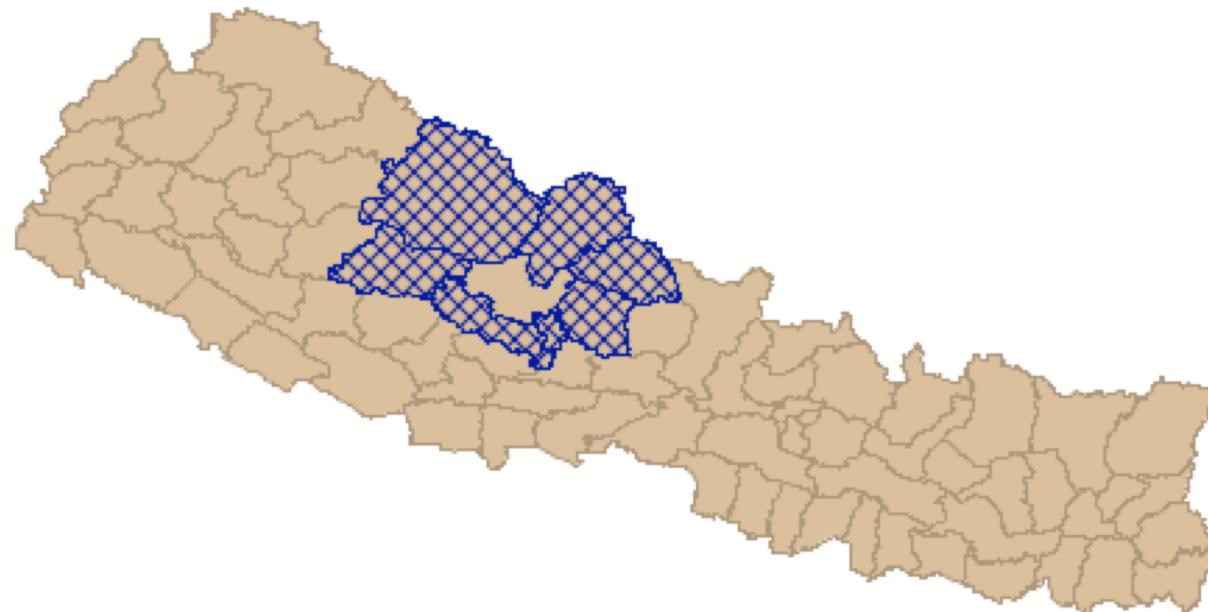
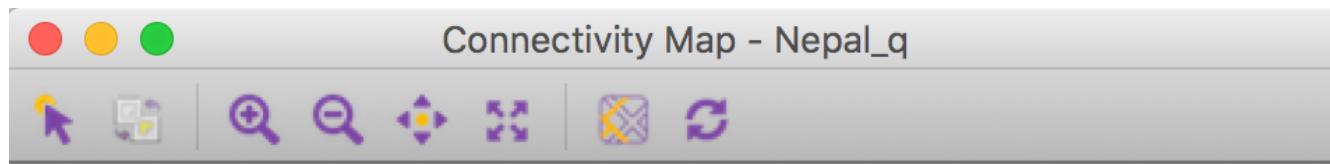
Weights Properties





connectivity histogram





obs 45 has 7 neighbors: 2, 44, 51, 20, 58, 33, 41

connectivity map

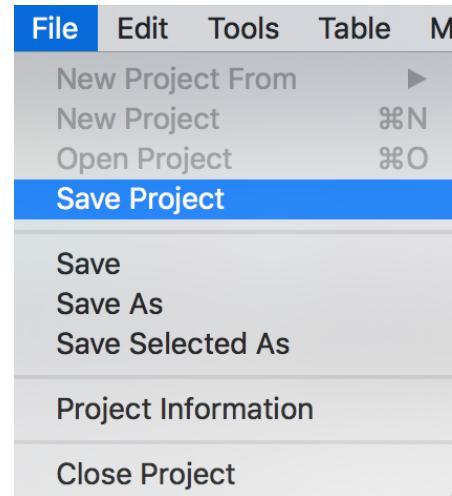


Project File



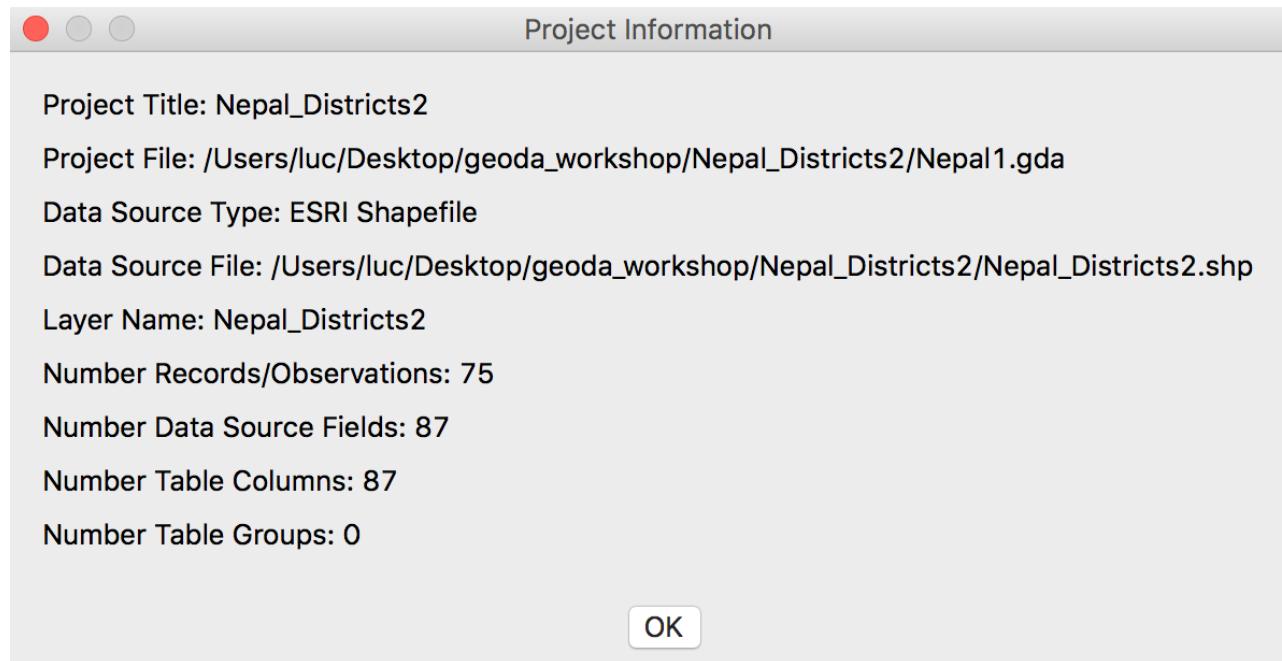
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creating a project file





project information



```
<weights_entries>
  <weights>
    <title>Nepal_q</title>
    <default/>
    <meta_info>
      <weights_type>queen</weights_type>
      <order>1</order>
      <inc_lower_orders>true</inc_lower_orders>
      <path>Nepal_q.gal</path>
      <id_variable>OID_</id_variable>
      <symmetry>symmetric</symmetry>
    </meta_info>
  </weights>
  <weights>
    <title>Nepal_k6</title>
    <meta_info>
      <weights_type>knn</weights_type>
      <dist_metric>euclidean</dist_metric>
      <dist_units>mile</dist_units>
      <dist_values>centroids</dist_values>
      <num_neighbors>6</num_neighbors>
      <path>Nepal_k6.gwt</path>
      <id_variable>OID_</id_variable>
      <symmetry>asymmetric</symmetry>
    </meta_info>
  </weights>
</weights_entries>
```

weights entries in project file



Spatial Autocorrelation



Moran scatter plot

spatial correlogram

local spatial autocorrelation

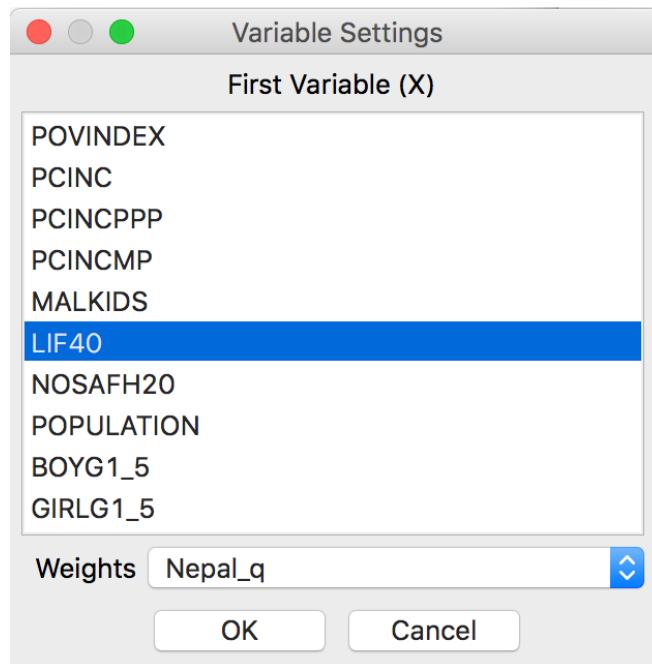
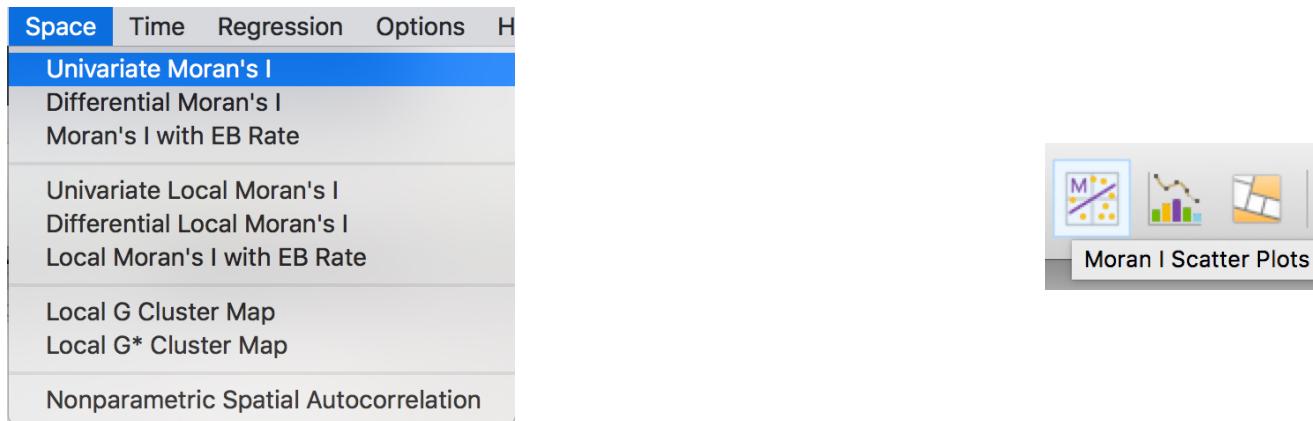


Moran Scatter Plot



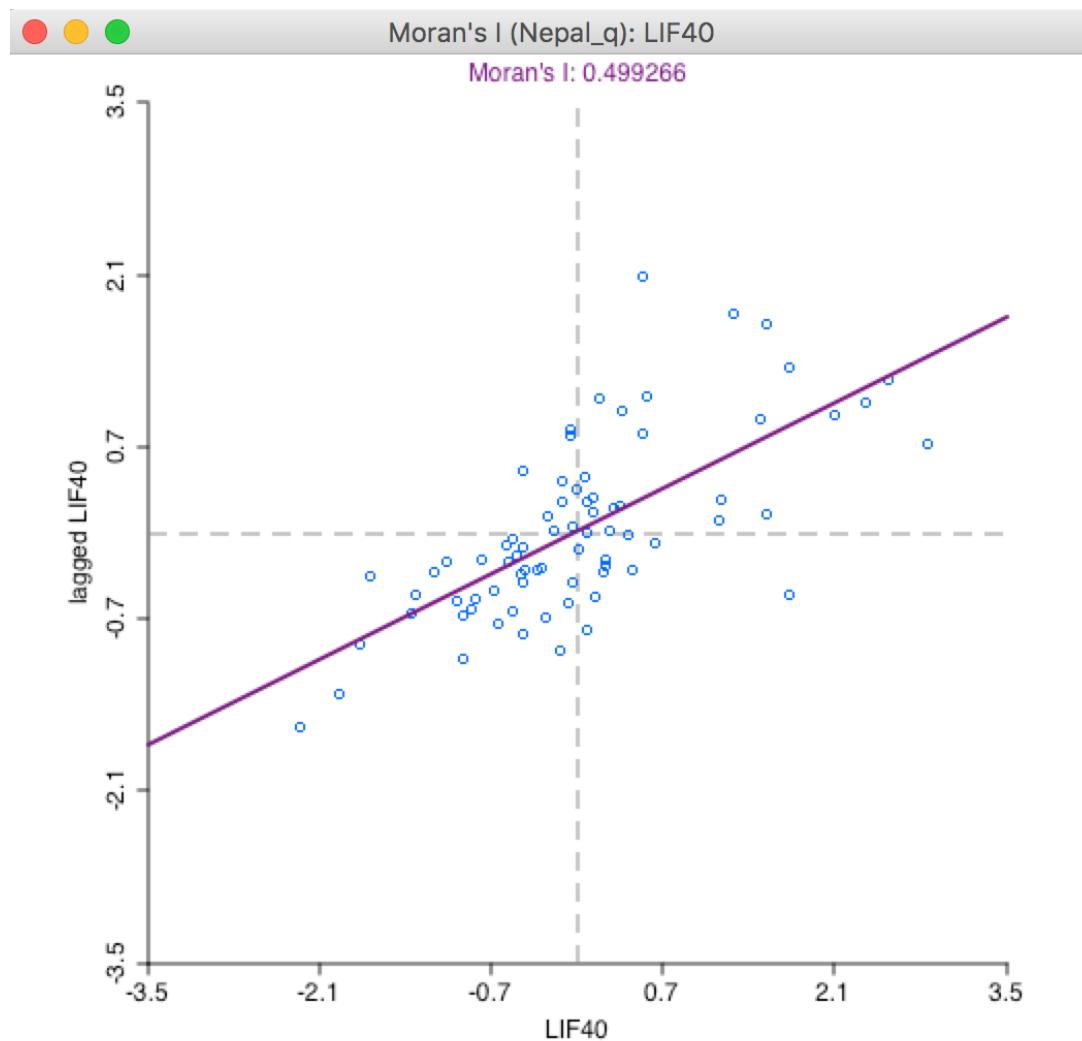
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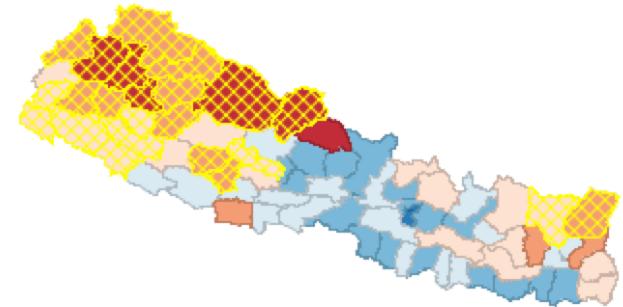
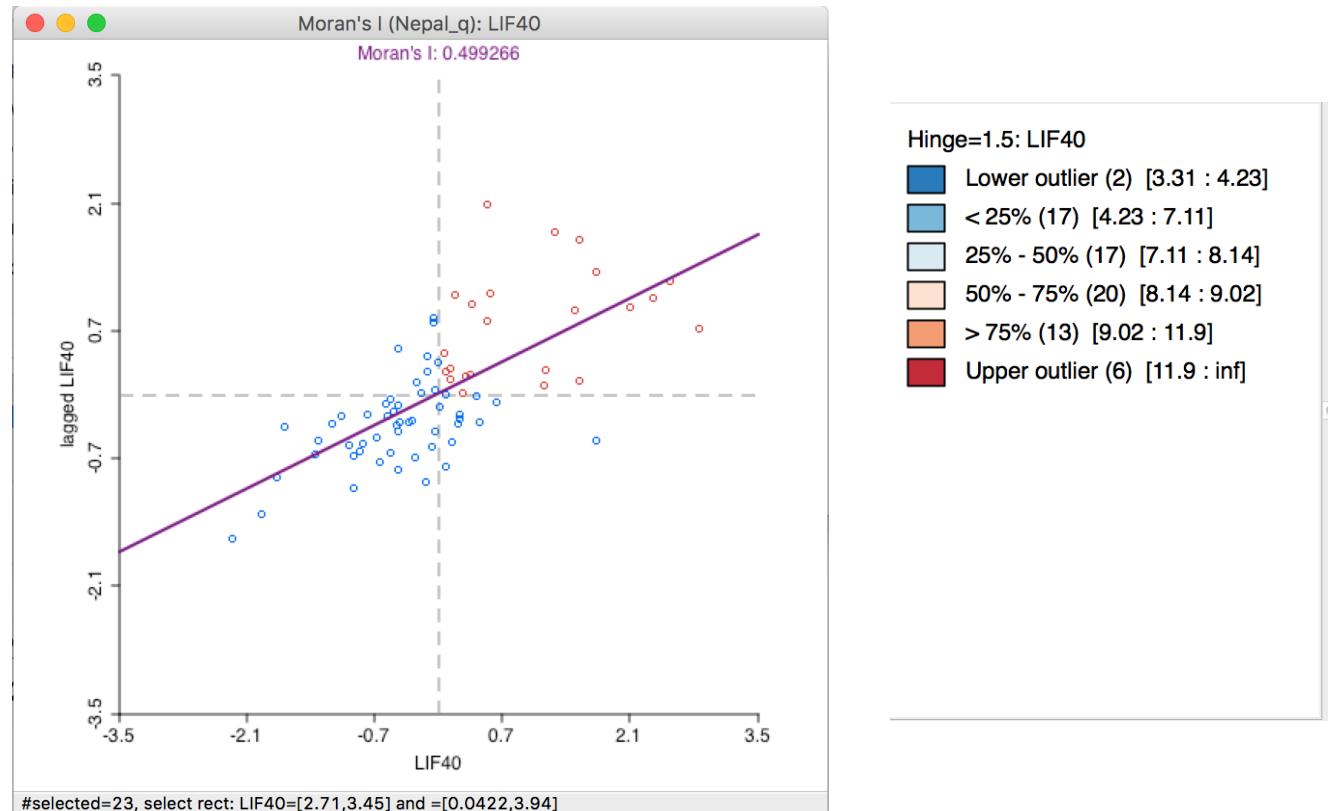
moran scatter plot setup





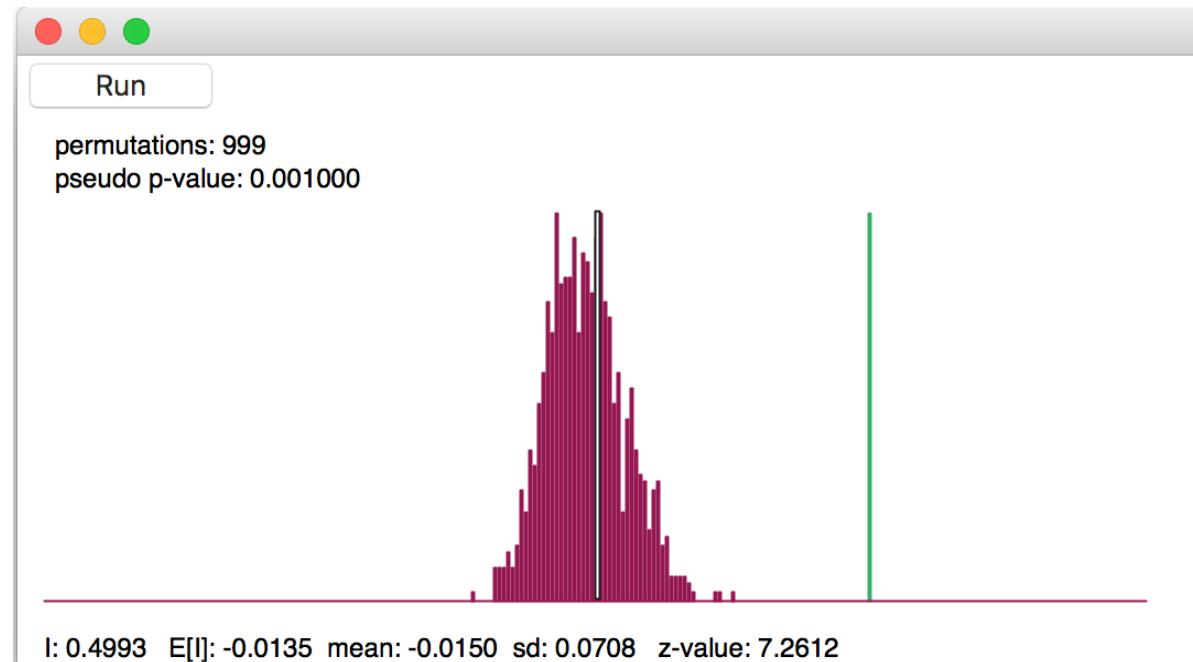
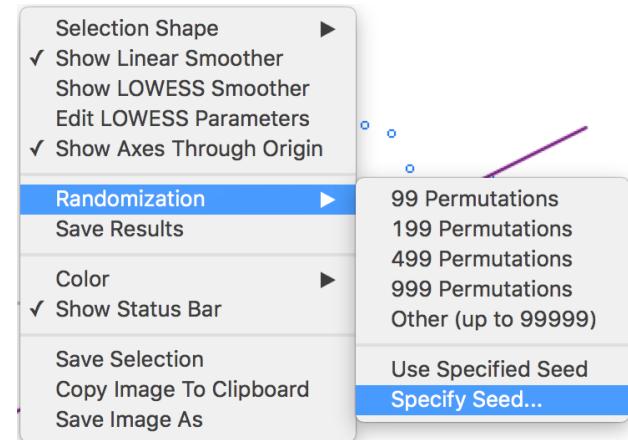
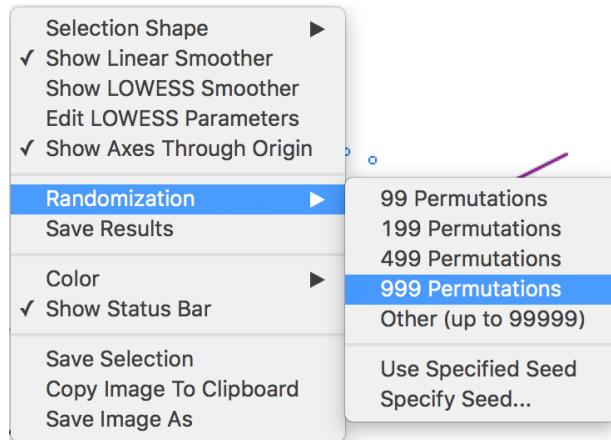
Moran scatter plot





Moran scatter plot, high-high locations





permutation inference

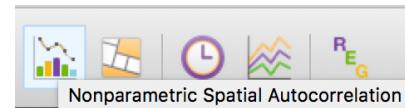
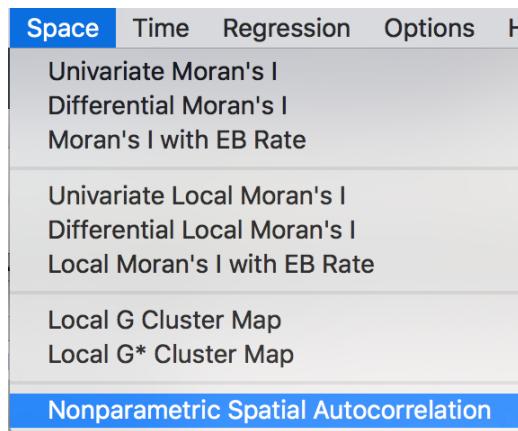


Spatial Correlogram



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Correlogram Parameters

Variable: LIF40

Distance: Euclidean Distance

Number Bins: 10

Max Distance: []

All Pairs
Estimated Pairs: 2775

Random Sample
Iterations: 1000000

Help Apply

Correlogram Parameters

Variable: LIF40

Distance: Euclidean Distance

Number Bins: 10

Max Distance: []

All Pairs
Estimated Pairs: 2775

Random Sample
Iterations: 1000000

Help Apply

Correlogram Parameters

Variable: LIF40

Distance: Euclidean Distance

Number Bins: 10

Max Distance: 4.0

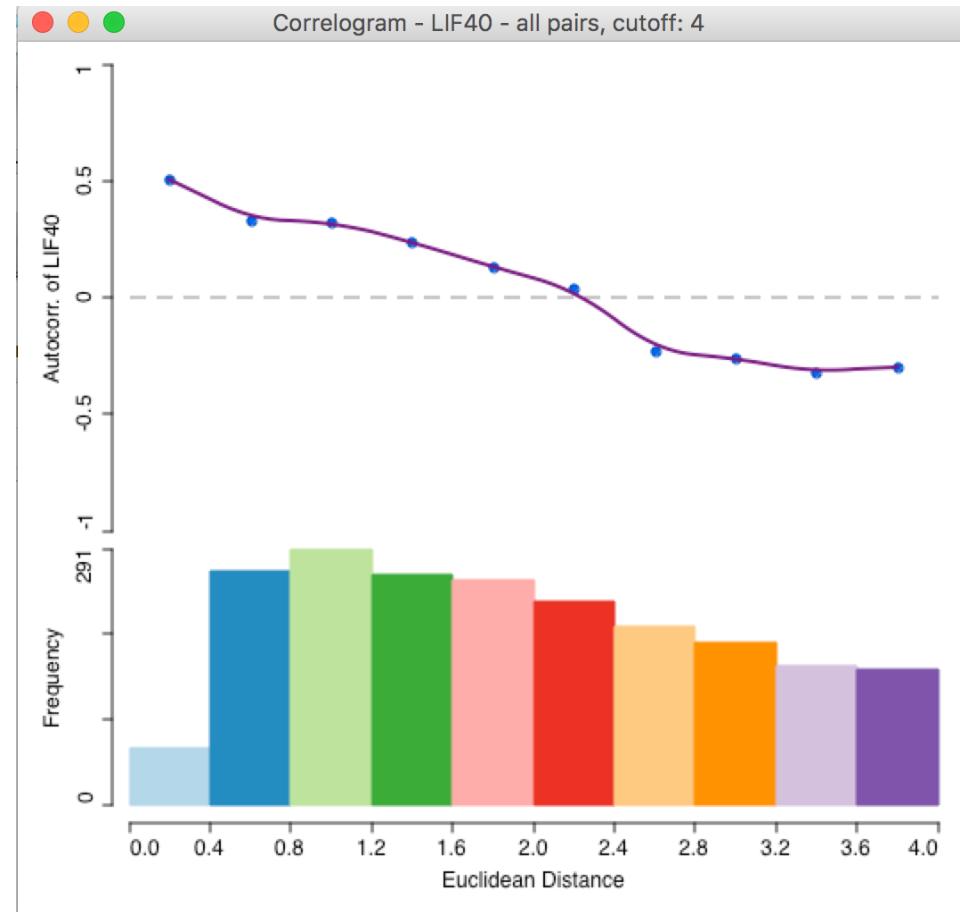
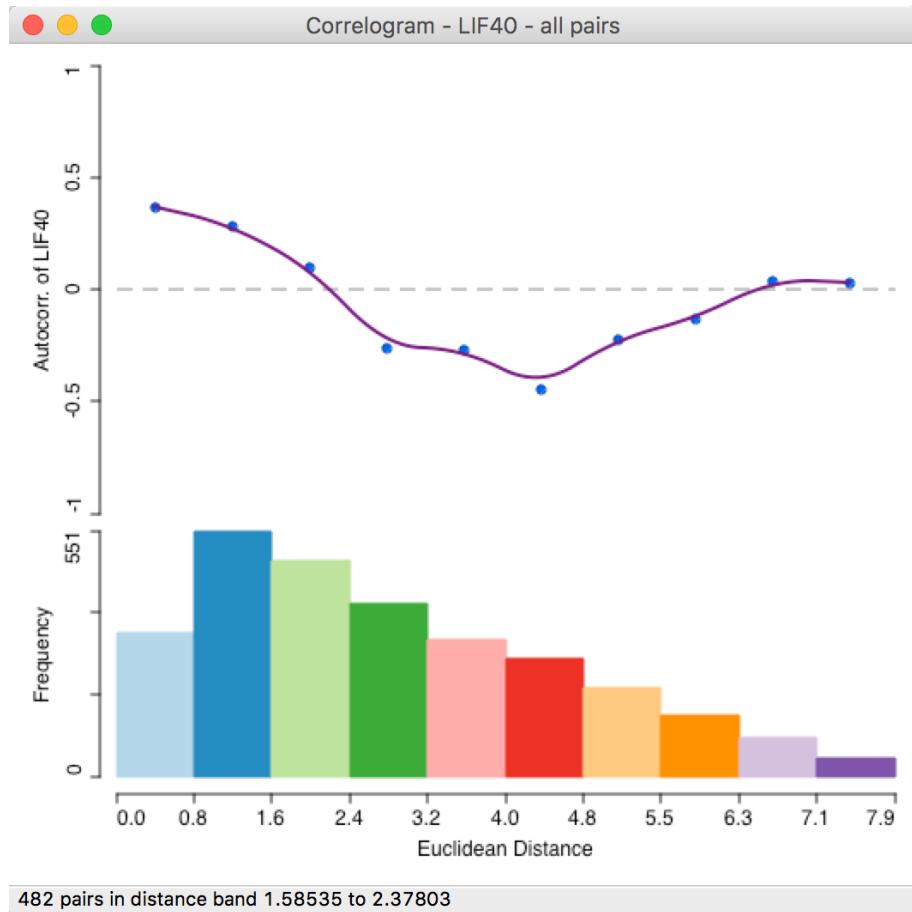
All Pairs
Estimated Pairs: 1411

Random Sample
Iterations: 1000000

Help Apply

spatial correlogram setup



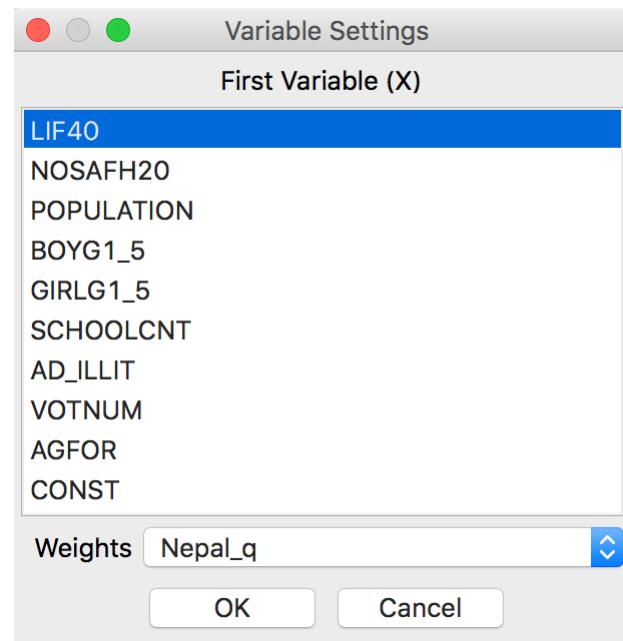
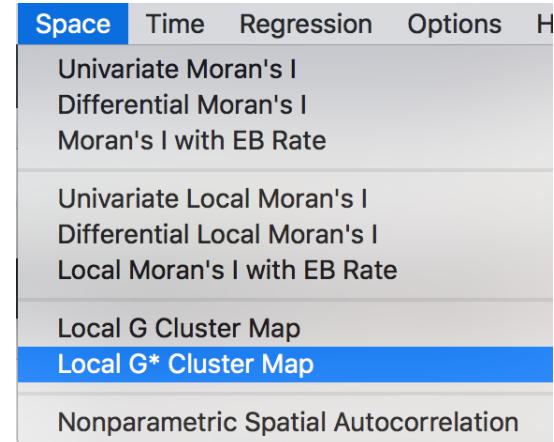
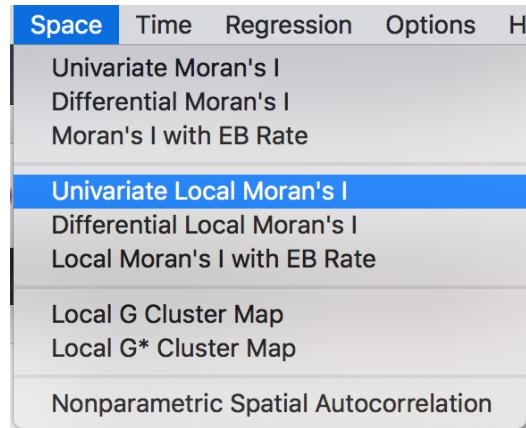


spatial correlogram



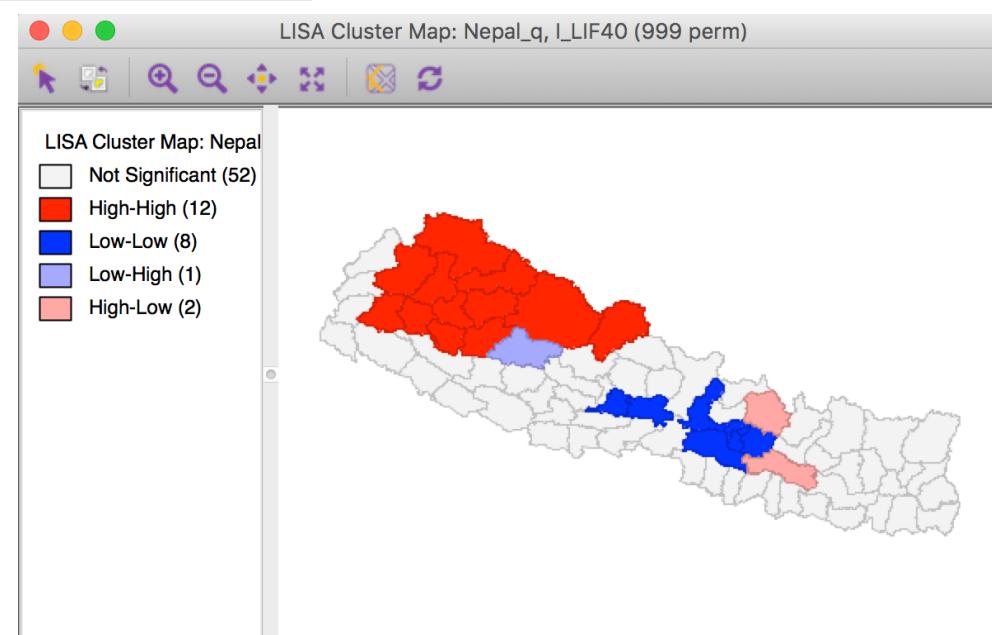
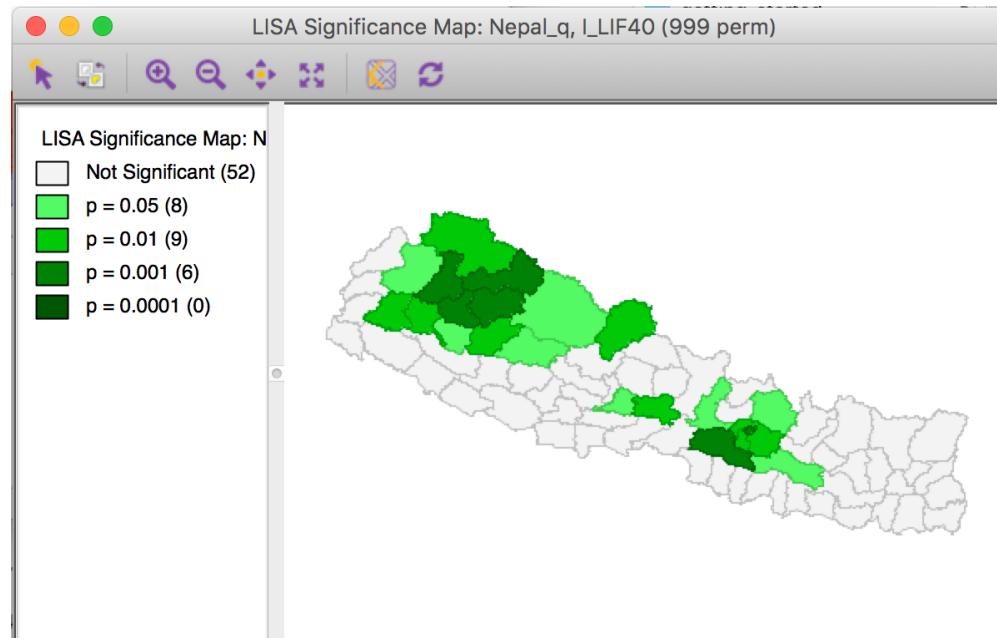
Local Spatial Autocorrelation





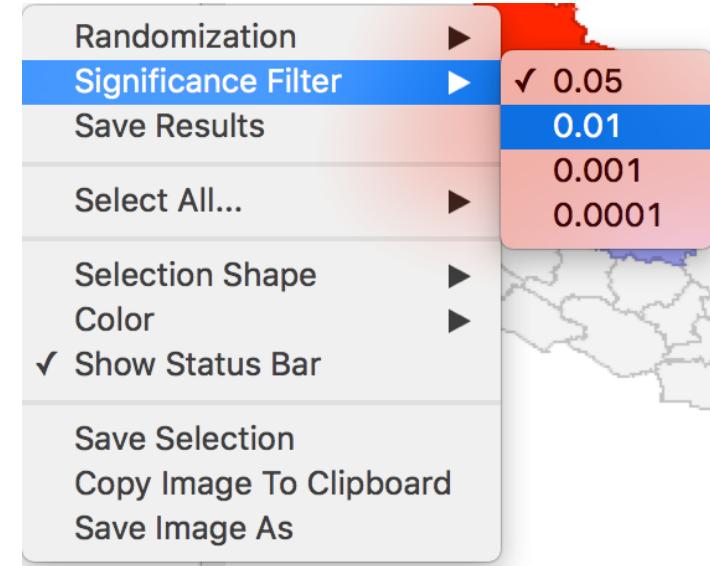
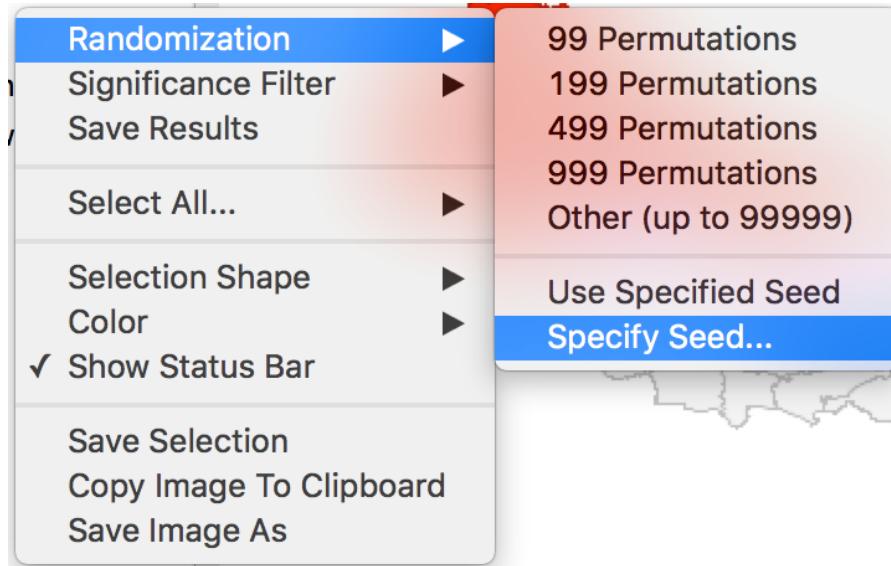
local spatial autocorrelation setup





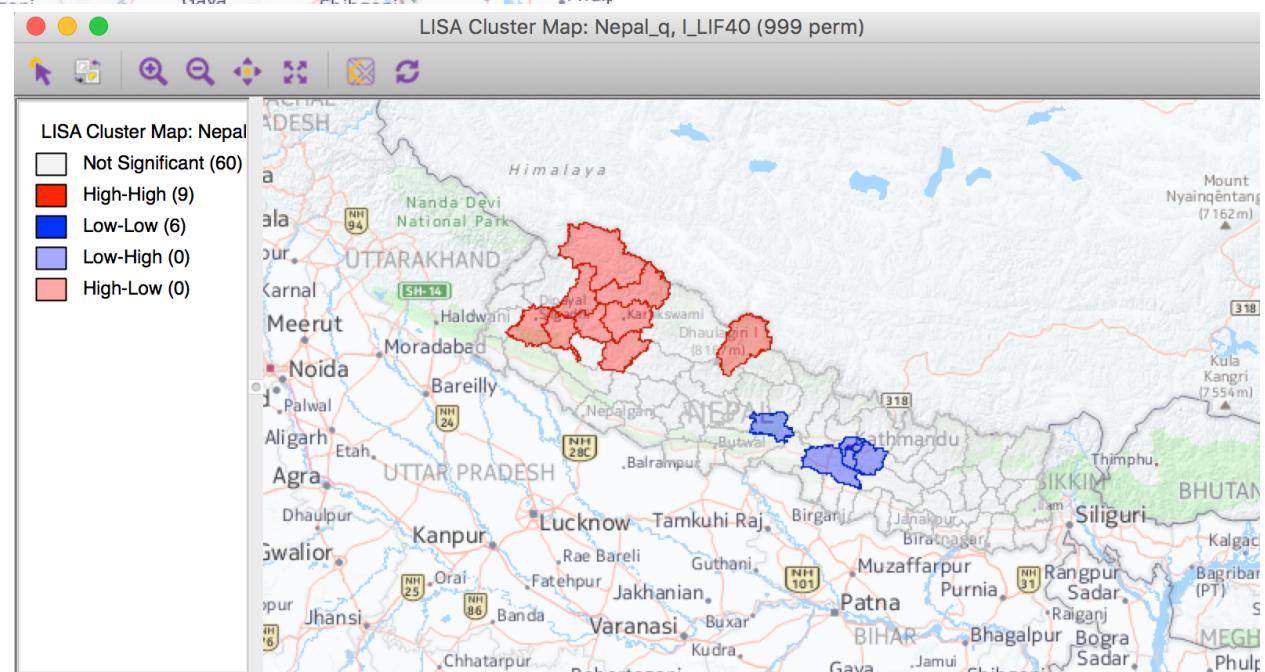
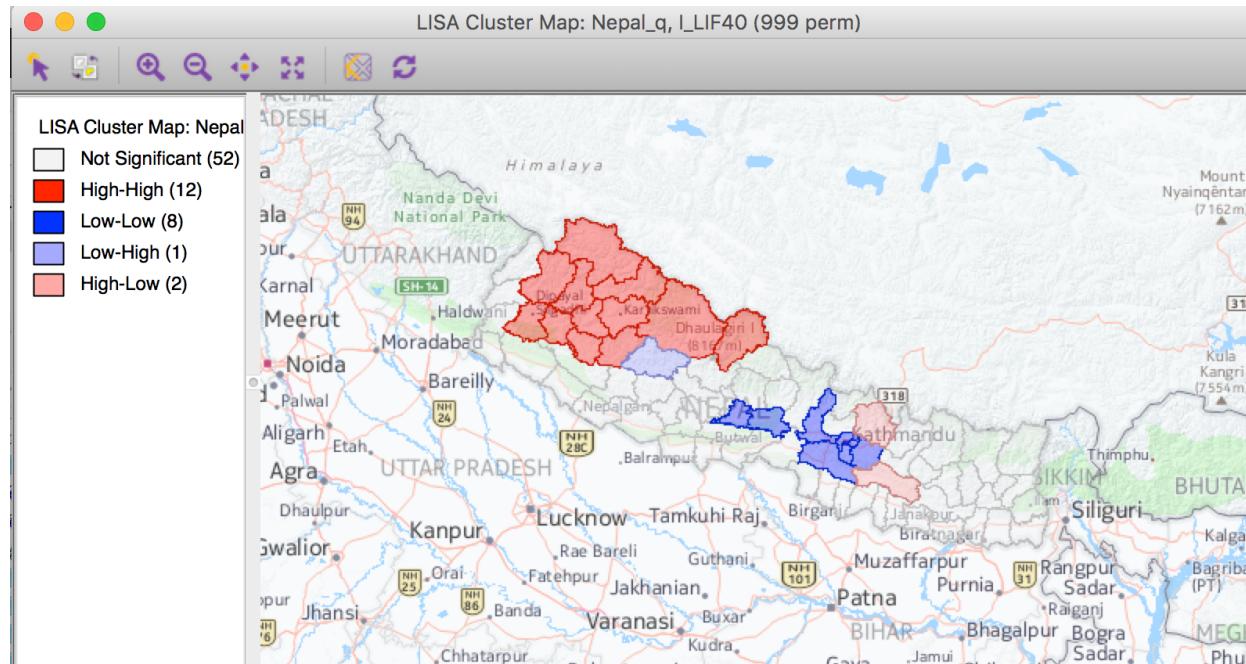
local moran significance and cluster map





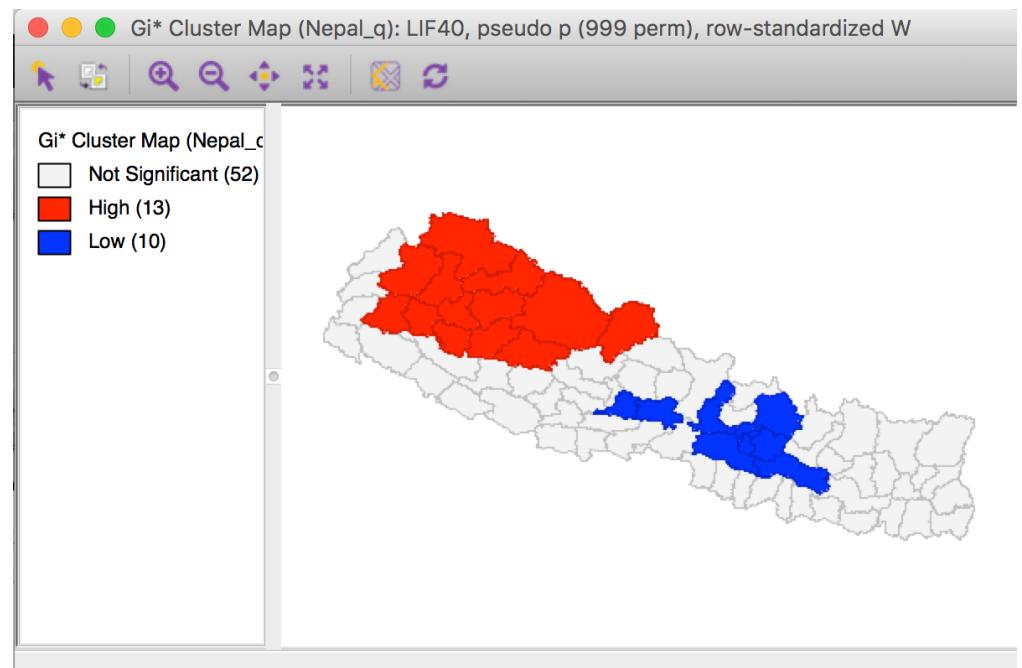
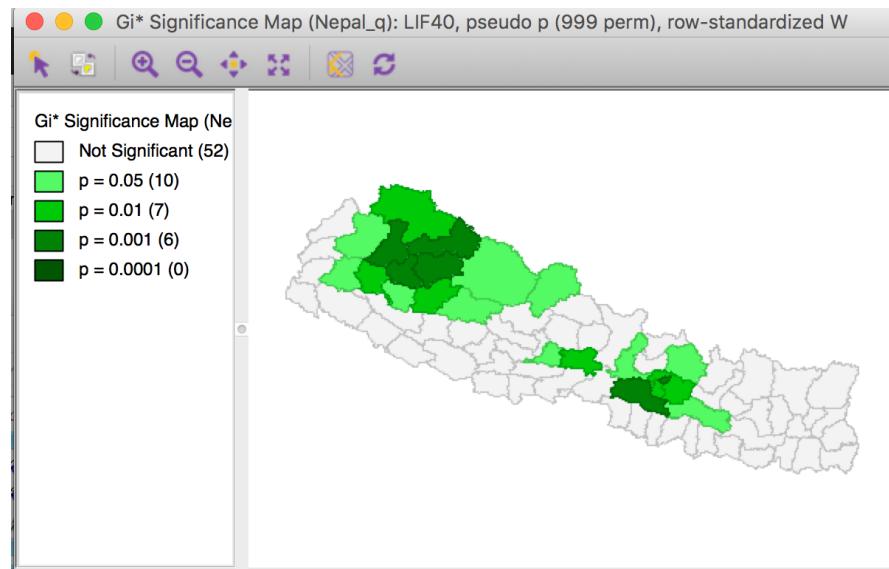
local spatial autocorrelation options





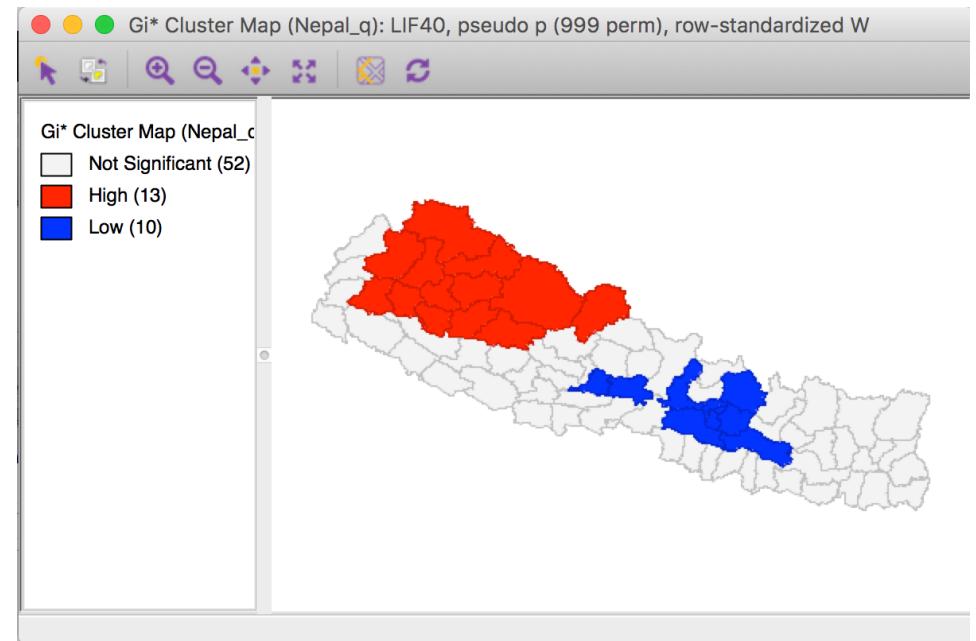
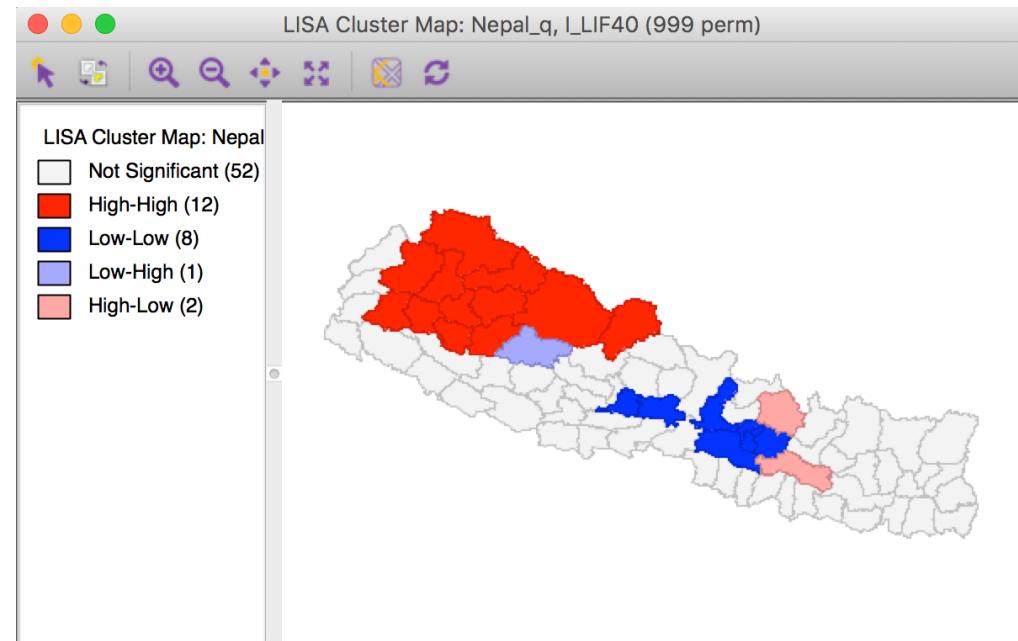
base map included, $p=0.05$ and 0.01





local G* significance and cluster map





local Moran vs local G*



Space-Time Exploration



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time editor

time player

differential spatial autocorrelation



Time Editor



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Time Editor

Ungrouped Variables ?

Name	Type
bor_subb	num
NAME	str
CODE	num
SUBBOROUGH	str
HHSIZ02	num
HHSIZ05	num
HHSIZ08	num
KIDS2000	num
KIDS2005	num
KIDS2008	num
RENT2002	num
RENT2005	num
RENT2008	num
RENTPCT02	num
RENTPCT05	num
RENTPCT08	num
YRHOM02	num
YRHOM05	num
YRHOM08	num

New Group Details ?

name:

0 variables to include

Time	Name
------	------

Grouped Variables ?

Move Up Move Down Save Space-Time Table/Weights ?

time editor setup



Time Editor

Ungrouped Variables ?

Name	Type
bor_subb	num
NAME	str
CODE	num
SUBBOROUGH	str
HHSIZ02	num
HHSIZ05	num
HHSIZ08	num
KIDS2000	num
KIDS2005	num
KIDS2008	num
RENT2002	num
RENT2005	num
RENT2008	num
RENTPCT02	num
RENTPCT05	num
RENTPCT08	num
YRHOM02	num
YRHOM05	num
YRHOM08	num

New Group Details ?

name:

0 variables to include

Time	Name
------	------

> <

Move Up Move Down

Save Space-Time Table/Weights ?

Grouped Variables ? 

select variables to be grouped



Time Editor

Ungrouped Variables ?

Name	Type
bor_subb	num
NAME	str
CODE	num
SUBBOROUGH	str
KIDS2000	num
KIDS2005	num
KIDS2008	num
RENT2002	num
RENT2005	num
RENT2008	num
RENTPCT02	num
RENTPCT05	num
RENTPCT08	num
YRHOM02	num
YRHOM05	num
YRHOM08	num
noHS00	num
noHS05	num
noHS08	num

New Group Details ?

name: HHSIZ
numeric
3 of 3 variables to include

Time	Name
2002	HHSIZ02
time 1	HHSIZ05
time 2	HHSIZ08

> <

Move Up Move Down

Save Space-Time Table/Weights ?

Grouped Variables ?

edit variable name and time labels



Time Editor

Ungrouped Variables ?

Name	Type
bor_subb	num
NAME	str
CODE	num
SUBBOROUGH	str
KIDS2000	num
KIDS2005	num
KIDS2008	num
RENT2002	num
RENT2005	num
RENT2008	num
RENTPCT02	num
RENTPCT05	num
RENTPCT08	num
YRHOM02	num
YRHOM05	num
YRHOM08	num
noHS00	num
noHS05	num
noHS08	num

New Group Details ?

name:

numeric

0 of 3 variables to include

Time	Name
2002	
2005	
2008	

> <

Move Up Move Down

Grouped Variables ? 

HHSIZ

Save Space-Time Table/Weights ?

grouped variable



```
<variable_order>
  <time_ids>
    <id>2002</id>
    <id>2005</id>
    <id>2008</id>
  </time_ids>
  <var>bor_subb</var>
  <var>NAME</var>
  <var>CODE</var>
  <var>SUBBOROUGH</var>
  <group>
    <name>HHsize</name>
    <var>HHSIZ02</var>
    <var>HHSIZ05</var>
    <var>HHSIZ08</var>
  </group>
```

grouped time variables in project file



Time Editor

Ungrouped Variables ?

Name	Type
bor_subb	num
NAME	str
CODE	num
SUBBOROUGH	str

New Group Details ?

name:

0 of 3 variables to include

Time	Name
2002	
2005	
2008	

> <

Grouped Variables ?

- HHsize
- %KIDS
- MedRENT
- %Renter
- %Owner
- %noHS
- MedRentBurd
- rentBurd30
- rentBurd50
- %Unempl
- %white
- %hisp
- %asian
- %black
- yrsNhood
- %foreign

Save Space-Time Table/Weights ?

grouped variables from project file



 nycvars.csv
 nycvars.gal

STID, CODE, TIME, HHSIZE, %KIDS, MedRENT
1,401,2002, 2.303200000000000,28.45
2,210,2002, 2.307200000000000,26.30
3,411,2002, 2.670800000000000,30.72
4,203,2002, 2.479900000000000,45.03
5,413,2002, 2.888700000000000,42.53
6,211,2002, 2.595700000000000,31.93
7,212,2002, 3.086600000000000,41.13
8,202,2002, 2.023200000000000,24.74
9,216,2002, 2.646400000000000,51.68

0 165 nycvars STID
1 1
2
2 2
3 1
3 1
2
4 2
6 5

space-time ID, space ID, time ID

$n = 55 \times 3$, space-time ID

saved space-time table/weights

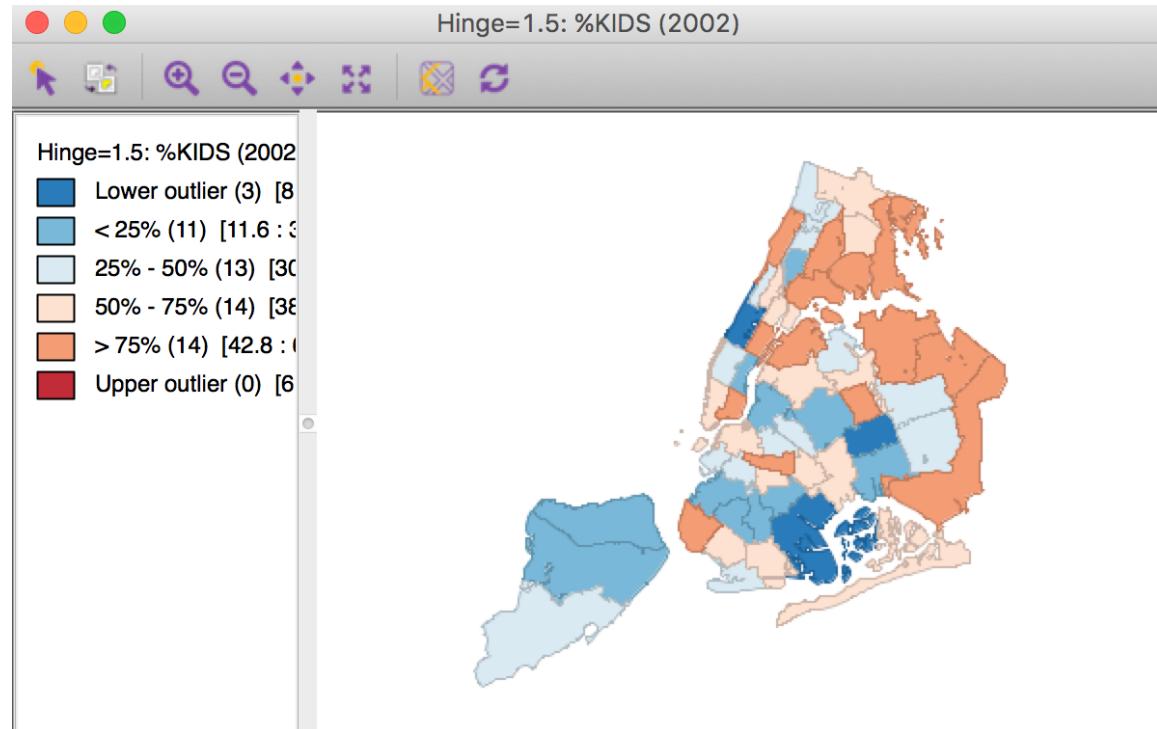
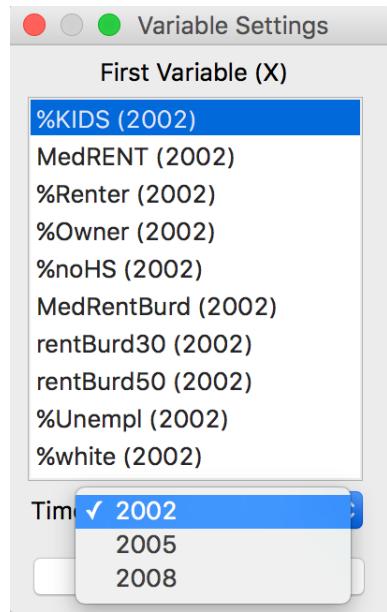


Time Player



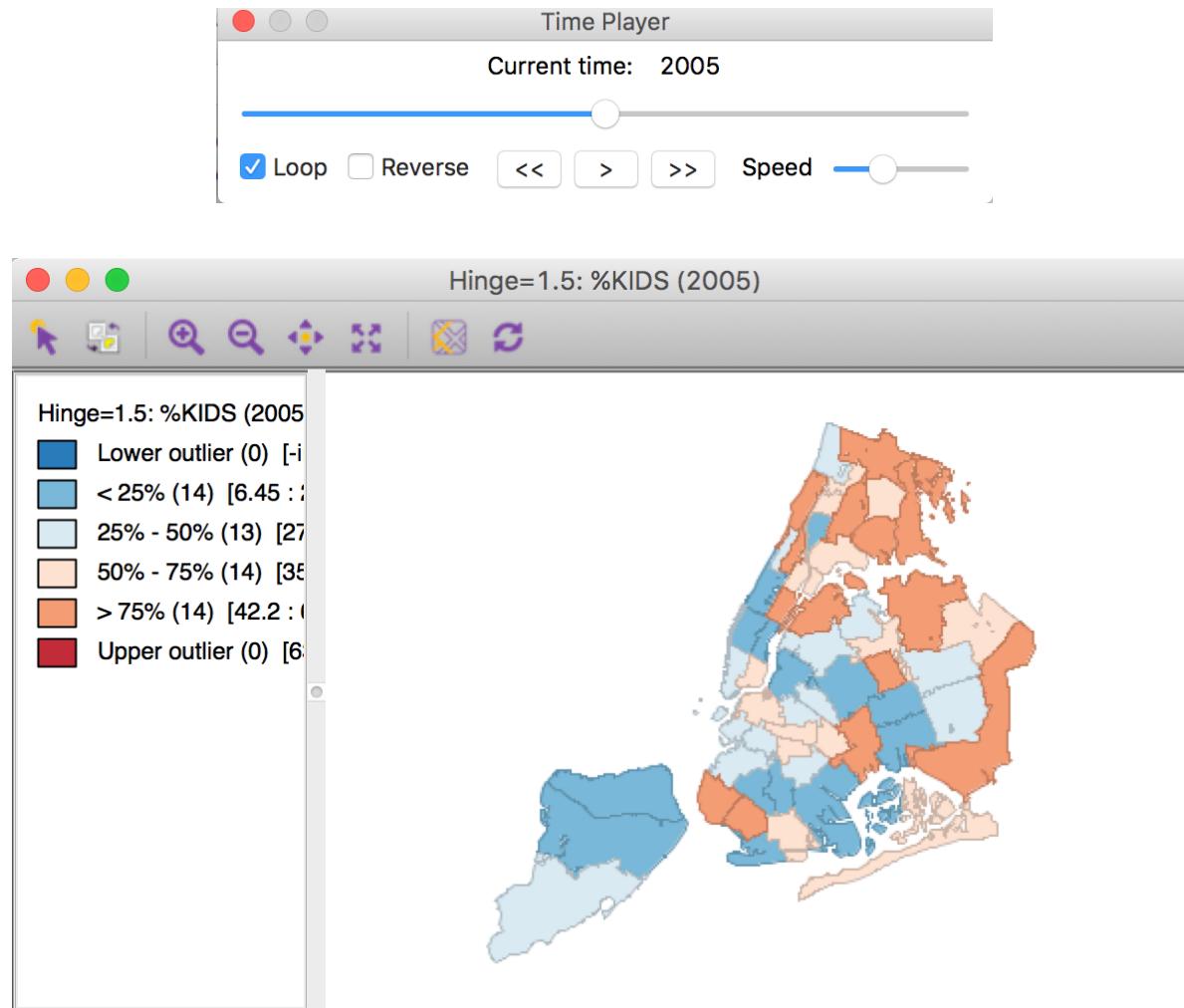
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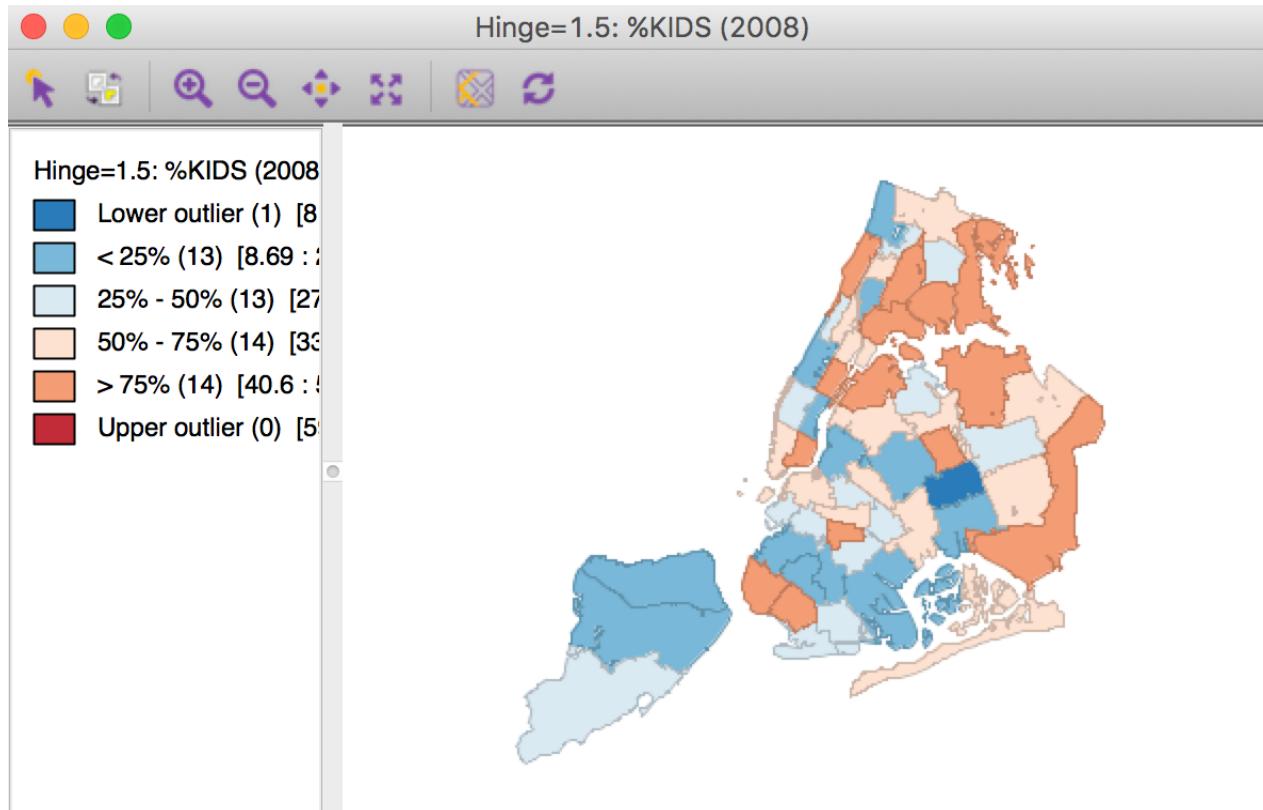
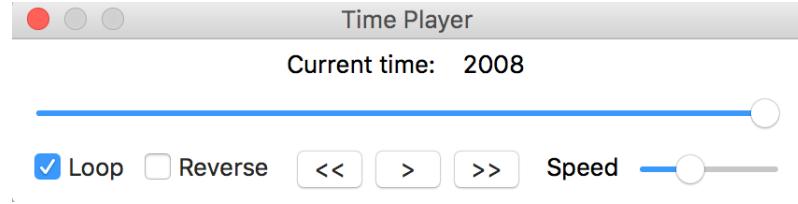
box map with time variable





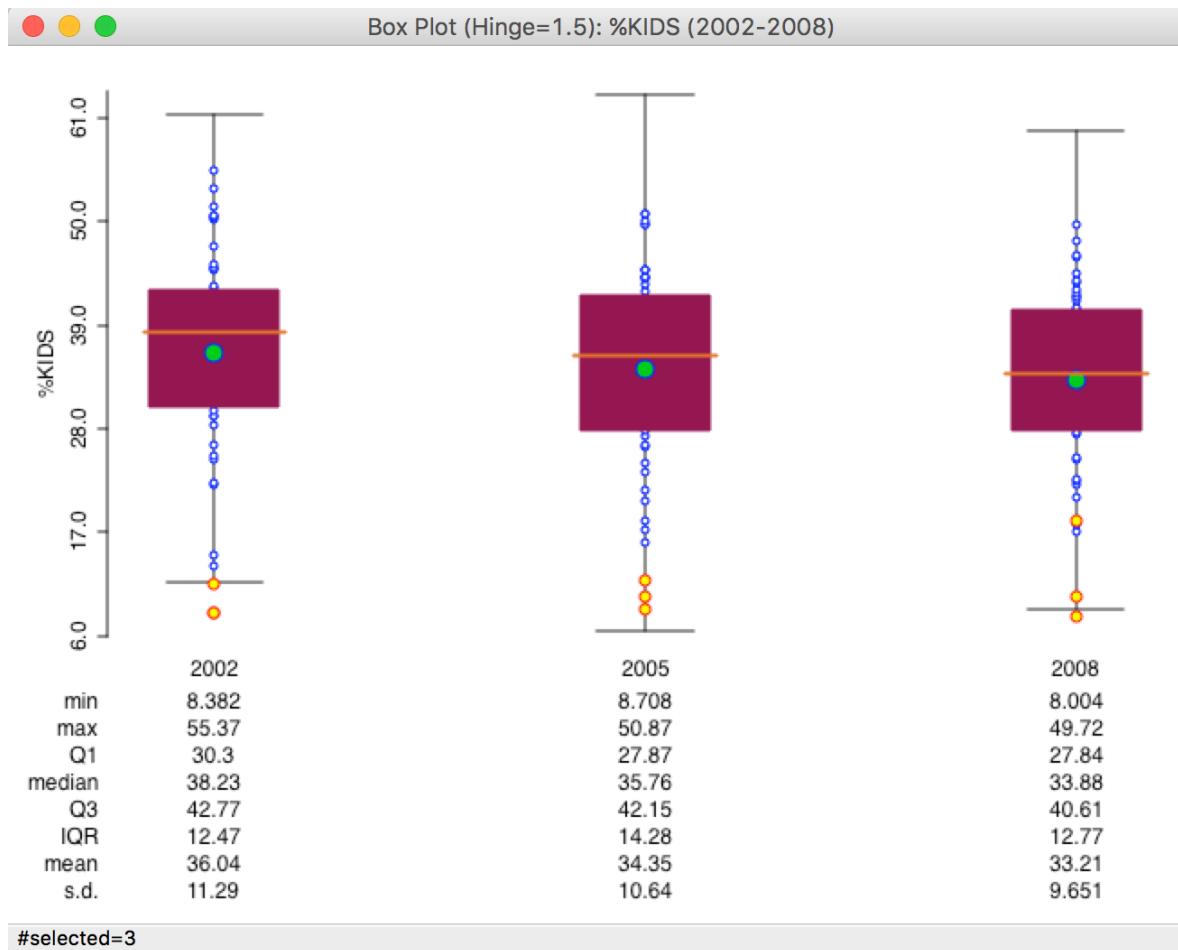
box map 2005





box map 2008





three period box plot



Scale Options ►

Number of Box Plots ► **1** **2** **✓ All**

Hinge ►

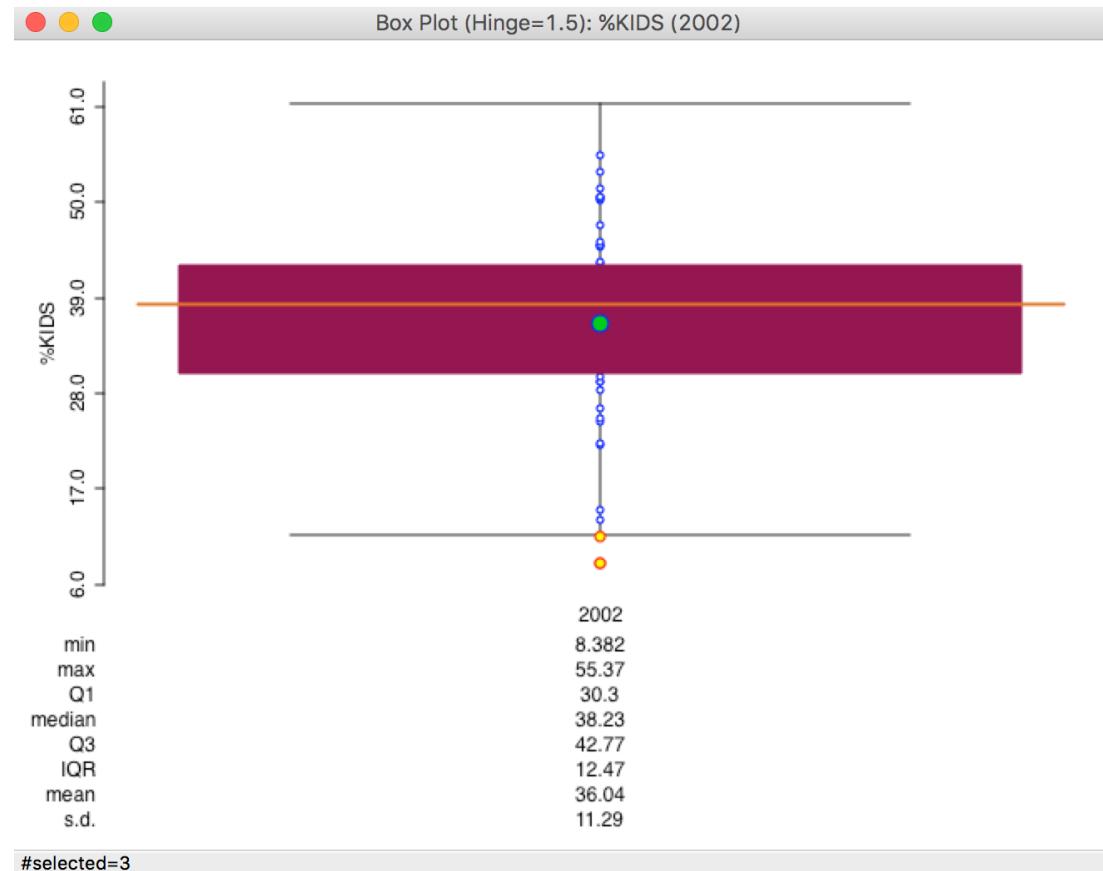
✓ Display Statistics
✓ Show Vertical Axis

Color ►

✓ Show Status Bar

Save Selection
Copy Image To Clipboard
Save Image As

Time Variable Options ►



number of box plots option



Differential Spatial Autocorrelation



- Principle

spatial autocorrelation on change over time, i.e.,
on $y_t - y_{t-1}$

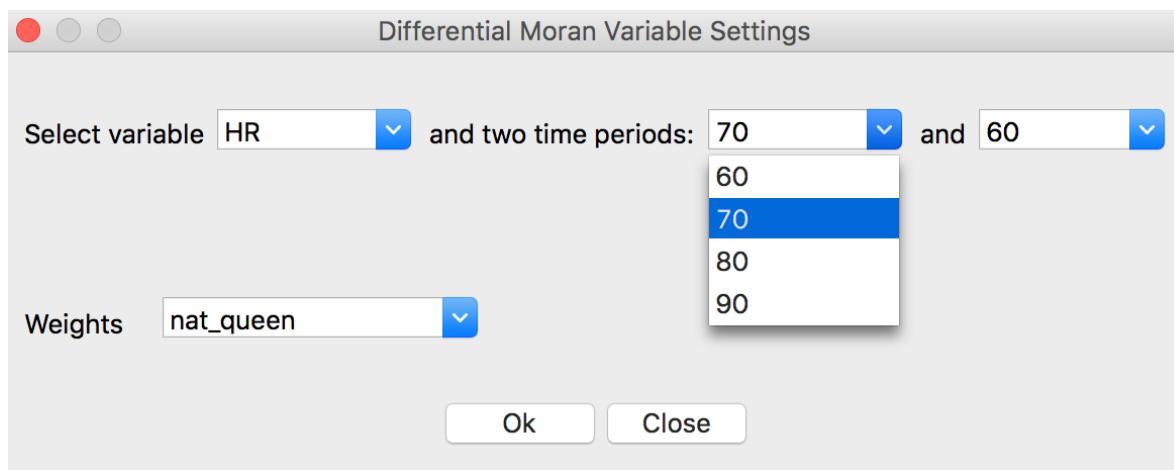
Moran scatterplot for $y_t - y_{t-1}$

Local Moran maps for $y_t - y_{t-1}$

replacement of bivariate Moran

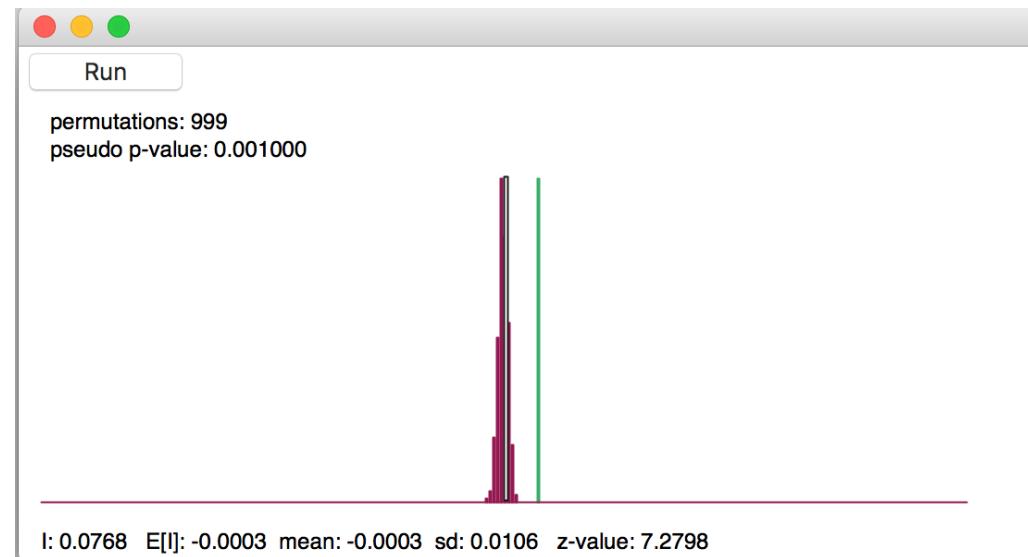
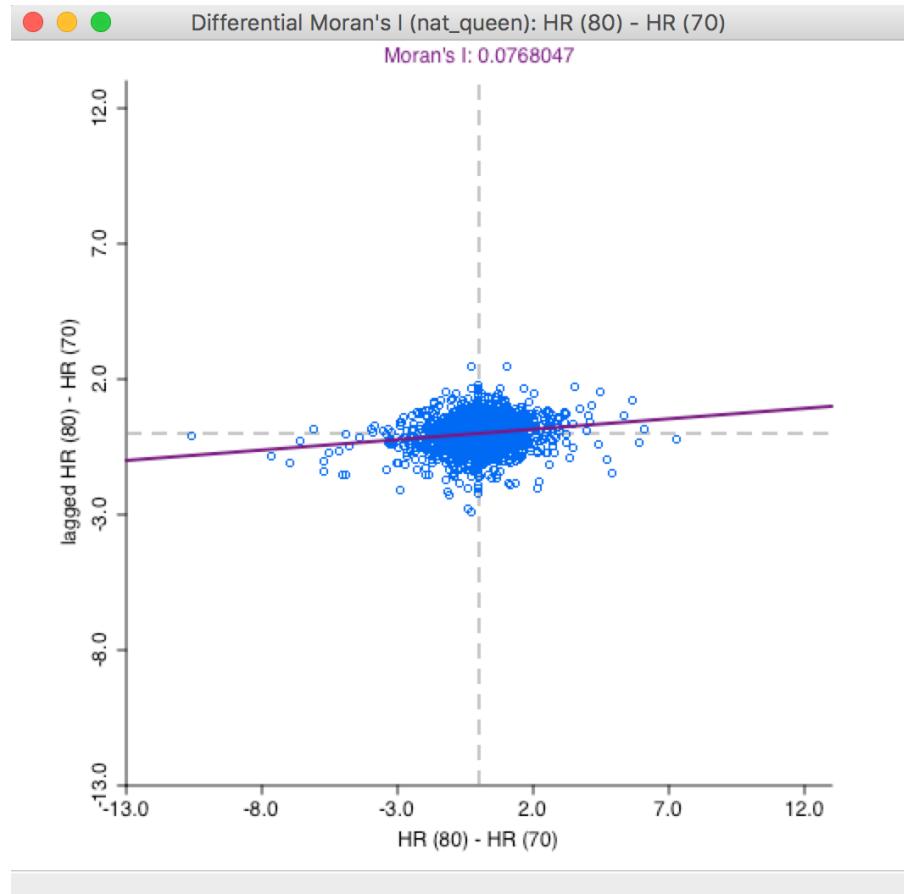


Univariate Moran's I
Differential Moran's I
Moran's I with EB Rate



**differential Moran's I (scatter plot)
variable selection using two time periods**





differential Moran scatter plot



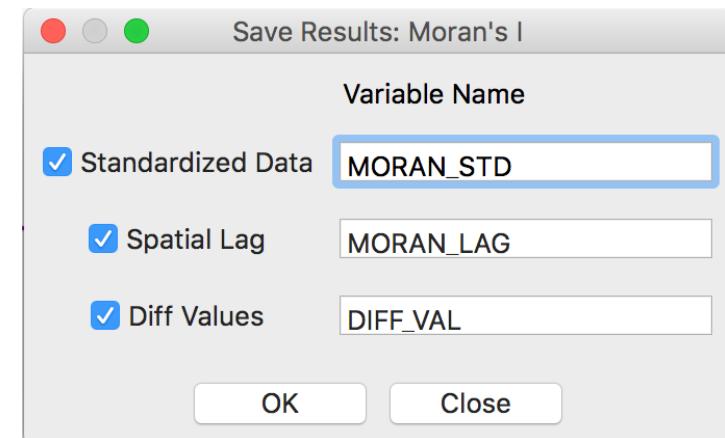
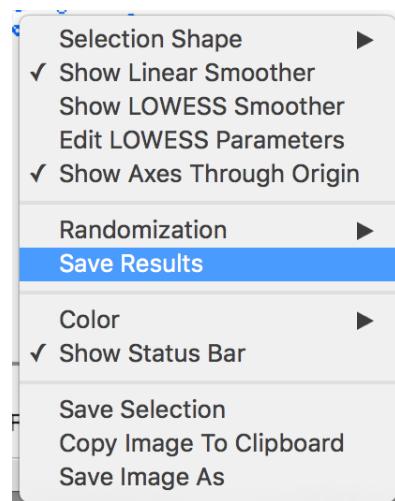
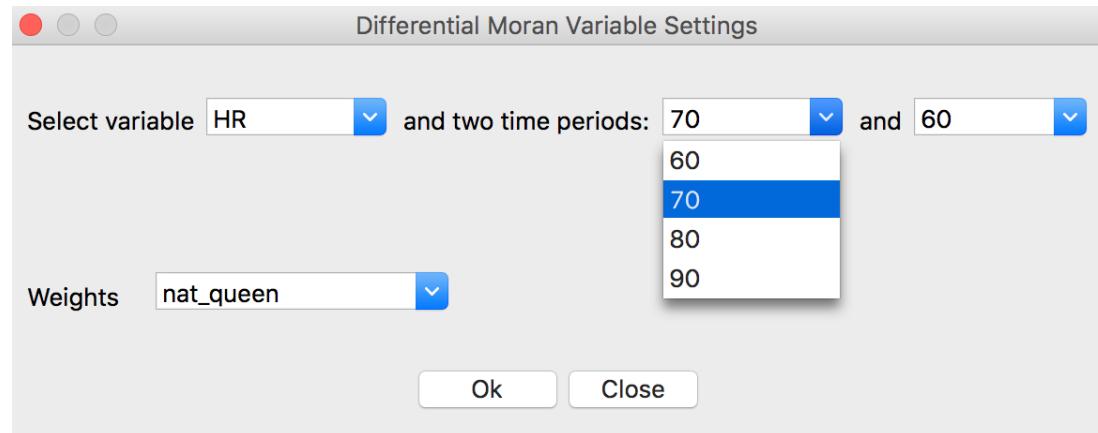
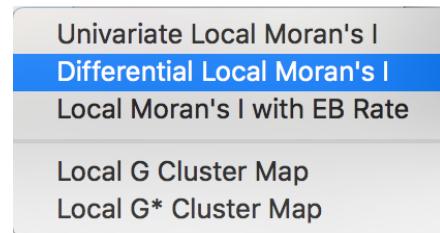


Table - natregimes					
	FH (60)	West	MORAN_STD	MORAN_LAG	DIFF_VAL
35	11.279621	0	1.2198860	0.0255470	8.8558270
58	10.053476	1	2.4456820	0.0914580	17.2087420
99	9.258437	1	0.1456410	0.8732250	1.5356160
40	9.039900	1	0.2101460	0.4930810	1.9751710
63	8.243930	1	1.0605420	0.3052060	7.7700080

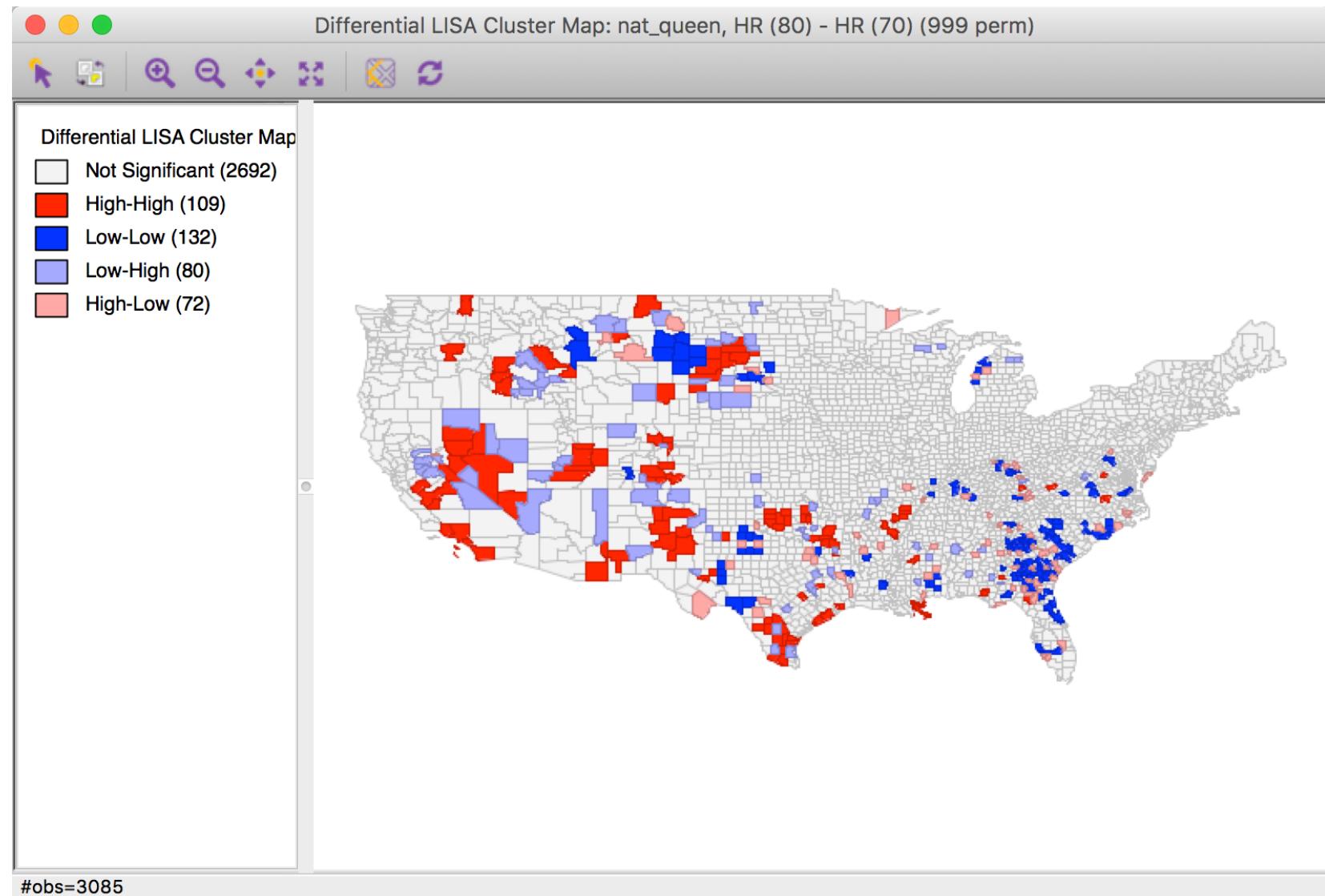
save lag and standardized and unstandardized first difference





differential local Moran





differential local Moran cluster map local clustering of the change



Averages Tool



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● Principle

simple treatment effects analysis

compare mean of a variable in selected vs unselected set of observations

cross-section: selected vs unselected

all observations: one time period vs another time period

selected: one time period vs another time period

simple F test on difference in means



- Difference-in-Differences Test

dummy variable regression

cross-sectional case: selected observations = 1

all observations: second time period = 1

selected at different points in time

selected = 1, second time = 1, interaction = 1



- **Save Dummy**

creates new data set with dummy variables

in space-time case a space-time data set is created with a matching space-time spatial weights file (if a weights file is specified)

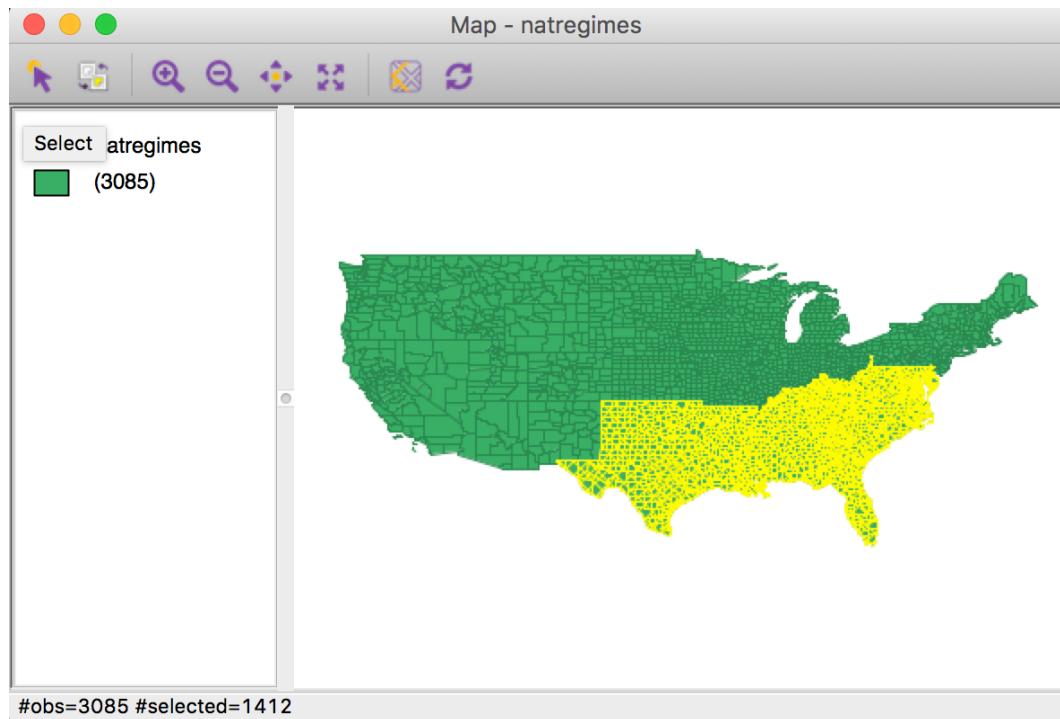
this allows for space-time regression in the regression modules using the new data file and matching spatial weights file

weights file is block-diagonal between time periods





averages chart icon and menu selection



selection: south = 1

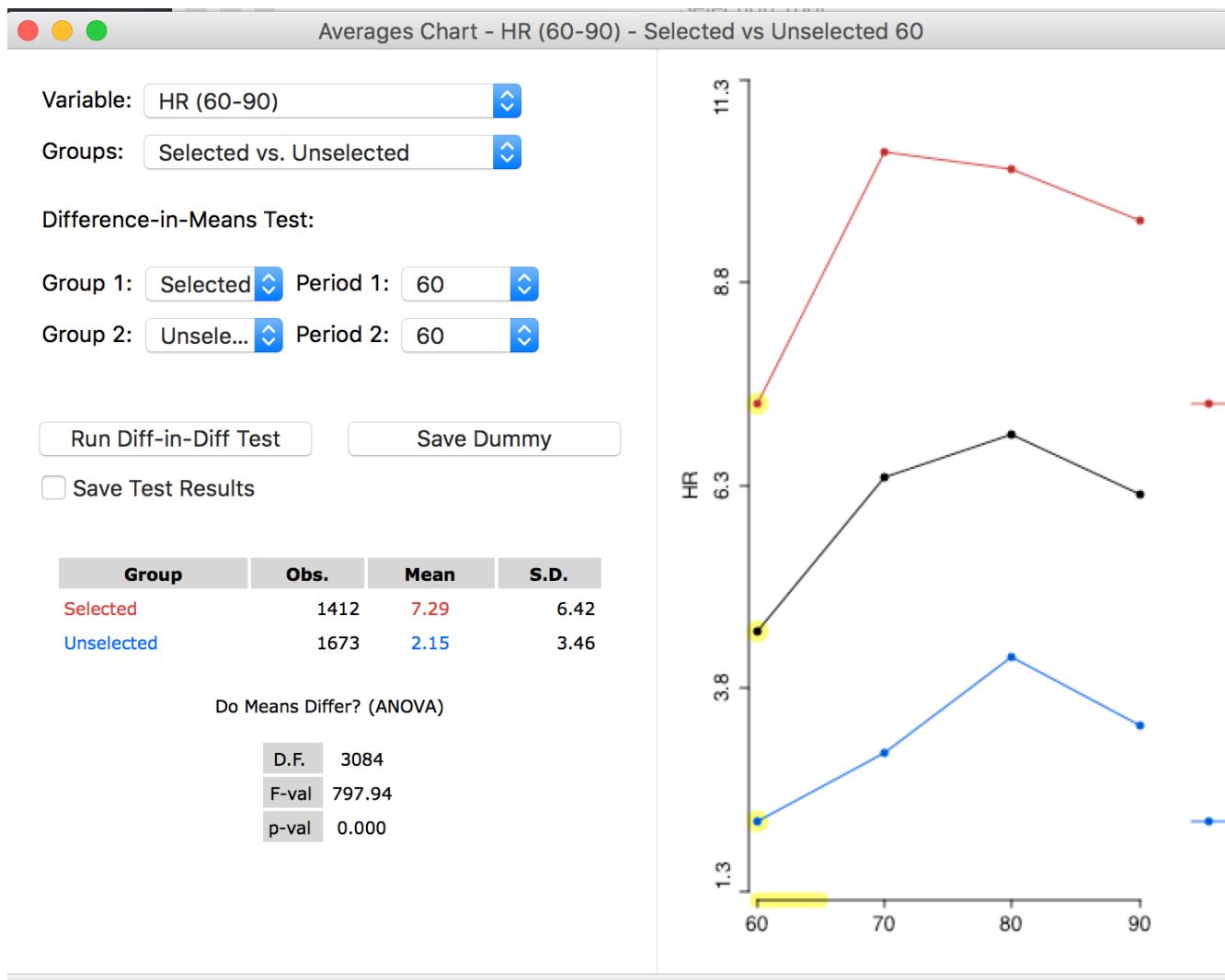


Cross-Section



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selected vs unselected for HR in 60



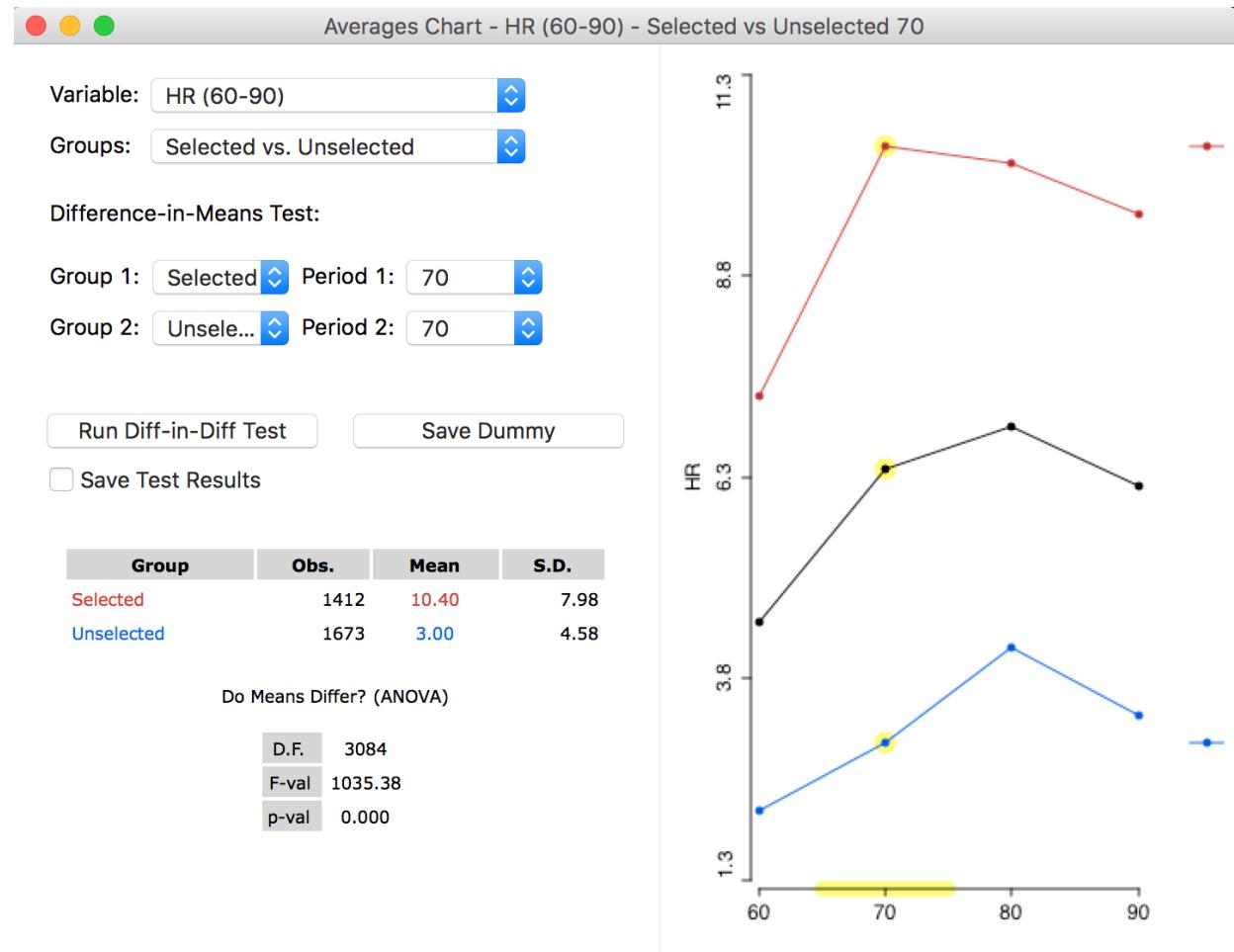
Variable: HR (60-90)

Groups: Selected vs. Unselected

Difference-in-Means Test:

Group 1: Selected Period 1 ✓ 60
70
80
90

Group 2: Unsele... Period 2



select different time period



Diff-in-Diff Regression Report

>>05/05/2016 03:45:52 PM

REGRESSION (DIFF-IN-DIFF, COMPARE REGIMES)

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION

Data Set	:	natregimes		
Dependent Variable	:	HR (60)	Number of Observations:	3085
Mean dependent var	:	4.50408	Number of Variables :	2
S.D. dependent var	:	5.64881	Degrees of Freedom :	3083
R-squared	:	0.205604	F-statistic :	797.938
Adjusted R-squared	:	0.205347	Prob(F-statistic) :	0
Sum squared residual:		78199.7	Log likelihood :	-9363.89
Sigma-square	:	25.3648	Akaike info criterion :	18731.8
S.E. of regression	:	5.03635	Schwarz criterion :	18743.8
Sigma-square ML	:	25.3484		
S.E. of regression ML:		5.03472		

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	2.15096	0.123131	17.4689	0.00000
SPACE	5.14118	0.182003	28.2478	0.00000

===== END OF REPORT =====

run diff-in-diff test = dummy variable regression





dummy1.csv
dummy1.gal

STID, FIPSNO, PERIOD, HR, SPACE
1,27077,60, 0.000000000,0
2,53019,60, 0.000000000,0
3,53065,60, 1.863863416,0
4,53047,60, 2.612330199,0
5,53051,60, 0.000000000,0
6,16021,60, 0.000000000,0
7,30053,60, 7.976389886,0
8,30029,60, 1.011173467,0
9,30035,60, 11.529038766,0
10,30101,60, 0.000000000,0

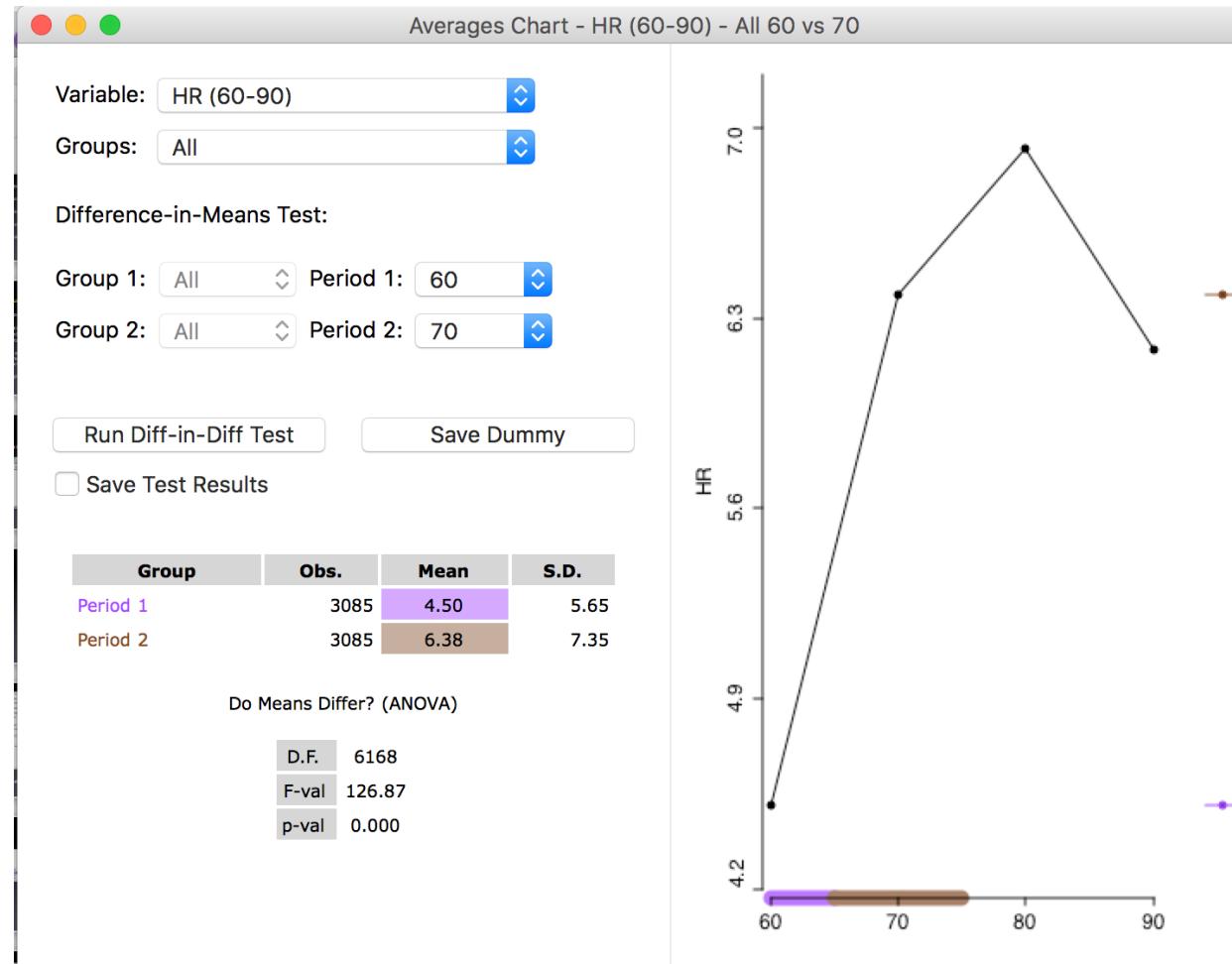
0 3085 dummy1 STID
1 3
30 22 40
2 3
69 2 3
3 4
1 62 4 69
4 7
69 1 27 31 42 55 68
5 4
2 5 28 62

files created by save dummy



All Observations - Two Periods





comparison of all observations in two time periods



Diff-in-Diff Regression Report

>>05/05/2016 04:48:20 PM
 REGRESSION (DIFF-IN-DIFF, COMPARE TIME PERIOD)

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION

Data Set	:	natregimes			
Dependent Variable	:	HR (60,70)	Number of Observations:	6170	
Mean dependent var	:	5.44426	Number of Variables	:	2
S.D. dependent var	:	6.62262	Degrees of Freedom	:	6168

R-squared	:	0.020154	F-statistic	:	126.868
Adjusted R-squared	:	0.019995	Prob(F-statistic)	:	3.81769e-29
Sum squared residual:	265156	Log likelihood	:	-20356.4	
Sigma-square	:	42.989	Akaike info criterion	:	40716.7
S.E. of regression	:	6.5566	Schwarz criterion	:	40730.2
Sigma-square ML	:	42.9751			
S.E of regression ML:	6.55554				

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	4.50408	0.118046	38.1553	0.00000
TIME	1.88037	0.166942	11.2636	0.00000

===== END OF REPORT =====

run diff-in-diff test = dummy variable regression



```
STID,FIPSNO,PERIOD,HR,TIME  
1,27077,60, 0.000000000,0  
2,53019,60, 0.000000000,0  
3,53065,60, 1.863863416,0  
4,53047,60, 2.612330199,0  
5,53051,60, 0.000000000,0  
6,16021,60, 0.000000000,0  
7,30053,60, 7.976389886,0  
8,30029,60, 1.011173467,0  
9,30035,60, 11.529038766,0
```

```
0 6170 dummy2 STID  
1 3  
30 22 40  
2 3  
69 2 3  
3 4  
1 62 4 69  
4 7  
69 1 27 31 42 55 68  
5 4  
2 5 28 62
```

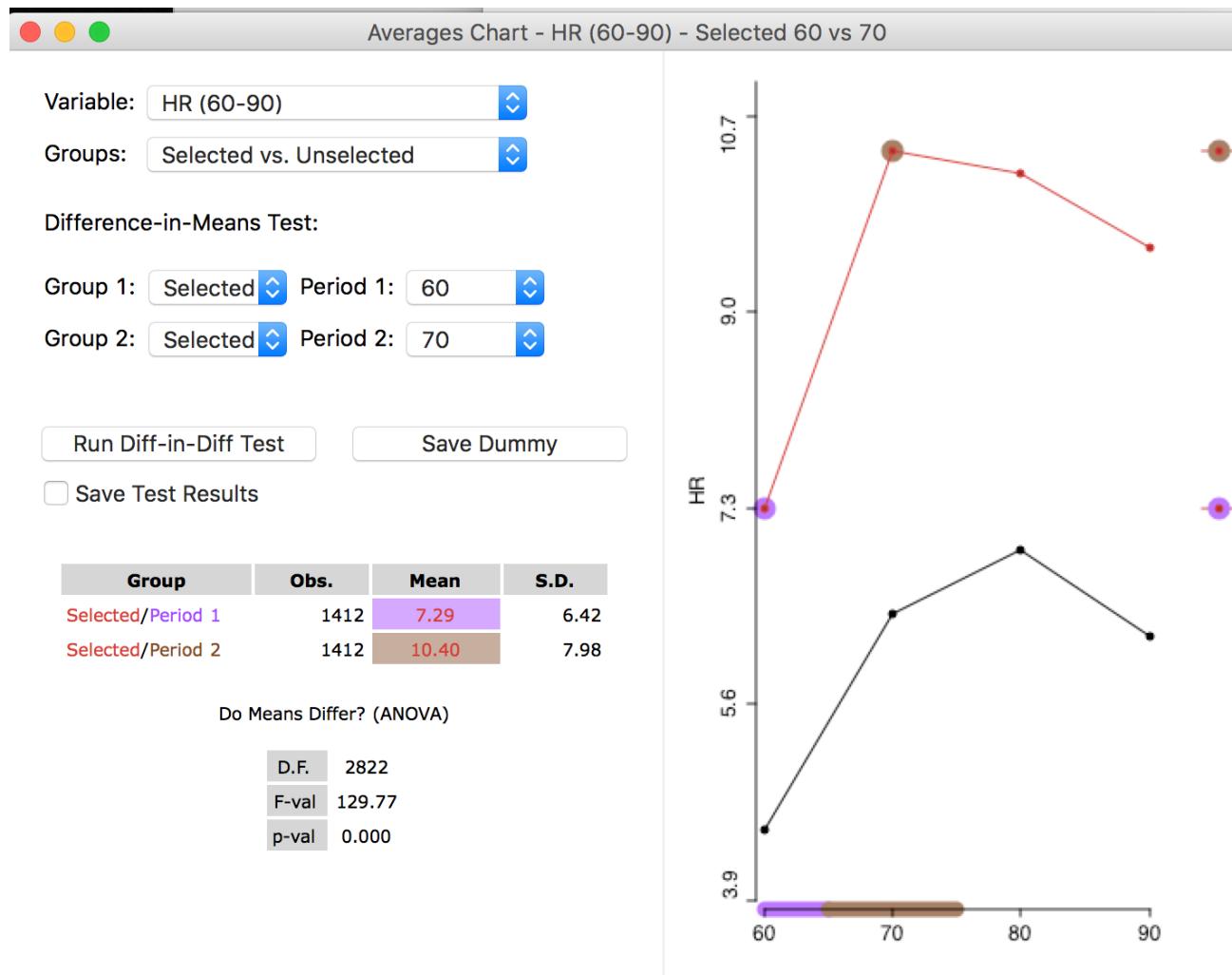
save dummy

space-time data set and gal weights file



Selected - Two Periods





comparison of selected observations in two time periods



Diff-in-Diff Regression Report

```

>>05/05/2016 04:55:51 PM
REGRESSION (DIFF-IN-DIFF, COMPARE REGIMES AND TIME PERIOD)
-----
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data Set          : natregimes
Dependent Variable : HR (60,70) Number of Observations: 6170
Mean dependent var :      5.44426 Number of Variables   :     4
S.D. dependent var :      6.62262 Degrees of Freedom    : 6166

R-squared          :  0.249831 F-statistic           : 684.495
Adjusted R-squared :  0.249466 Prob(F-statistic)    : 0
Sum squared residual: 203003 Log likelihood       : -19532.4
Sigma-square       :  32.923 Akaike info criterion : 39072.7
S.E. of regression  :  5.73786 Schwarz criterion   : 39099.7
Sigma-square ML    :  32.9017
S.E of regression ML:  5.736

-----
Variable          Coefficient   Std.Error   t-Statistic   Probability
-----
CONSTANT          2.15096     0.140282   15.3332     0.00000
SPACE             5.14118     0.207354   24.7942     0.00000
TIME              0.847231    0.198389   4.27056    0.00002
INTERACT          2.25724     0.293243   7.69751    0.00000
-----
===== END OF REPORT =====

```

run diff-in-diff test = space and time dummies and interaction



Spatial Regression



- **Functionality**

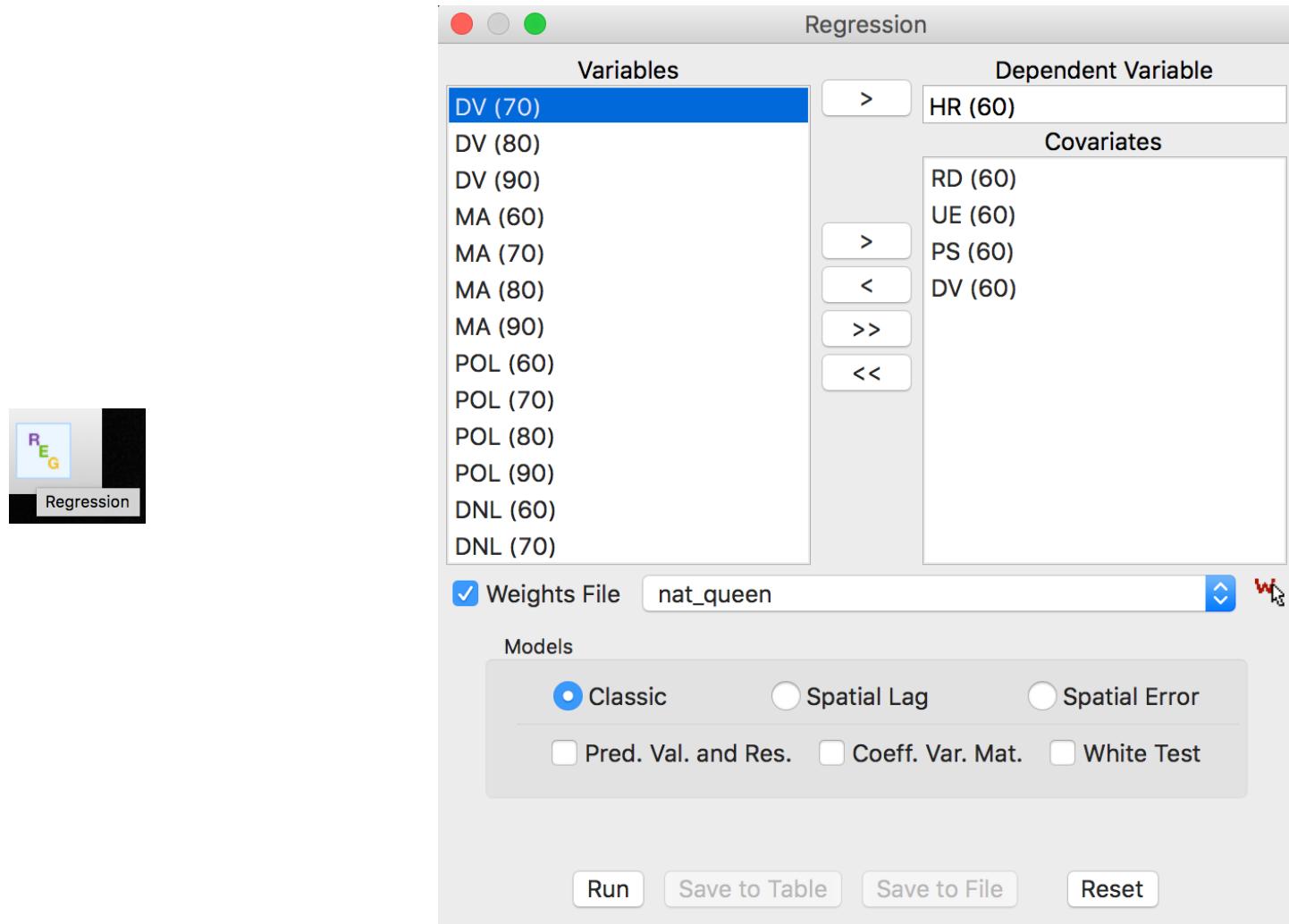
- OLS regression with diagnostics for spatial effects

- ML regression of spatial lag and spatial error models

- save residuals and predicted values

- limitation: only for intrinsically symmetric weights





regression toolbar icon and interface



Regression Report

>>05/05/2016 05:57:42 PM
REGRESSION

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION

Data set	:	natregimes		
Dependent Variable	:	HR (60)	Number of Observations:	3085
Mean dependent var	:	4.50408	Number of Variables :	5
S.D. dependent var	:	5.64881	Degrees of Freedom	: 3080

R-squared	:	0.220243	F-statistic	:	217.488
Adjusted R-squared	:	0.219231	Prob(F-statistic)	:	0
Sum squared residual	:	76758.7	Log likelihood	:	-9335.2
Sigma-square	:	24.9217	Akaike info criterion	:	18680.4
S.E. of regression	:	4.99216	Schwarz criterion	:	18710.6
Sigma-square ML	:	24.8813			
S.E. of regression ML	:	4.98811			

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	2.65084	0.252745	10.4882	0.00000
RD (60)	2.87011	0.0987288	29.0706	0.00000
UE (60)	-0.0367479	0.0364174	-1.00908	0.31300
PS (60)	0.702509	0.094004	7.47318	0.00000
DV (60)	1.07469	0.0976658	11.0037	0.00000

REGRESSION DIAGNOSTICS

MULTICOLLINEARITY CONDITION NUMBER 5.711199

TEST ON NORMALITY OF ERRORS

TEST	DF	VALUE	PROB
Jarque-Bera	2	296191.3107	0.00000

DIAGNOSTICS FOR HETEROSKEDASTICITY

RANDOM COEFFICIENTS

TEST	DF	VALUE	PROB
Breusch-Pagan test	4	460.2628	0.00000
Koenker-Bassett test	4	18.6704	0.00091

DIAGNOSTICS FOR SPATIAL DEPENDENCE

FOR WEIGHT MATRIX : nat_queen
(row-standardized weights)

TEST	MI/DF	VALUE	PROB
Moran's I (error)	0.1906	17.8535	0.00000
Lagrange Multiplier (lag)	1	382.1303	0.00000
Robust LM (lag)	1	70.8931	0.00000
Lagrange Multiplier (error)	1	313.2932	0.00000
Robust LM (error)	1	2.0560	0.15161
Lagrange Multiplier (SARMA)	2	384.1863	0.00000

===== END OF REPORT =====

ols regression results with diagnostics



```

>>05/05/2016 05:58:11 PM
REGRESSION
-----
SUMMARY OF OUTPUT: SPATIAL LAG MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set : natregimes
Spatial Weight : nat_queen
Dependent Variable : HR (60) Number of Observations: 3085
Mean dependent var : 4.50408 Number of Variables : 6
S.D. dependent var : 5.64881 Degrees of Freedom : 3079
Lag coeff. (Rho) : 0.387045

R-squared : 0.309955 Log likelihood : -9191.23
Sq. Correlation : - Akaike info criterion : 18394.5
Sigma-square : 22.0186 Schwarz criterion : 18430.7
S.E of regression : 4.6924

-----
Variable Coefficient Std.Error z-value Probability
-----
W_HR (60) 0.387045 0.0231936 16.6876 0.00000
CONSTANT 1.32898 0.251275 5.28893 0.00000
RD (60) 1.88275 0.106873 17.6167 0.00000
UE (60) 0.00261764 0.0342308 0.0764703 0.93904
PS (60) 0.49365 0.0893103 5.52736 0.00000
DV (60) 0.735294 0.0924862 7.95031 0.00000
-----
REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST DF VALUE PROB
Breusch-Pagan test 4 649.4843 0.00000

DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX : nat_queen
TEST DF VALUE PROB
Likelihood Ratio Test 1 287.9311 0.00000
=====
END OF REPORT =====

```

ML estimation spatial lag



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REGRESSION

SUMMARY OF OUTPUT: SPATIAL ERROR MODEL - MAXIMUM LIKELIHOOD ESTIMATION

Data set : natregimes
Spatial Weight : nat_queen
Dependent Variable : HR (60) Number of Observations: 3085
Mean dependent var : 4.504075 Number of Variables : 5
S.D. dependent var : 5.648806 Degrees of Freedom : 3080
Lag coeff. (Lambda) : 0.391016

R-squared : 0.300728 R-squared (BUSE) : -
Sq. Correlation : - Log likelihood : -9212.716168
Sigma-square : 22.3131 Akaike info criterion : 18435.4
S.E of regression : 4.72367 Schwarz criterion : 18465.6

Variable	Coefficient	Std.Error	z-value	Probability
CONSTANT	2.96545	0.309134	9.59279	0.00000
RD (60)	2.44082	0.129618	18.8308	0.00000
UE (60)	0.0359107	0.0413815	0.867796	0.38551
PS (60)	0.650578	0.111279	5.84636	0.00000
DV (60)	0.693085	0.109803	6.31207	0.00000
LAMBDA	0.391016	0.0243657	16.0478	0.00000

REGRESSION DIAGNOSTICS

DIAGNOSTICS FOR HETROSKEDEASTICITY

RANDOM COEFFICIENTS

TEST	DF	VALUE	PROB
Breusch-Pagan test	4	613.6859	0.00000

DIAGNOSTICS FOR SPATIAL DEPENDENCE

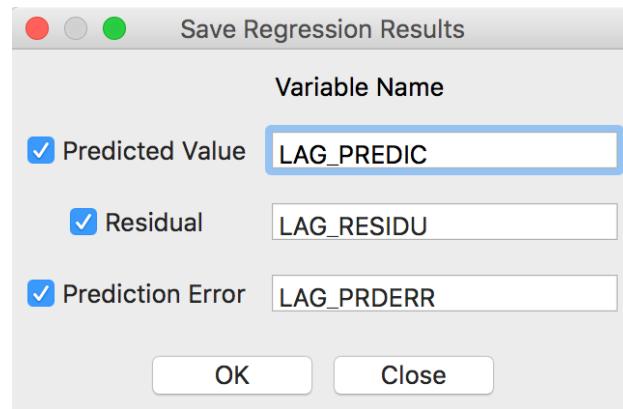
SPATIAL ERROR DEPENDENCE FOR WEIGHT MATRIX : nat_queen

TEST	DF	VALUE	PROB
Likelihood Ratio Test	1	244.9628	0.00000

===== END OF REPORT =====

ML spatial error model





save to table for spatial lag model

