Methods for Space-Time Analysis: Examples From the China Historical GIS

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Data Models for History in GIS

- History for historians or data managers?
- Arc/Info Coverage model or Geodatabase?
- Transactional model or Versioning?
- ESRI White Paper: “Modeling and Using History”

Chinese History: Why GIS?

- Historical continuity of records and county seats
- County gazeteers and memorials as data sources
- Position of counties in administrative hierarchy

The Chinese Historical GIS Project

Main project goals

- Create a database of historical administrative geography
- Provide a common framework for georeferencing historical materials
- Offer a GIS platform for spatio-temporal analysis

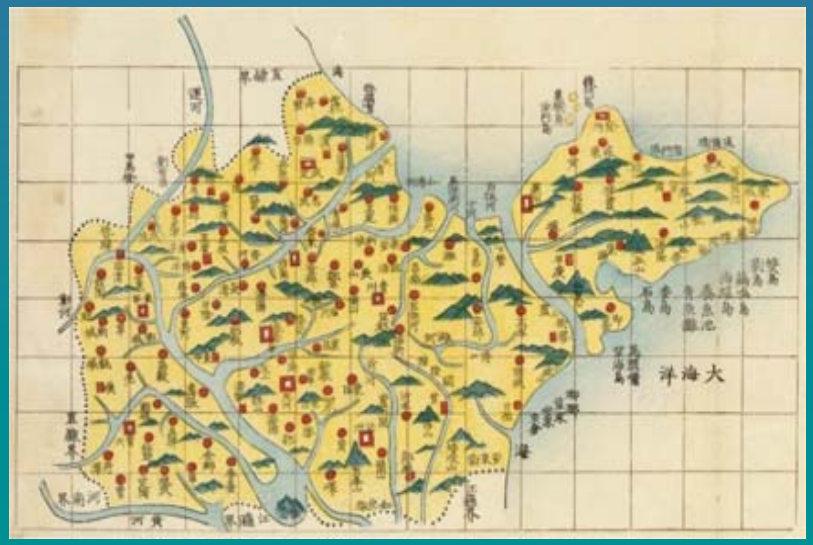
Other historical GIS projects:

- Great Britain Historical GIS
- US National Historical GIS
- TimeMap (University of Sydney)
- Electronic Cultural Atlas Initiative

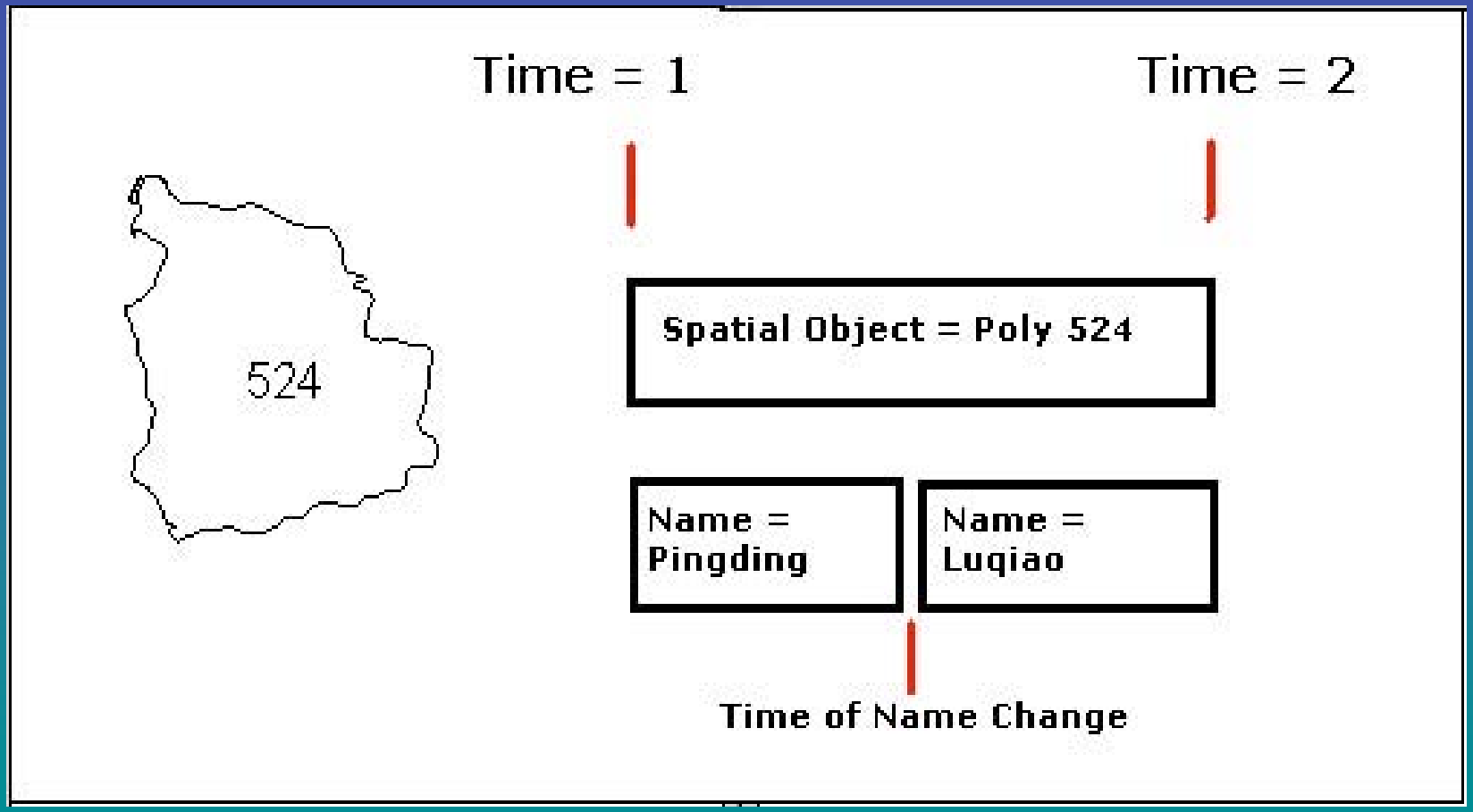
Today's Topic: Data Models

Three components
- Textual notes
- Digital map
- Data Tables
  - Historical Instance Table

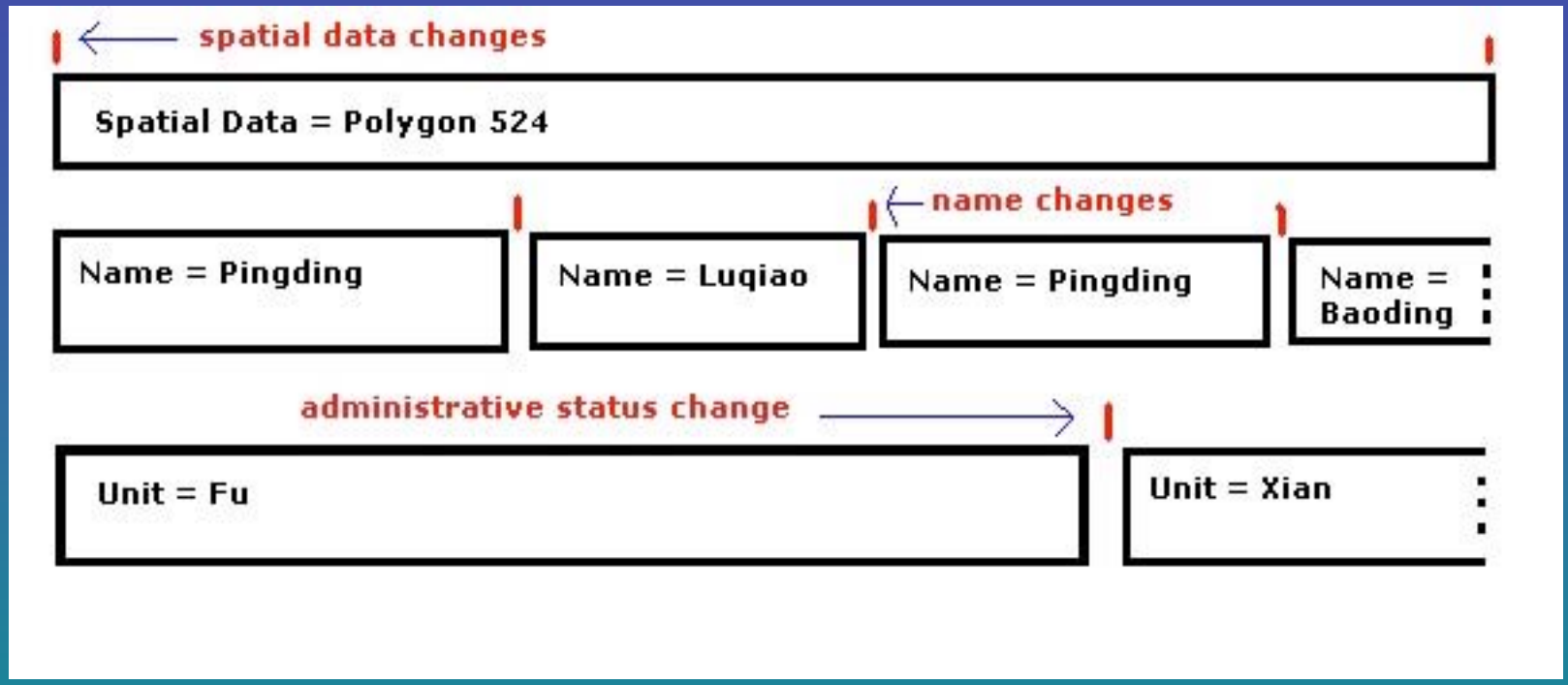
One "Historical Instance" has
- One place name
- One administative status
- One spatial object



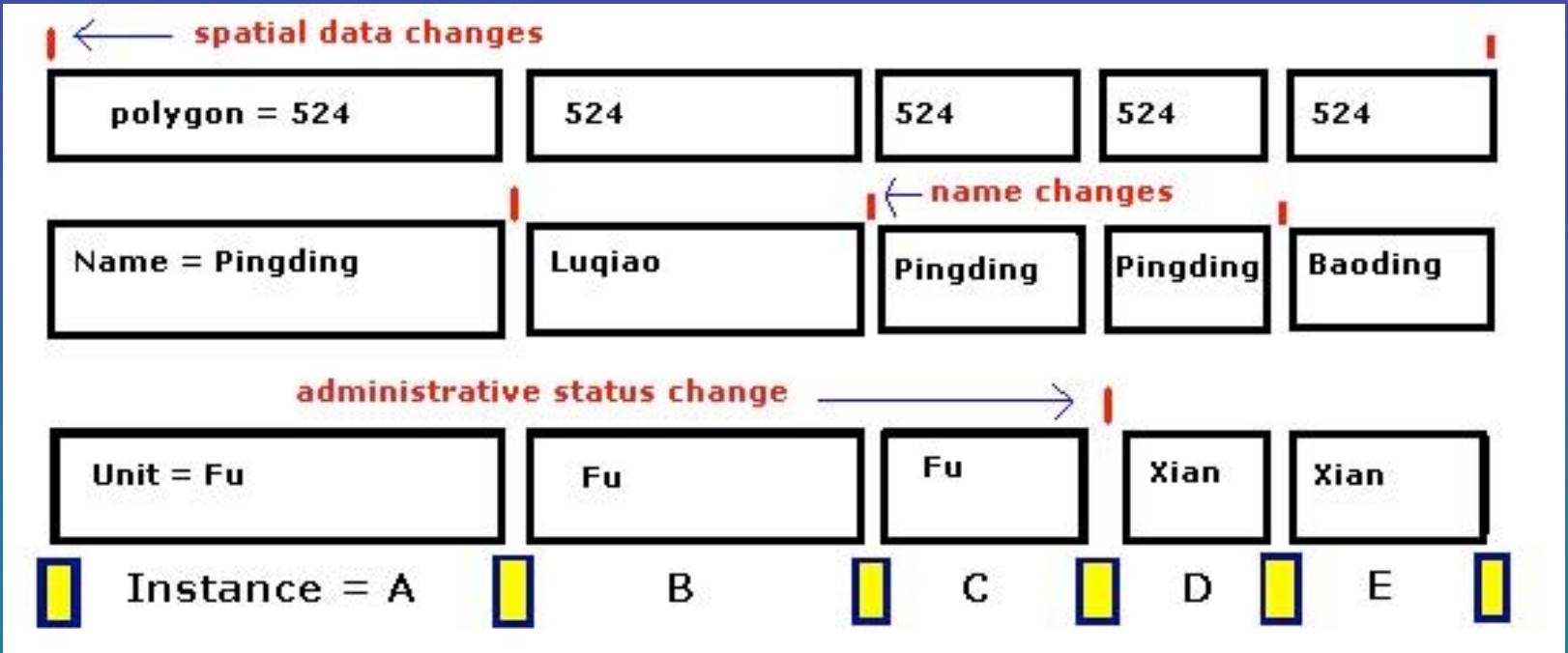
Name Change Makes Two Historical Instances



More Changes Make More Instances

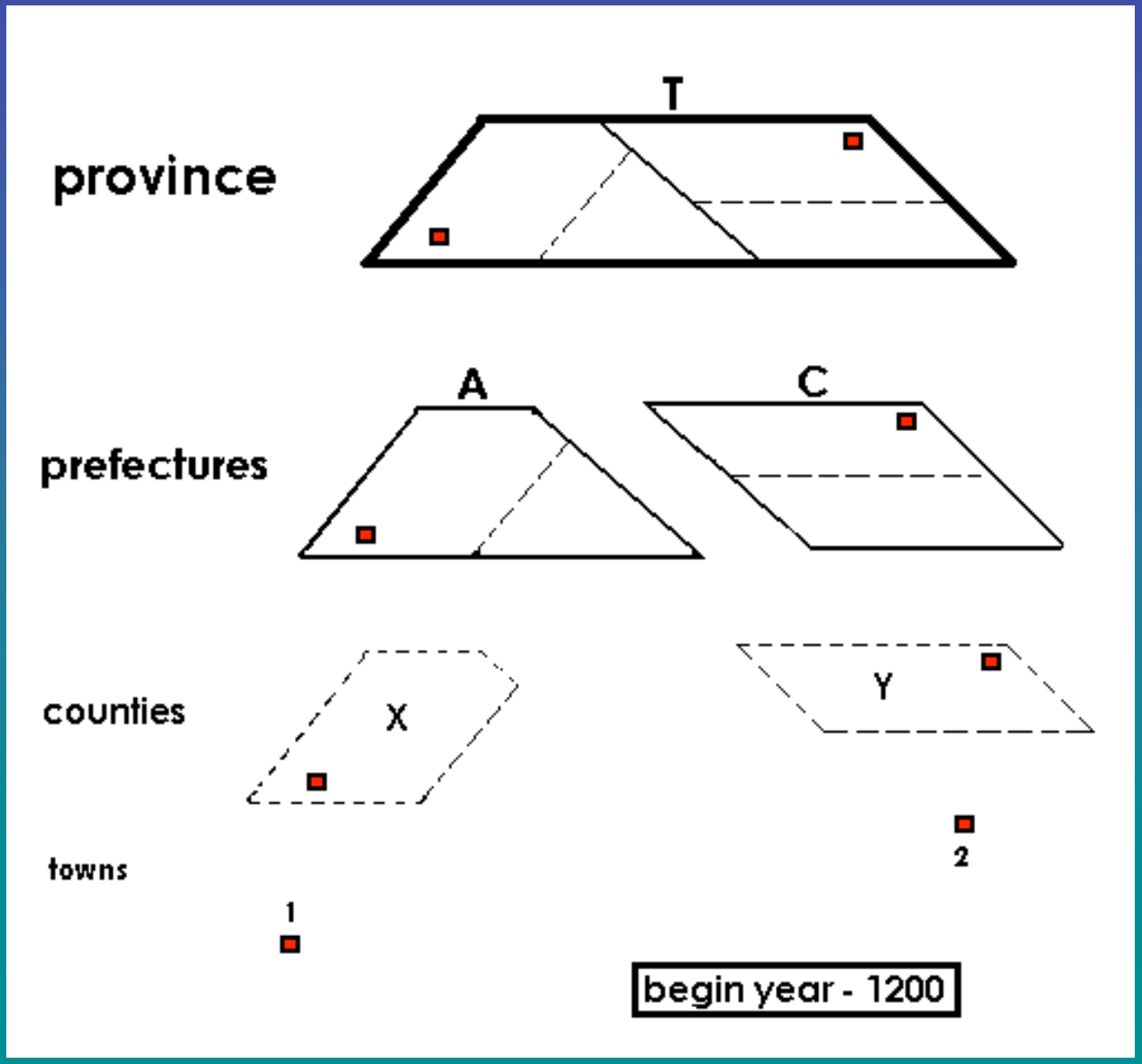


Attributes Unchanged Through Each Instance



Instance	Polygon	Name	Admin_Unit
A	524	Pingding	Fu
B	524	Luqiao	Fu
C	524	Pingding	Fu
D	524	Pingding	Xian
E	524	Baoding	Xian

Administrative Hierarchy



Historical Instances Table

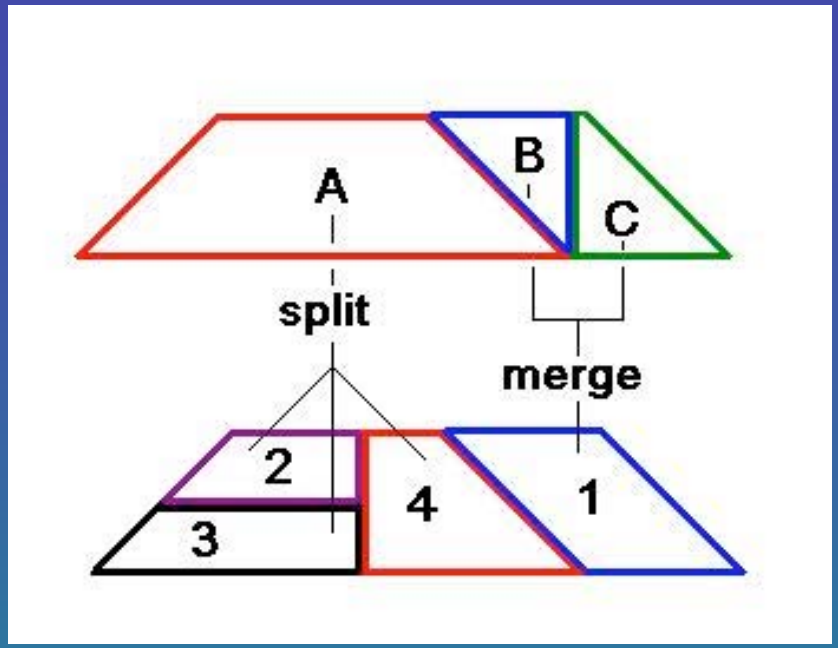
sys-id	hist-place	begin	end
333	Province T	1200	1350
334	Prefecture A	1200	1249
335	Prefecture B	1250	1350
336	Prefecture C	1200	1350
337	County X	800	1500
338	County Y	1200	1320
339	County Z	1321	1340
340	Town 1	200	1700
341	Town 2	100	1500

Temporal Sequence Table

sys-id	place-name	prec-by	prec-by-name
335	Prefecture B	334	Prefecture A
339	County Z	338	County Y

Part-Of Table

sys-id	place-name	part-of	part-of-name	begin	end
334	Prefecture A	333	Province T	1200	1249
335	Prefecture B	333	Province T	1250	1350
336	Prefecture C	333	Province T	1200	1350
337	County X	334	Prefecture A	1200	1249
337	County X	335	Prefecture B	1250	1350
338	County Y	336	Prefecture C	1200	1350
339	County Z	336	Prefecture C	1200	1350
340	Town 1	337	County X	1200	1350
341	Town 2	338	County Y	1300	1320
341	Town 2	339	County Z	1321	1340



Historical Instances Table

sys-id	hist-place
5001	A
5002	B
5003	C
5004	1
5005	2
5006	3
5007	4

Temporal Sequence Table

sys-id	place-name	prec-by	prec-by-name
5004	1	5002	B
5004	1	5003	C
5005	2	5001	A
5006	3	5001	A
5007	4	5001	A

Suzhou from 1367 to 1990

Historical Source Notes

Source Note: 苏州府（1375-1723年）界线
明洪武八年（1375），扬州府崇明县来属，府境扩大。清顺治二年（1645）地入清，属江南省。康熙六年（1667）为江苏省会。清雍正二年（1724），太仓州升为直隶州，境域缩小。
明洪武八年（1375年），扬州府崇明县来属，[1]府境扩大。洪武十一年正月（1378年2月）隶京师。[2]永乐元年正月（1421年2月）属南京。洪熙元年三月戊戌（1425年4月16日）复属京师。[3]正统六年十一月甲午（1441年11月14日）复属南京（南直隶）。[4]弘治十年正月己巳（1497年2月11日）增领太仓州，崇明县改隶太仓州。[5]至明末，苏州府领吴、长洲、昆山、常熟、吴江、嘉定6县、太仓州（领崇明县）。清顺治二年闰六月乙巳（1645年8月19日）地入清，属江南省。[6]康熙六年七月甲寅（1667年8月30日）以原江南省右布政使司为江苏布政使司，[7]府属江苏省，江苏巡抚及布政、按察两使治此，为江苏省会。[8]雍正二年九月甲辰（1724年10月20日），增领元和、震泽、昭文、新阳、镇洋、新阳6县。[9]治所为吴、长洲、元和3县。[10]清雍正二年（1724），太仓州升为直隶州，镇洋、嘉定、宝山、崇明4县往属太仓直隶州，境域缩小[11]。

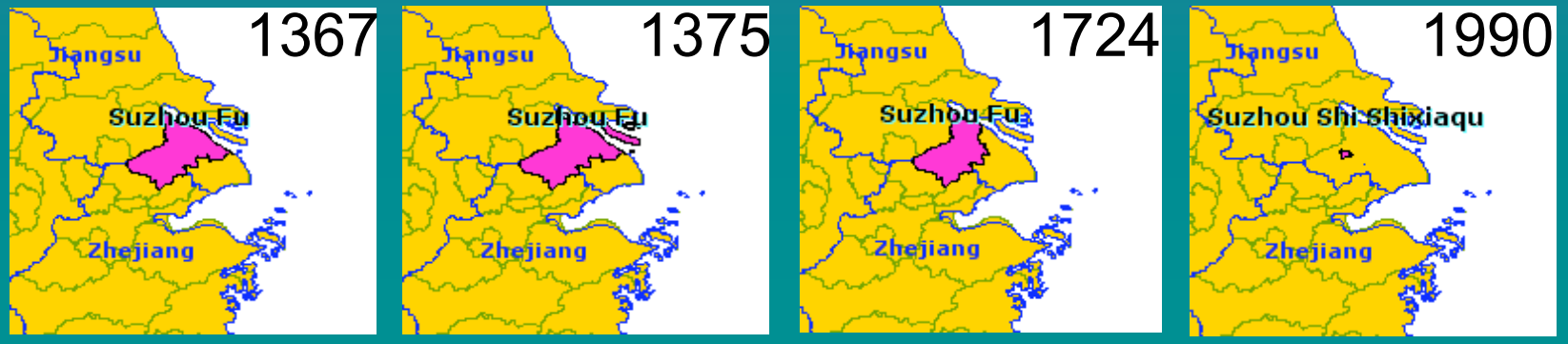
Tables

Sys-ID	Hist-Place	From	To
90244	Suzhou Fu	1367	1374
90245	Suzhou Fu	1375	1723
90246	Suzhou Fu	1724	1911
333320501	Shzhou Shi	1990	1990

Sys-ID	Place-Name	Prec-ID	Prec-Name
90245	Suzhou Fu	90244	Suzhou Fu
90245	Suzhou Fu	40385	Chongming Zhou

Sys-ID	Name	Part-Of	From	To
90245	Suzhou Fu	Jiangnan Province	1645	1667
90245	Suzhou Fu	Jiangsu Province	1667	1911

Spatial Objects (Regions)



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Temporal Sequence Table

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90245	Suzhou Fu	40385	Chongming Zhou

Part-Of Table

Sys-ID	Place-Name	Part-Of	From	To
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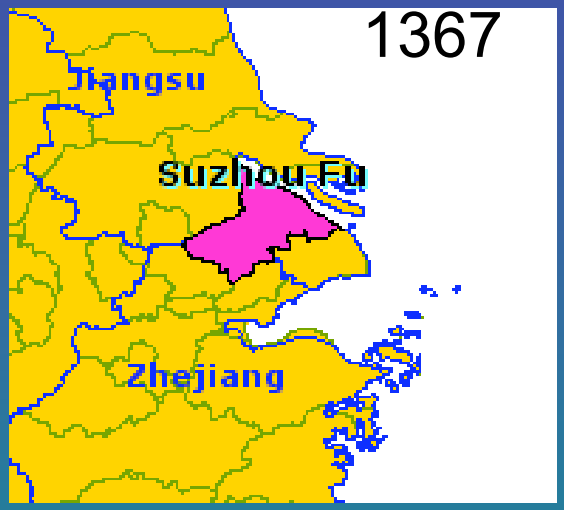
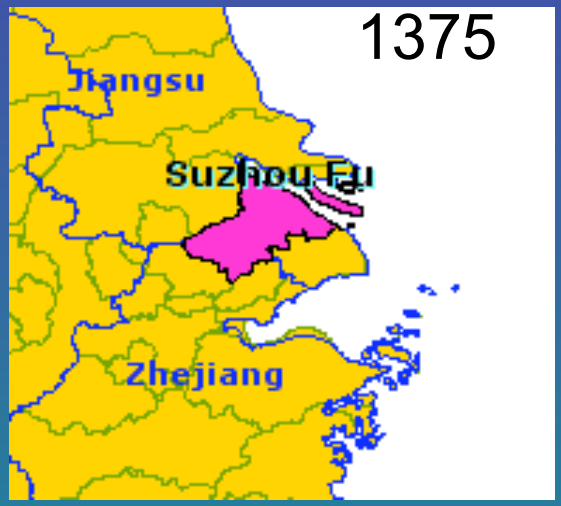
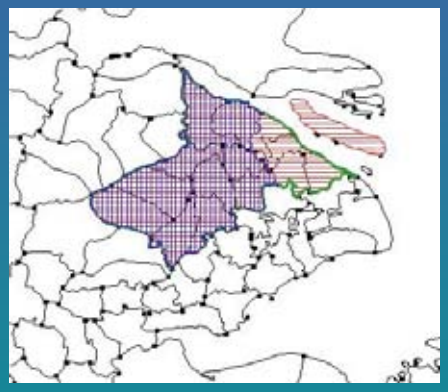
Suzhou from 1367 to 1990

Spatial Objects (Regions)





Generating Slices in Time



- "Atomic Polygons" with Regions for each historical instance
- Select Instances for a specific date

```
Resel HistInst.dat start <= 1644 and ~
end >= 1644
Resel cov region.fu keyfile HistInst.dat ~
info fu# keyitem sys-id
```

- Select Arcs associated with Regions

```
Resel cov.PALfu info keyfile cov region.fu ~
unit keyitem fu#
Resel cov arc keyfile cov.PALfu info fu# ~
keyitem arc
```

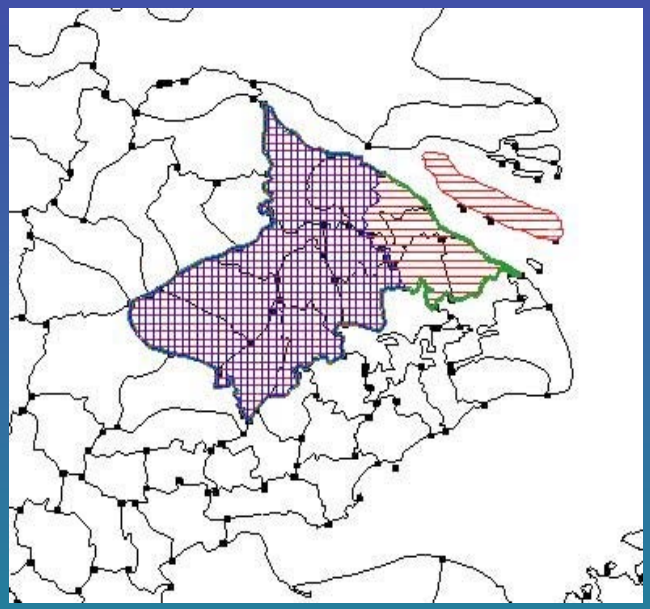
- Assign boundary symbols by comparing neighbors' parents

```
Resel cov arc PALright//PartOfTable//part-of ~
<> PALleft//PartOfTable//part-of
Calc cov arc slice1644//btype = ~
slice1644//btype + 1
Arclines cov slice1644//btype ~
boundarysymbols.alut
```

The Modifiable Areal Unit Problem (MAUP)

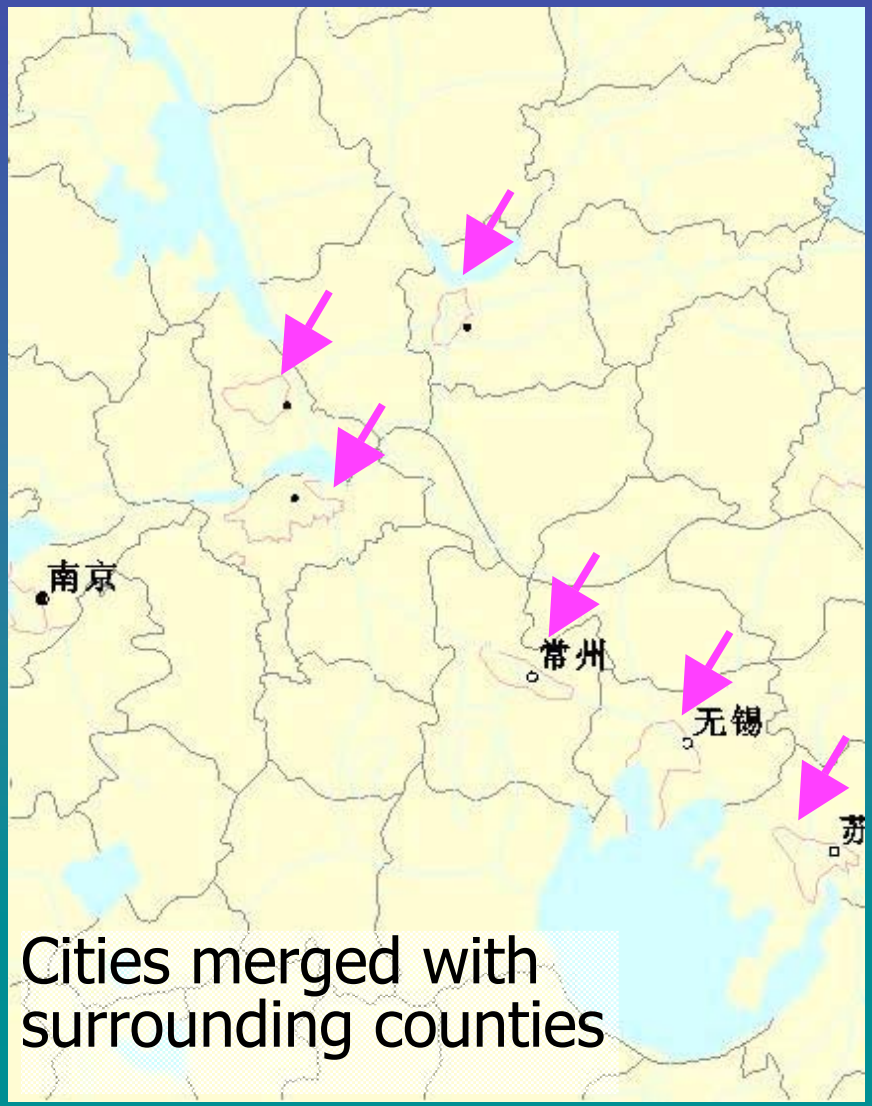
- Comparing areal units of different sizes in space
  - Aggregation effects
  - Scale effects
- MAUP compounded as units change through time
- Smallest Common Unit approach

REGIONXAREA to Identify Smallest Common Units

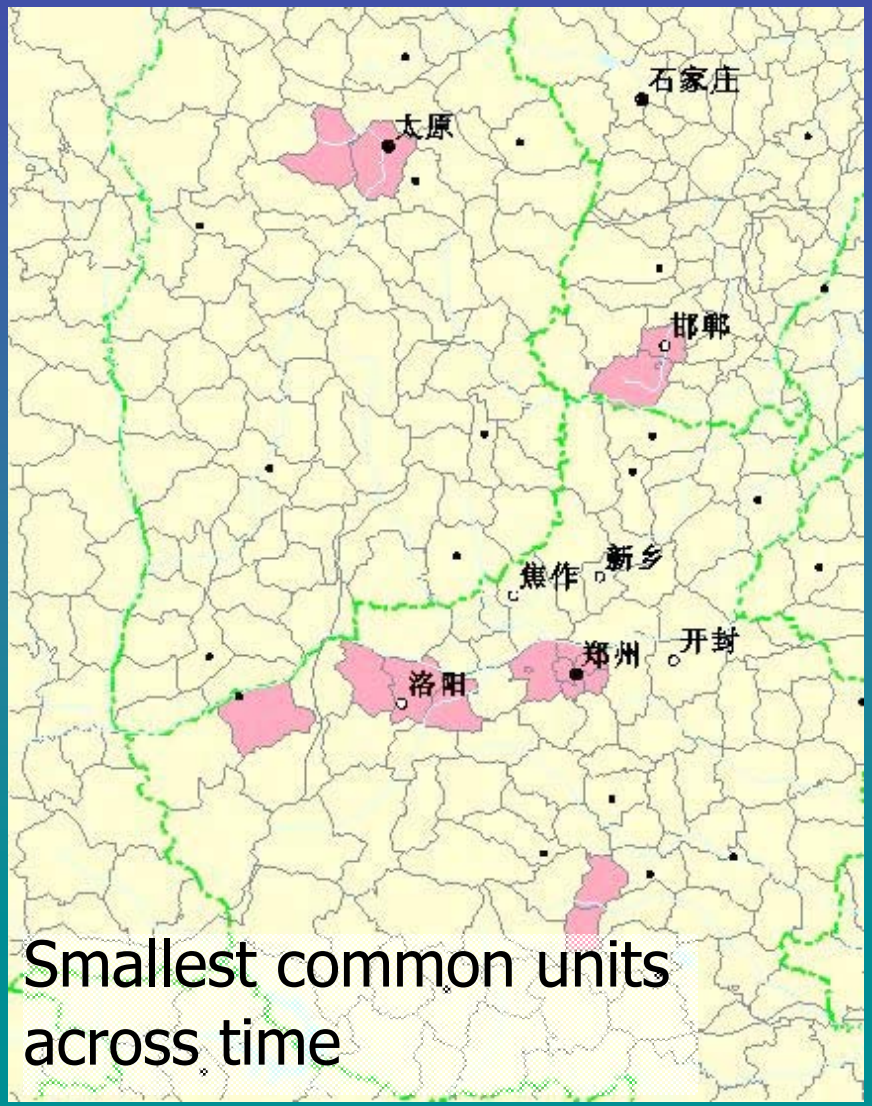


- XAREA table gives area and percentage of overlap between pairs of regions
- If overlap is not 100%, iteratively merge other regions that overlap
- Calculate statistics for Smallest Common Unit

The MAUP and Analytical Mergers

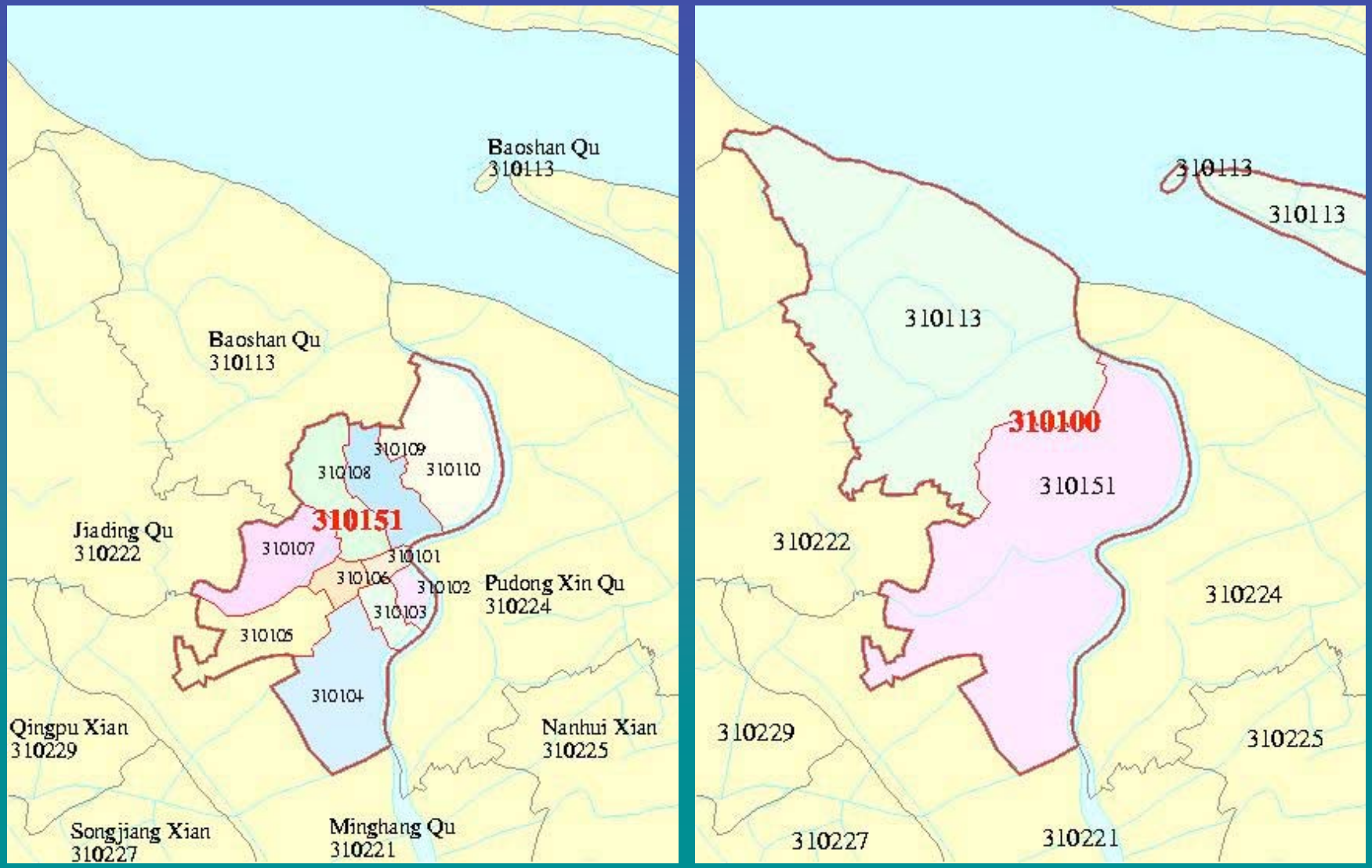


Cities merged with surrounding counties

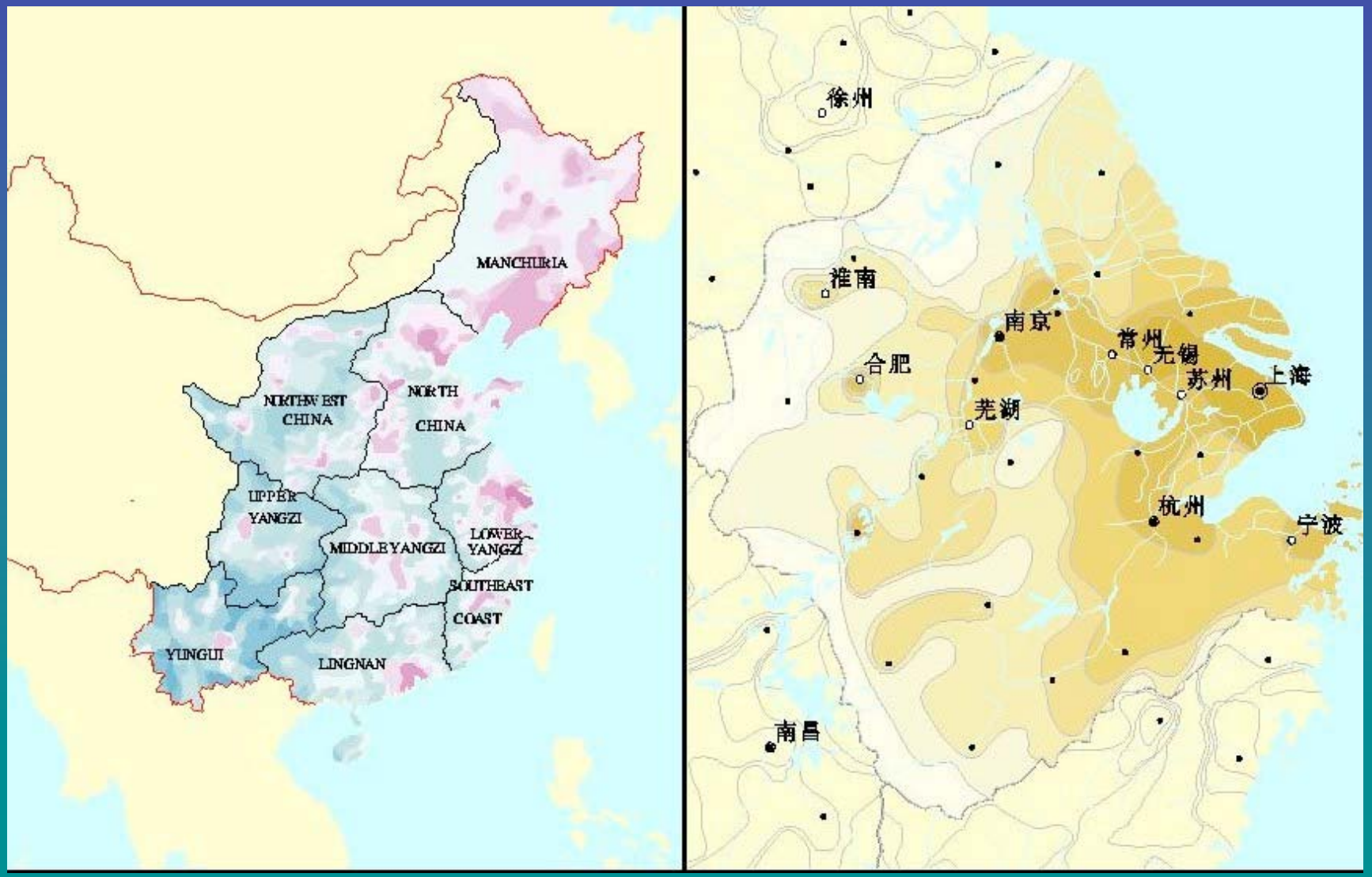


Smallest common units across time

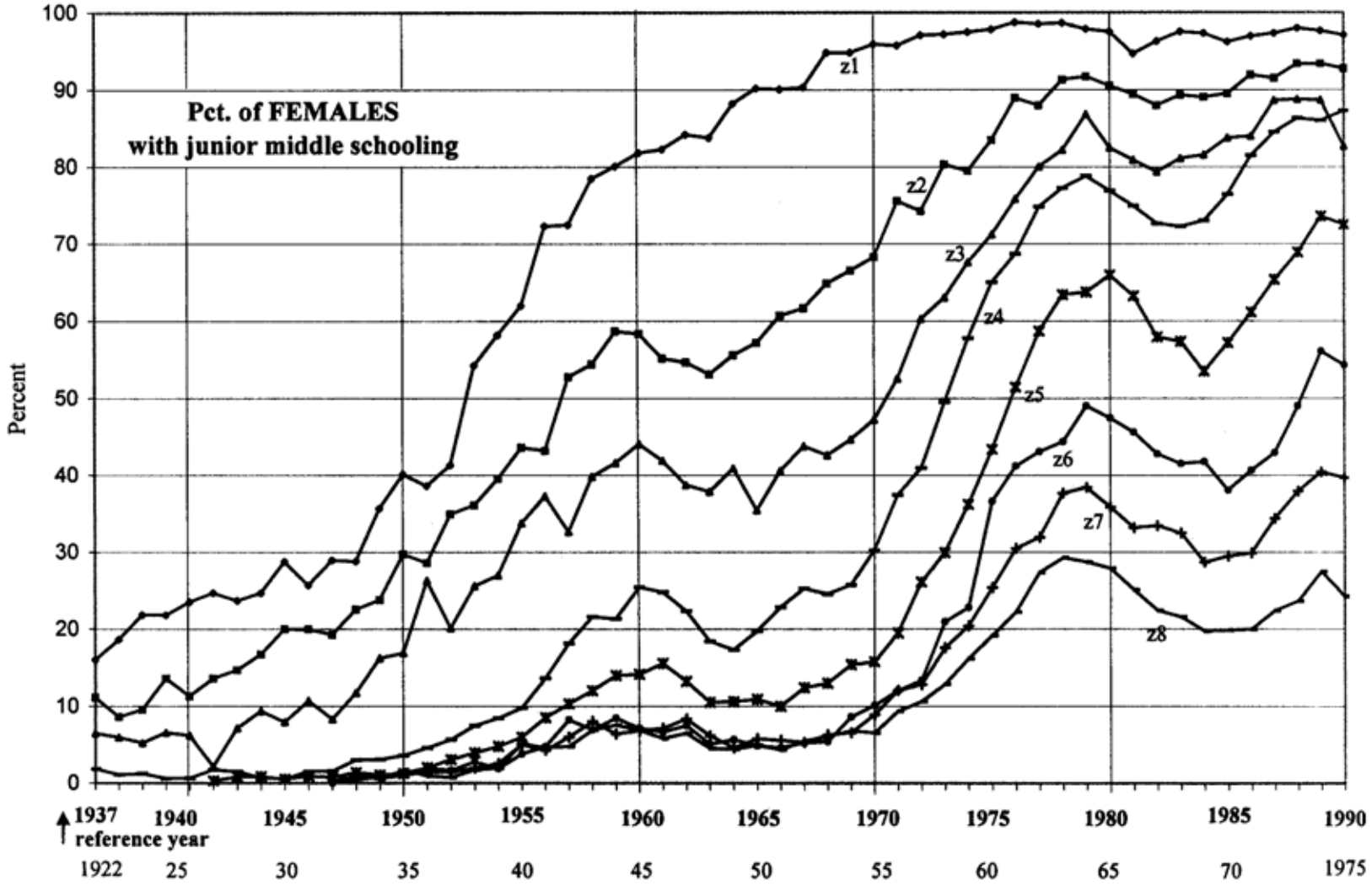
Analytical Mergers: Shanghai



The Spatial Approach to Chinese History



Space-time analysis of junior middle schooling, FEMALES only:
data by year of birth, 1922-1975
(and reference year, 15 years later, 1937-1990)
and by HRS zone, Lower Yangzi macroregion



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www.fas.harvard.edu/~chgis

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