American Planning Association
Georgia Chapter

Making Great Communities Happen

Quantitative, Spatial, Mapping, and Visualization
Plan-Making Methods

AICP EXAM REVIEW

Session Outline

Introduction (5 min)

A. Basic statistics concepts (5 min)

B. Forecasting methods (5 min)

C. Population analysis and projection (10 min)

D. Economic analysis (10 min)

E. Maps, charts, and visualization (5 min)

F. GIS and spatial analysis (10 min)

Example of a plan-making methods question

Industry	Local Employment	National Employment
X	3%	6%
Y	10%	7%
Z	11%	3%

5. Listed above are two types of employment percentages for industries X, Y, and Z in a metropolitan area. The local employment for each industry is listed as a percent of total local employment, and the national employment in each industry is listed as a percent of total national employment. Under the location quotient method, an economic planner can assign which of these industries to the export sector of the metropolitan area?   Y and Z only

Basic methods bibliography

- ★ Berke, P., Godschalk, D. & Kaiser, E. (2006). **Urban land use planning** (5th ed.). Urbana: University of Illinois Press. (This classic text also has excellent, brief overviews of various plan-making methods. It is the best single plan-making review source.)
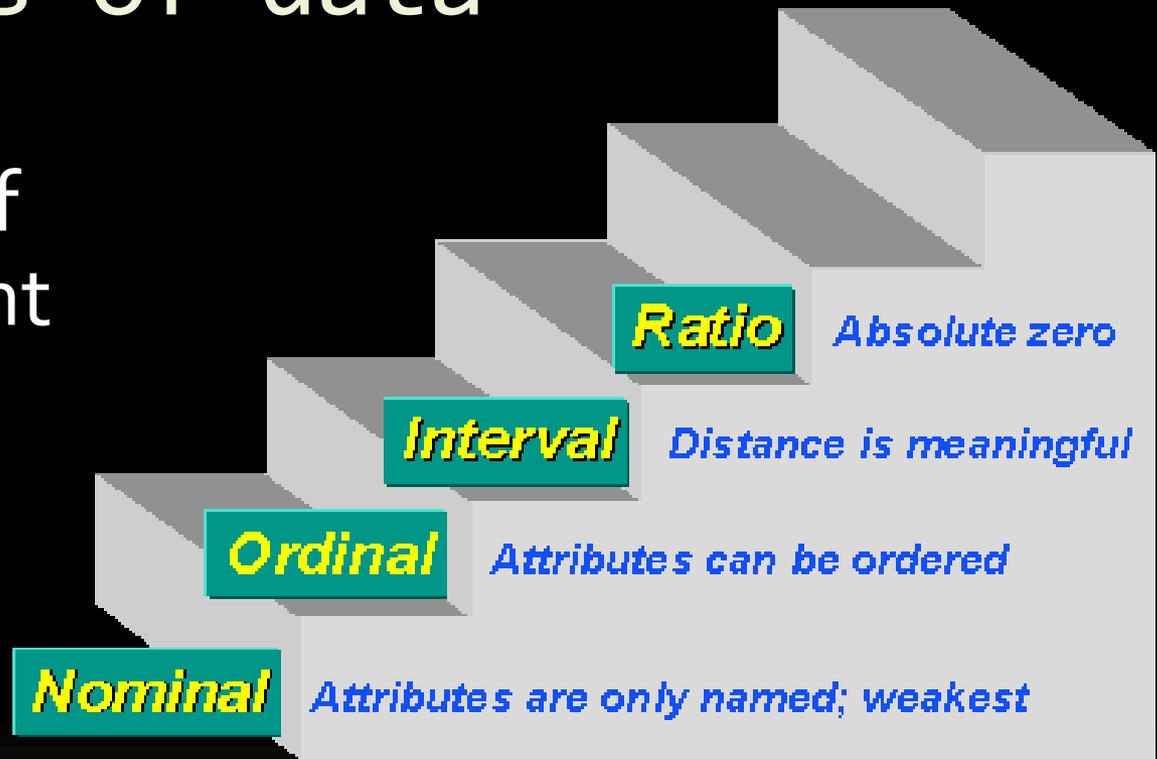
- Klosterman, R. E. (1990). **Community analysis and planning techniques**. Savage, Md.: Rowman & Littlefield. (Technical but good)

- McLean, M. (1992). **Understanding your economy** : using analysis to guide local strategic planning (2nd ed.). Chicago, Ill.: Planners Press, American Planning Association. (Very clearly written)

- Meier, K. J., & Brudney, J. L. (1997). **Applied statistics for public administration** (4th ed.). Fort Worth: Harcourt Brace College Publishers. (Many editions; any edition is fine)

- Patton, C. V., & Sawicki, D. S. (1993). **Basic methods of policy analysis and planning** (2nd ed.). Englewood Cliffs, NJ: Prentice Hall. (Excellent overview of fundamental methods and terms)

- Smith, S. K., Tayman, J., & Swanson, D. A. (2001). **State and local population projections** : methodology and analysis. New York: Kluwer Academic/Plenum Publishers. (Best resource on local projections)

A. Statistics
Types of data

- Four types of measurement scales
 - Nominal
  - Ordinal
  - Interval
  - Ratio
- Primary data vs. secondary data
- Enumeration or census vs. sample

Ratio — Absolute zero

Interval — Distance is meaningful

Ordinal — Attributes can be ordered

Nominal — Attributes are only named; weakest

Measures of central tendency

Mean vs. Median vs. Mode Home Price

$200,000

$150,000

$100,000

$50,000

$0

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

—— Median Price Trend   —— Mean Price Trend   —— Mode Price Trend

Mean, Median & Mode: Home Prices Through February 2014   Source: Tallahassee MLS
As Seen On The Tallahassee Real Estate Website www.Manausa.com

- Mean
  - Sum of items divided by Count of items
- Median
  - Sort items high to low
  - Select middle item, or average of two middle items
- Mode
  - What value occurs most often?
  - Bimodal distributions
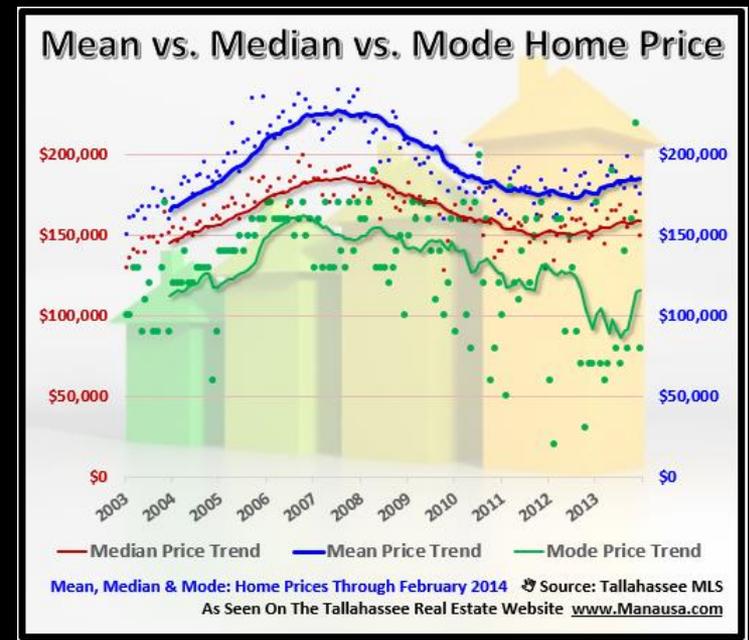
Measures of dispersion
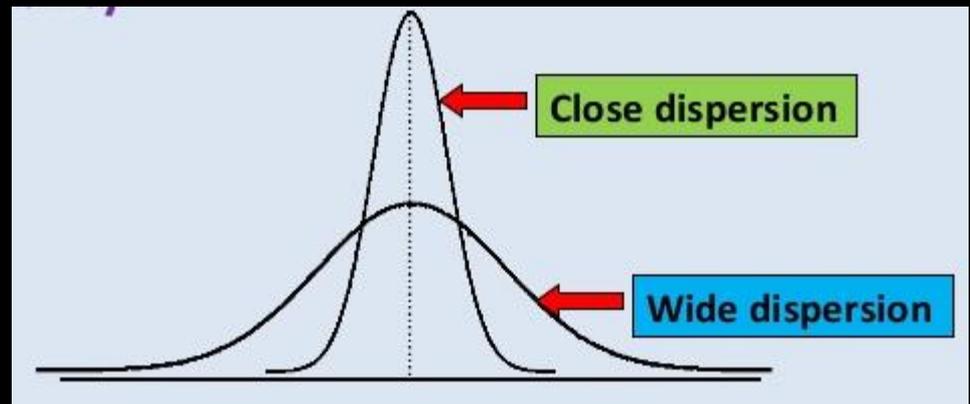
- Range
  - High value minus low value
- Interquartile range
  - 75th percentile value minus 25th percentile value
- Variance
  - Subtract the mean from each value
  - Square each difference
  - Sum the squares of the differences and divide by the number of cases
- Standard deviation
  - Take the square root of the variance
 - Can relate to original units

B. Forecasting methods

- Intuitive methods
  - Delphi technique
  - Scenario writing
- Trend extrapolation methods
  - Assume future change of same amount added or subtracted per year (or decade)
  - Assume future change of same percentage increase (or decrease) per year (or decade, or any period)
  - Regression methods to fit lines or curves

Regression terms

- Dependent variable or y variable: the variable being predicted or explained

- Independent variable(s) or x variable(s): the variable(s) used to predict or explain

- How many variables used to predict?
  - Bivariate regression (one x variable)
  - Multiple regression (two or more x variables)

Regression
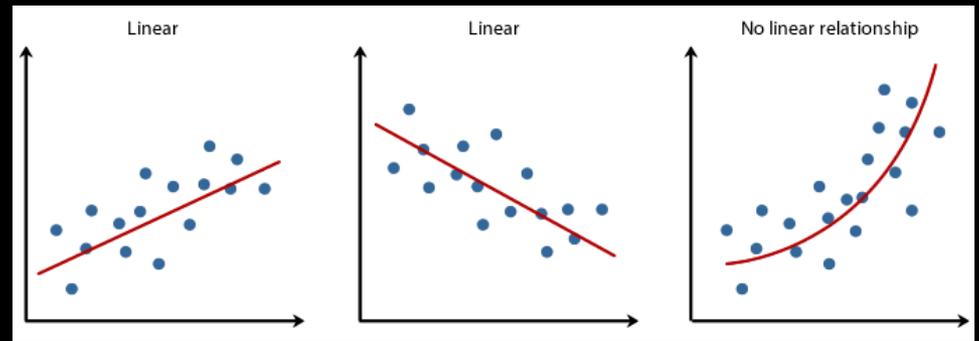
- Assumes a straight line can be used to describe the relationship between the independent (x) variable and the dependent (y) variable.
- $y = a + b*x$ (or $y = m*x + b$)
- a is the line's y intercept
- b is the line's slope
- R^2 measures how well the line fits the data and ranges from 0.0 to 1.0
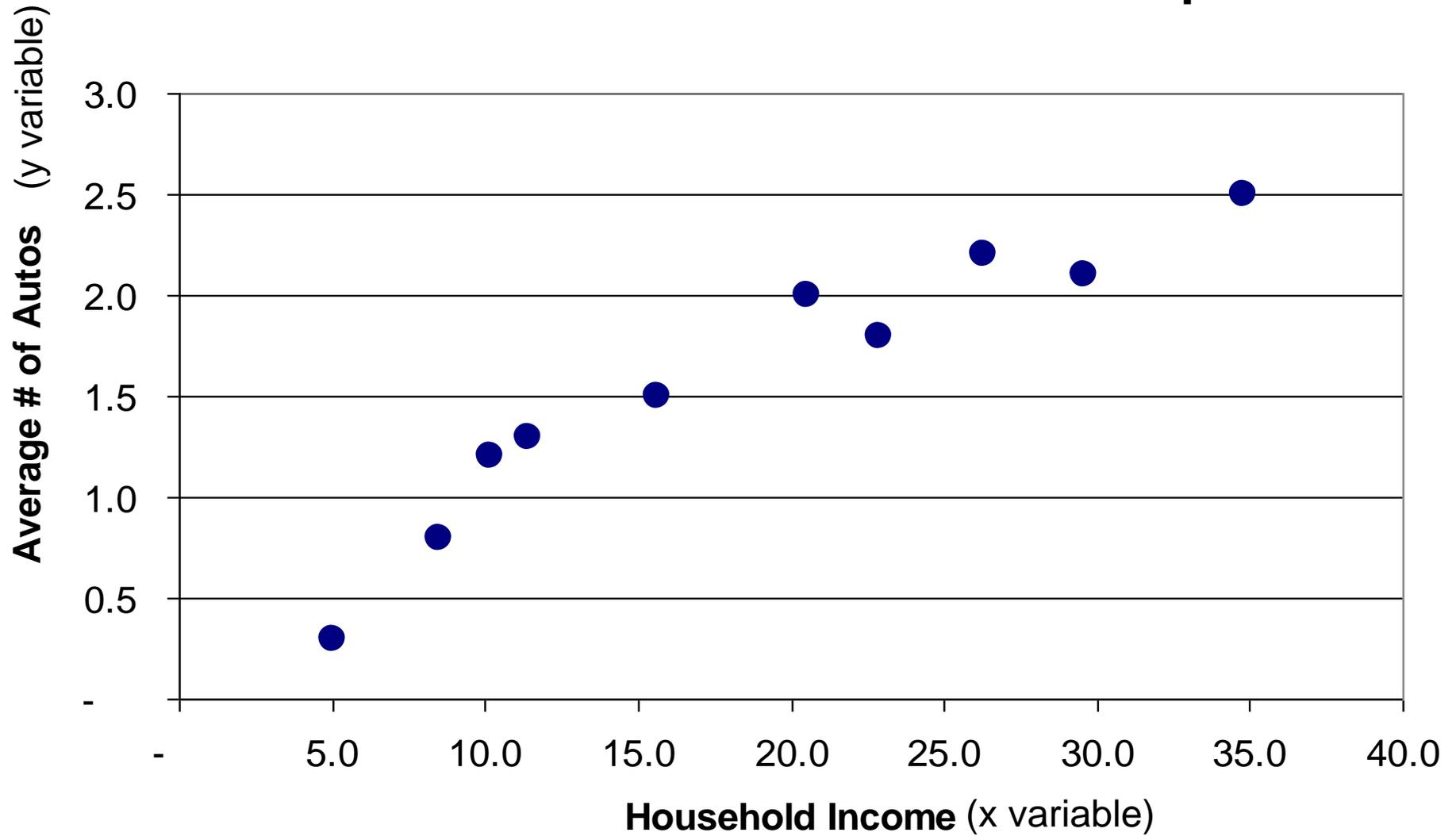
Bivariate regression

We want to predict the number of autos per household.
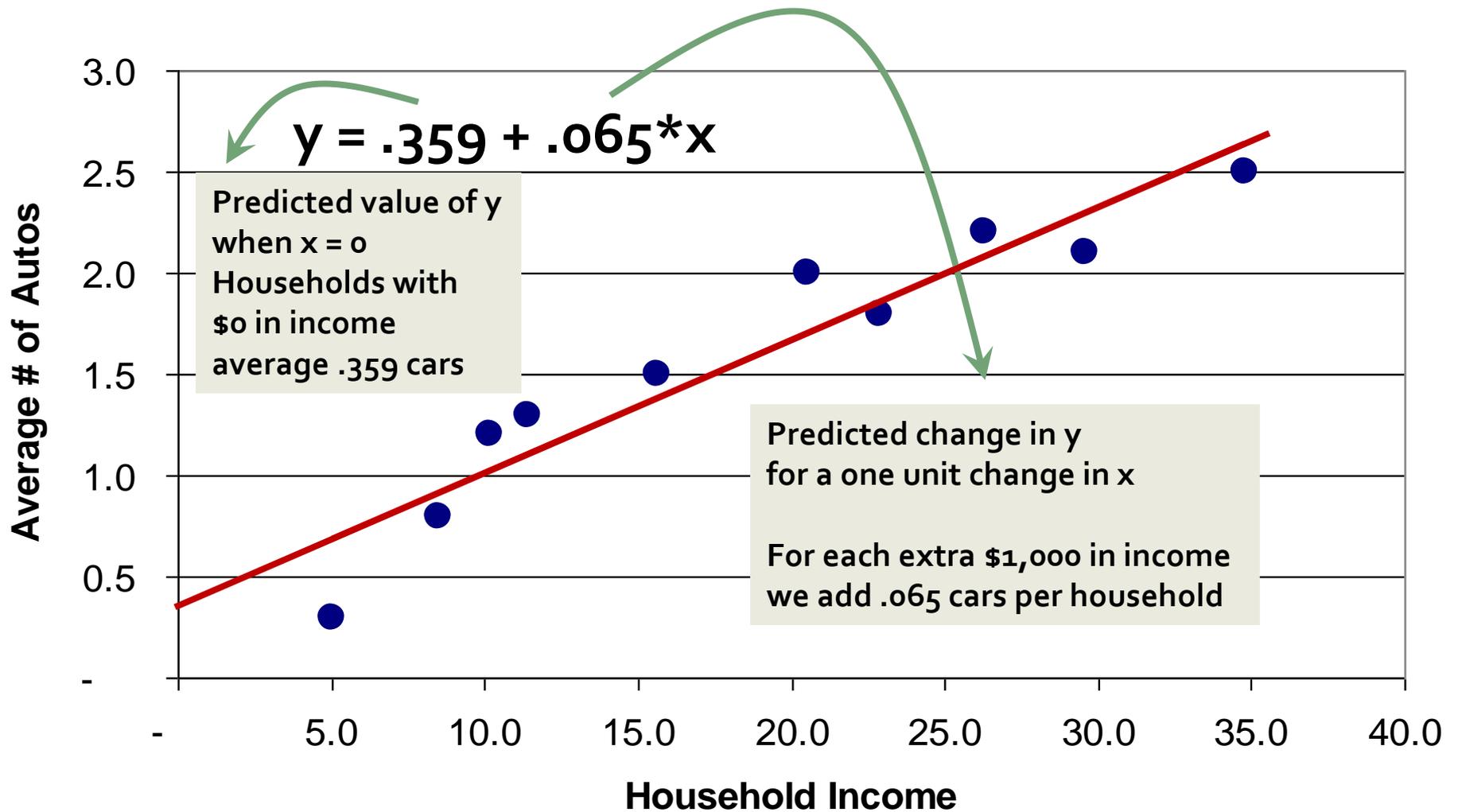
This is our data for 10 census tracts.

Income is listed in thousands of dollars.

| Tract	x Avg HH Income	y Avg # of Autos per HH
1	5.0	0.3
2	8.5	0.8
3	10.2	1.2
4	11.4	1.3
5	15.6	1.5
6	20.5	2.0
7	22.9	1.8
8	26.3	2.2
9	29.6	2.1
10	34.8	2.5

Household Income vs. Auto Ownership

Multiple regression uses more than one x variable

- y (house sale price) =
  b_1 * Square footage +
  b_2 * Number of bedrooms +
  b_3 * Number of bathrooms +
  b_4 * Accessibility to employment +
  b_5 * Location in historic district
- When an x coefficient (b) is positive, higher values of x lead to higher values of y; when negative, lower

$488K
$451K
$719K
$608K
$641K
$441K
$551K
$452K
$455K
Cosmos Ct NE

C. Population analysis and projection
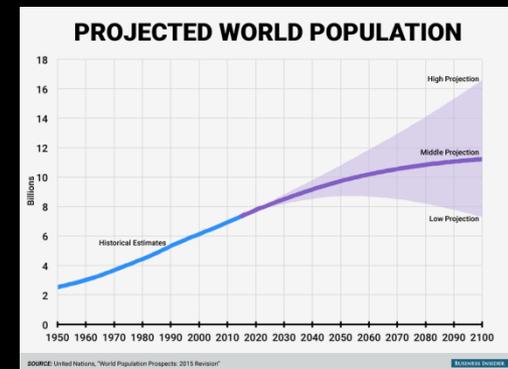
- An estimate is an indirect measure of a present or past condition that can not be directly measured.

- A projection (or prediction) is a conditional statement about the future.

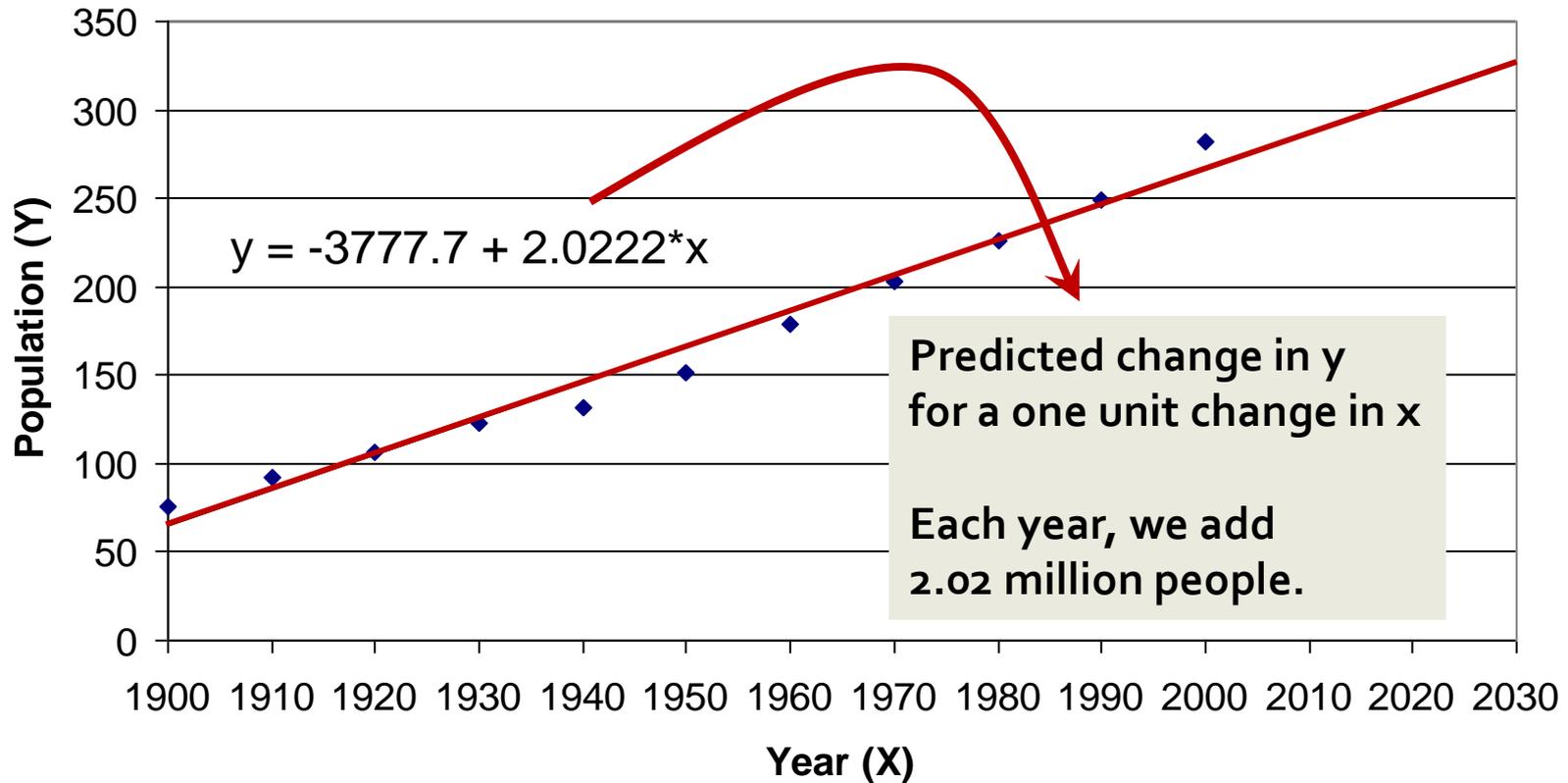- A forecast is a judgmental statement of what the analyst believes to be the most likely future.
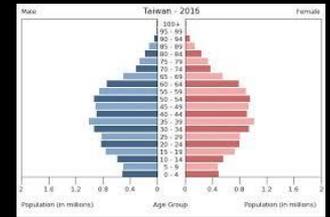
Non-component projection methods
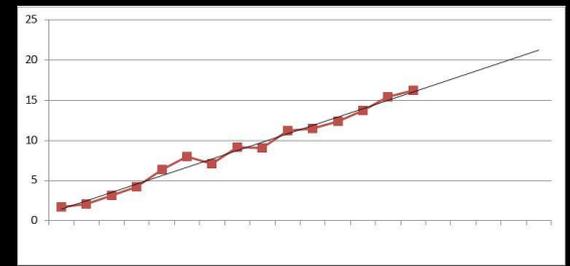
- Extrapolation with graphs
- Time series regression, with time (year) as the independent (x) variable
- Ratio methods comparing to similar areas
- Share methods using proportions of regional or state projections

# Time series regression to project US population

US Population

y = -3777.7 + 2.0222*x

Predicted change in y
for a one unit change in x

Each year, we add
2.02 million people.

Cohort component models

- **We divide the population into cohorts by age (often five years), sex, and race/ethnicity.**

- **Population change is subdivided into three components: births, deaths, migrants**

- **Calculate birth rates, survival rates, and migration rates for a recent period**

- **Extend those rates into the future, possibly adjusting them upward or downward**

- **Birth and death data is readily available; migration data is difficult, primary source is American Community Survey**

Migration notes
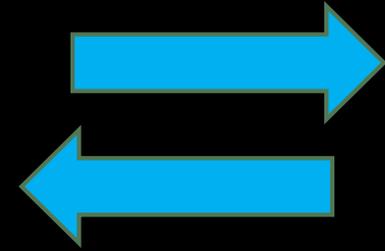
- **Migration can be projected as a function of changes in employment, or**

- **If net migration = in-migration minus out-migration**

- **Then net migration can estimated by the residual method:**

  2000 population: 100,000

  2010 population: 120,000

  2000 to 2010 births: 5,000

  2000 to 2010 deaths   3,000

  How many 2000 to 2010 net migrants?   +18,000

D: Economic analysis
## (1) Economic base theory

- Assumes two kinds of industry
  - Basic or export: sells to customers outside the area of analysis
  - Service or non-basic: sells to customers within the area
- Economic base multiplier
  - Total employment / basic employment
  - A multiplier of 4.0 says that 4 total jobs are created for every additional basic job

(2) Location quotients

- LQs compare the local concentration of employment in an industry to the national employment in that industry
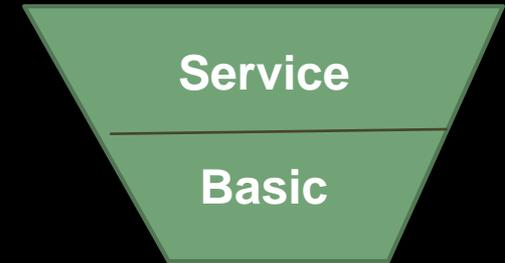
- $LQ_i =$

$$\frac{\left(\dfrac{\text{Local employment in industry i}}{\text{Total local employment in all industries}}\right)}{\left(\dfrac{\text{National employment in industry i}}{\text{Total national employment in all industries}}\right)}$$
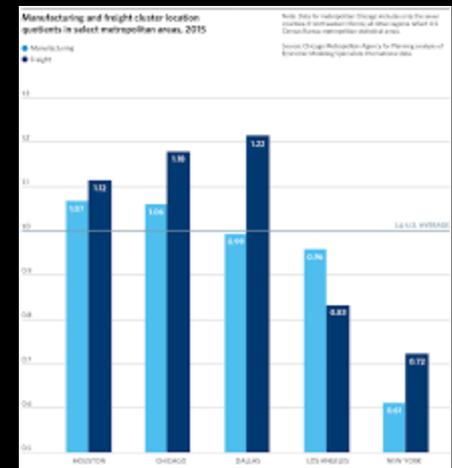
More on location quotients

- Alternate formula: $LQ_i =$

  Local percent of employment in industry i

  National percent of employment in industry i

- Interpreting LQs
  - If LQ_i is greater than 1.0 we can assume an export or basic industry
  - If LQ_i is less than 1.0 we can assume we import some goods or services
  - If $LQ_i = 1.0$, the region produces just enough to serve the region, and no more

Calculating basic employment

Service
_____
Basic

1. **We can use LQs to estimate total basic employment**

   □ **Use only industries whose LQ is greater than 1.0**

   □ **For industry i basic employment is (1-1/LQ$_i$) * Local industry employment**

   □ **Add basic employment for all industries**

2. **Or you can assign entire industries to either basic or service:**

   □ **Which is manufacturing?**

   □ **Which is local government?**

(3) Shift share analysis

Shift share analysis interprets changes in an industry's local employment (over a period of x years) in terms of three components:

- National share: how much would local industry employment have changed if it mirrored the change in total national employment

- Industry mix: how much additional would it have changed if it mirrored the difference between national industry employment and national total employment

- Local shift: how many additional jobs did the local industry gain or lose, presumably due to local competitive advantage or disadvantage.

(4) Input output analysis

- Each sale of a commodity (transaction) requires multiple inputs, including raw inputs, parts, and labor
- Sales of any one commodity ripple back through the economy, creating sales of many different commodities
- IO is useful for understanding the linkages between different industries, especially industries upstream and downstream from a target industry.

Industry-by-Industry Total Requirements

(Total requirements, direct and indirect, per dollar of delivery to final demand, at producers' prices)

Supplying Industry	Purchasing Industry	Agric.	Mining	Utilities	Const.	Manuf.	Whole.	Retail
	Industry code	1	2	3	4	5	6	7
01	Agric.	1.38	0.01	0.01	0.03	0.08	0.00	0.01
02	Mining	0.03	1.06	0.21	0.03	0.07	0.01	0.01
03	Utilities	0.04	0.03	1.01	0.01	0.03	0.01	0.02
04	Const.	0.01	0.04	0.03	1.01	0.01	0.00	0.01
05	Manuf.	0.36	0.21	0.12	0.43	1.62	0.09	0.08
06	Whole.	0.08	0.03	0.02	0.06	0.09	1.04	0.02
07	Retail	0.00	0.01	0.00	0.05	0.01	0.00	1.00
08	Transp.	0.06	0.04	0.09	0.04	0.06	0.04	0.04
09	Info.	0.02	0.03	0.02	0.04	0.05	0.03	0.03
10	FIRE	0.23	0.21	0.10	0.10	0.11	0.09	0.15
11	Prof/Bus Serv.	0.11	0.19	0.12	0.17	0.22	0.15	0.13
12	Ed/Health /Serv.	0.01	0.00	0.00	0.00	0.00	0.00	0.00
13	Accom/Food	0.01	0.01	0.02	0.01	0.02	0.01	0.01
14	Other Serv.	0.01	0.01	0.01	0.02	0.01	0.01	0.01
15	Gvmt.	0.02	0.01	0.01	0.01	0.02	0.02	0.02
T010	Total industry output r	2.36	1.90	1.78	2.02	2.41	1.51	1.54

Table coefficients show how many dollars (.43) of input from the supplying industry (Manuf.) are required to produce $1.00 of output from the purchasing industry (Const.)
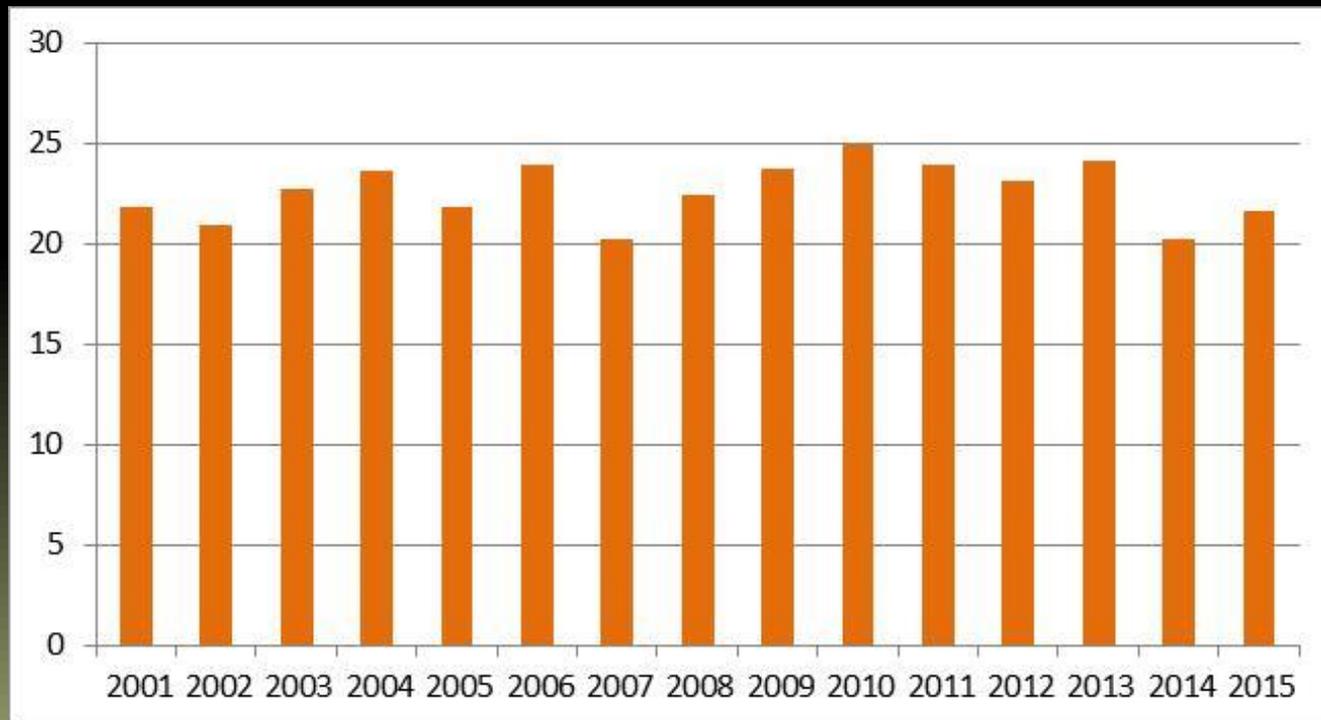
E. Maps, charts, and visualization
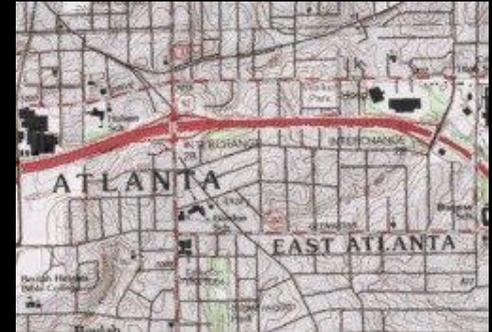
- Basic types of maps used by planners
  - USGS topographic (quad sheets)
  - Cadastral or parcel
  - Census geography (tracts, block groups)
  - Utilities (water, sewer, electricity, communication)
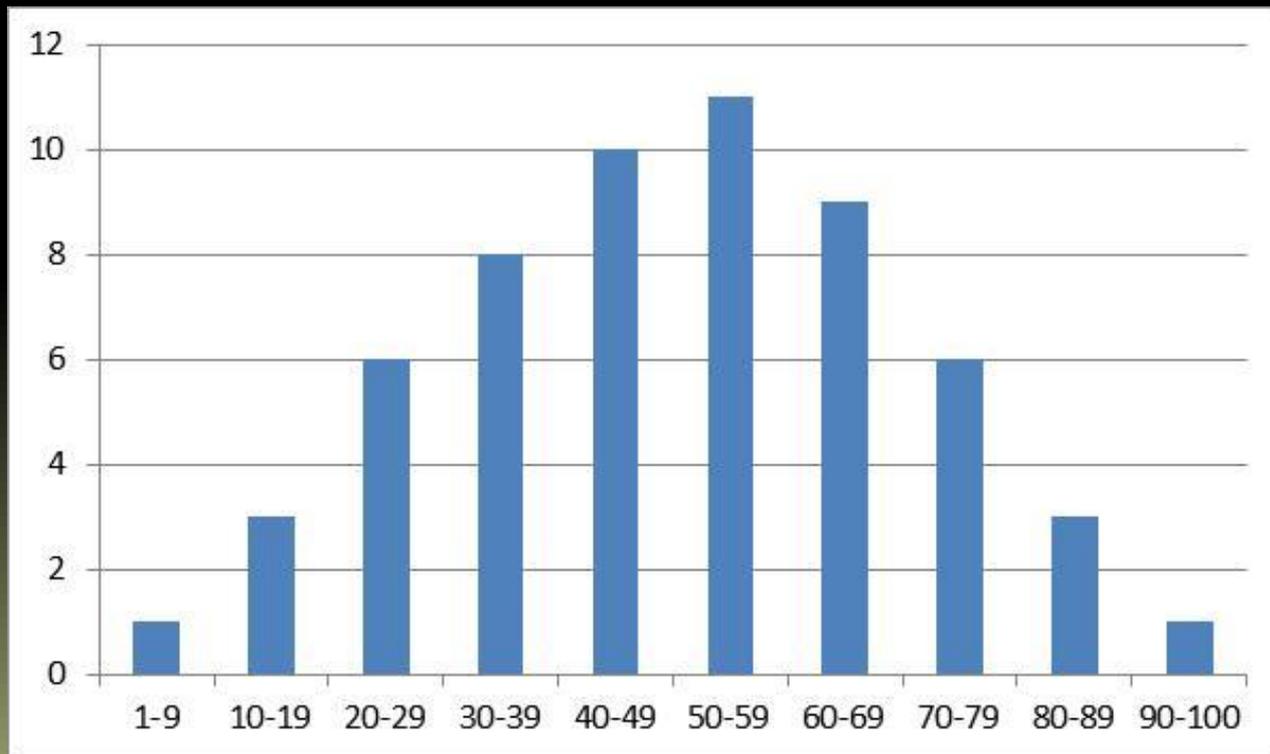 - Zoning
  - Subdivision plat

Basic types of charts

- Bar chart
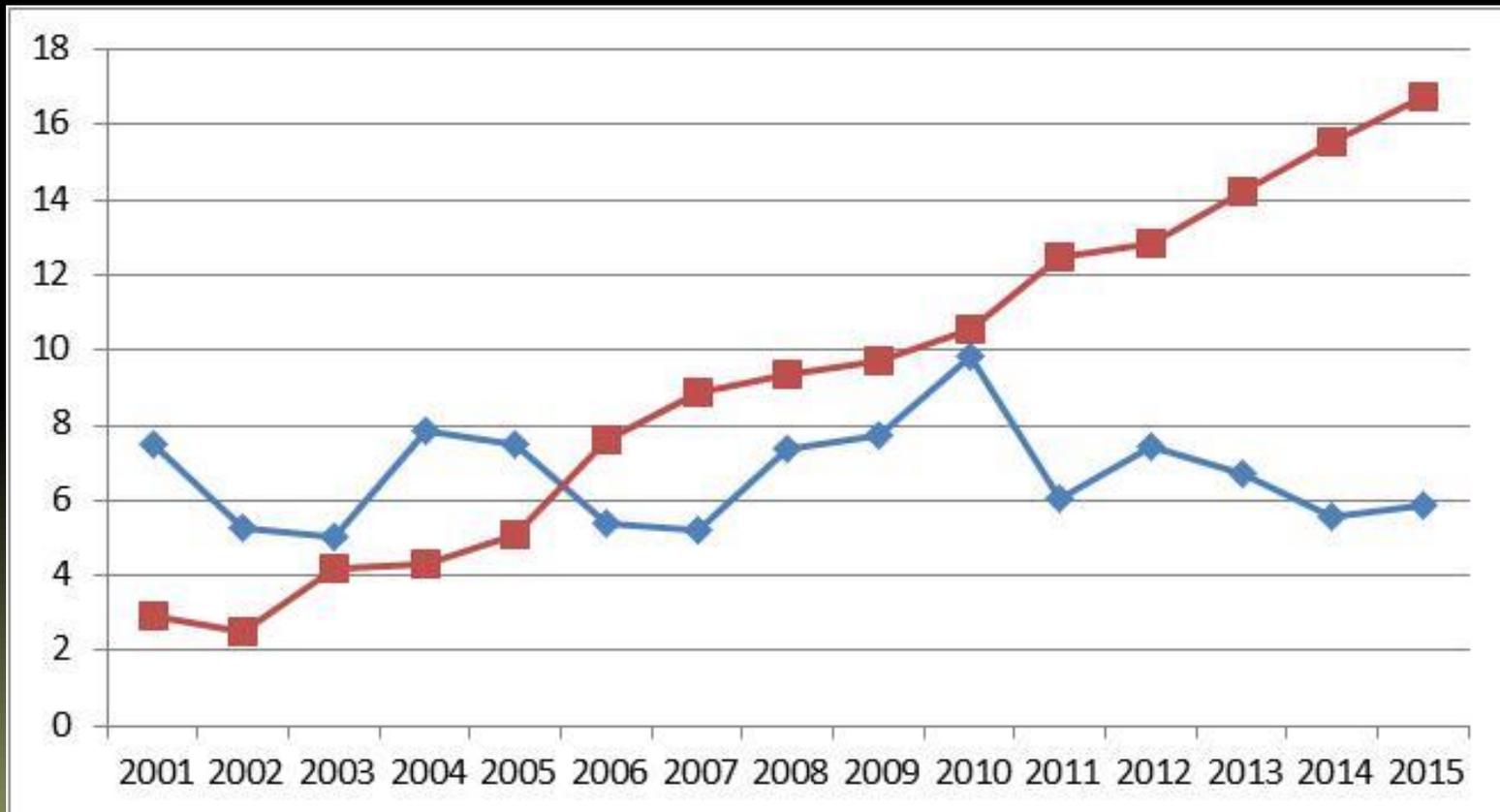- Height of bar shows value for that category (year)

Basic types of charts

- Histogram (frequency distribution)
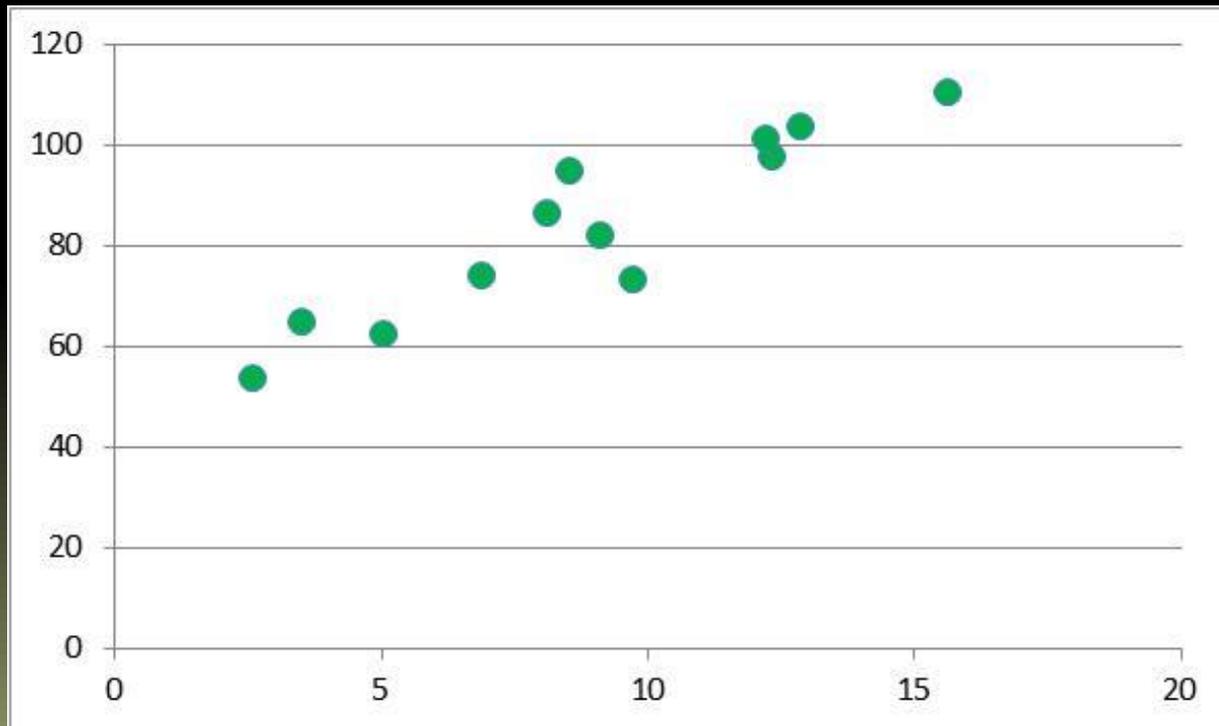- Height of bar shows count of cases in within the category range

Basic types of charts
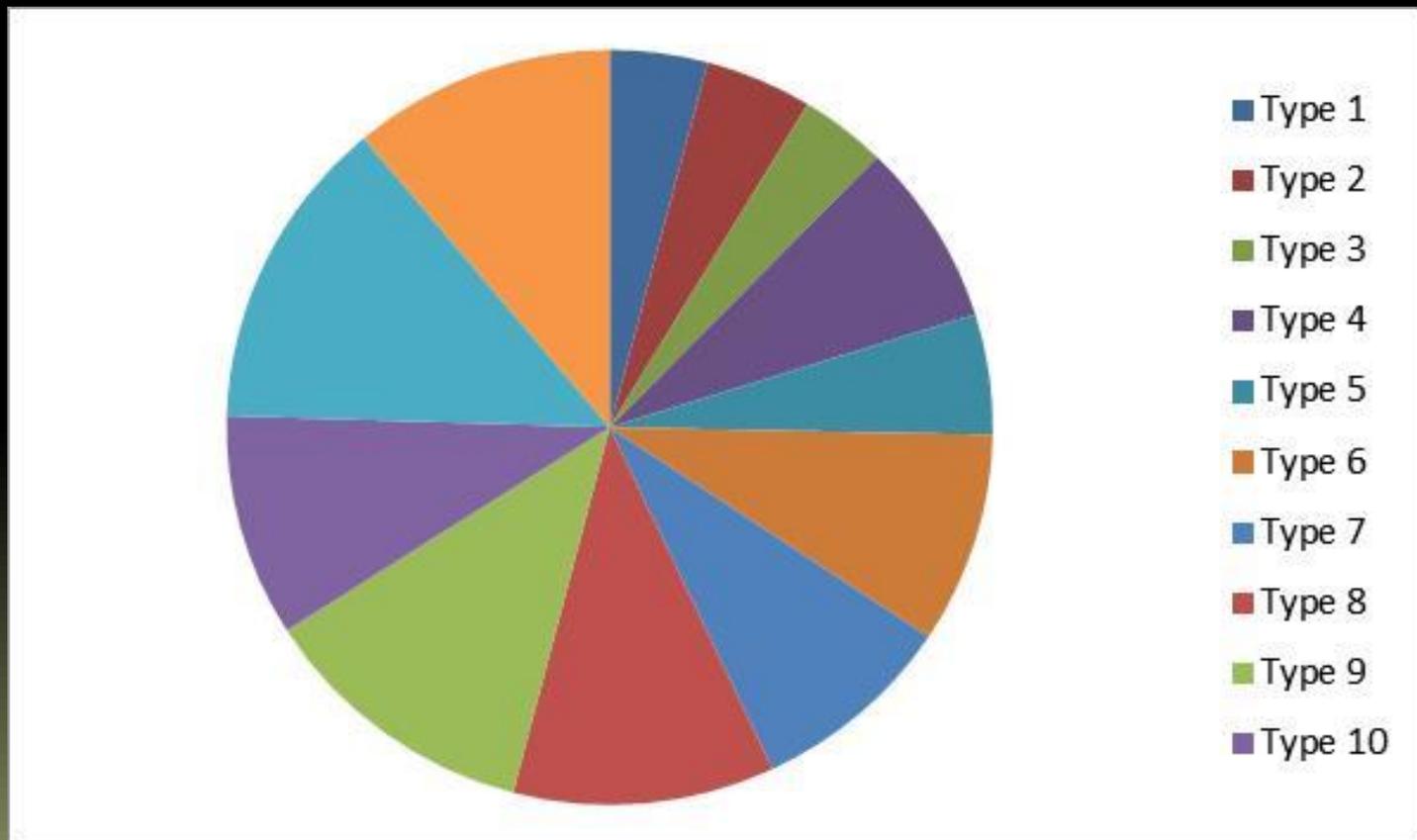
- Line chart (with multiple series)

Basic types of charts

- Scattergram (or xy graph)
- Each case has an x value (horizontal axis and a y value (vertical axis)

Basic types of charts

- Pie chart: proportions of a whole

Six principles for visualization and map design

- Visual contrast: use colors for map features that are easily distinguishable https://sashat.me/2017/01/11/list-of-20-simple-distinct-colors

- Legibility: Symbols must be distinct and text large enough for readers or everyone in the audience

Six principles for visualization and map design

- Balance: arrange map elements so neither left nor right dominates the page
- White space: arrange elements to eliminate large areas of empty space
- Simplicity: choose map elements to reinforce the map's story, argument, or theme
- Highlighting: use drop shadows, feature outlines, and subtle backgrounds

F. GIS and spatial analysis

- Review a list of GIS terms, for example
  http://blog.getchee.com/25-important-gis-terms

- Understand basic mapping concepts, including
  - Scale
  - Projections
  - Coordinate systems, in particular
    - Geographic coordinates (longitude and latitude)
    - Universal transverse Mercator (UTM) and
    - State plane coordinate systems

Land suitability analysis

- LSA was popularized by Ian McHarg in *Design with Nature.*

- It is used in land use planning to determine areas more or less suitable for different land uses.

- It was originally done with physical Mylar maps, which were overlaid on a light table.

- It is now conducted GIS systems capable of overlaying multiple polygon layers.
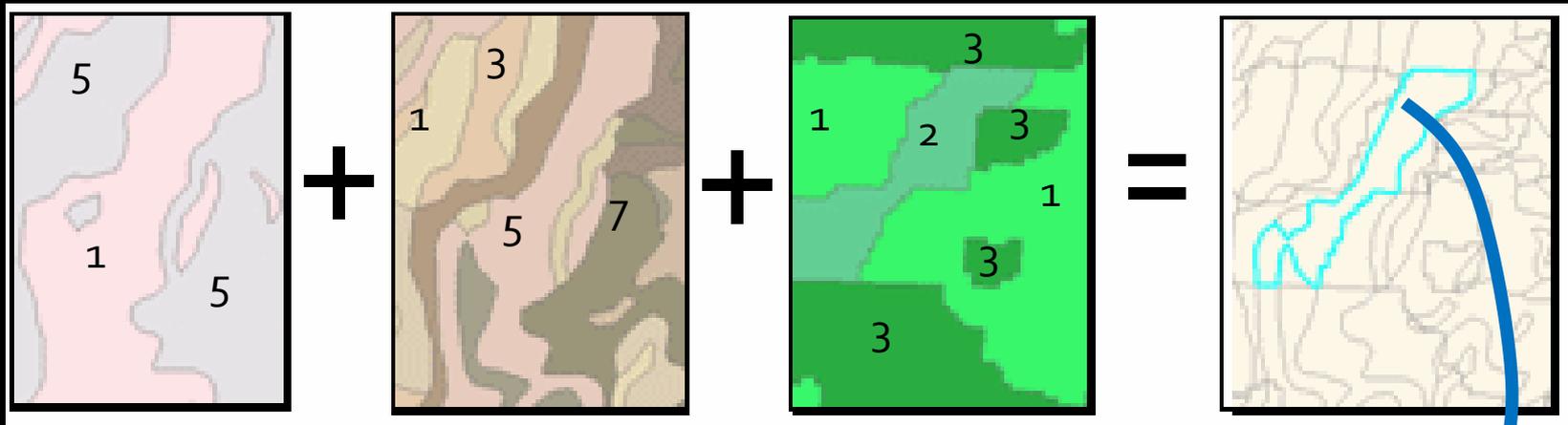
Soils — Layer Weight: 1

Slope — Layer Weight: 3

Vegetation — Layer Weight: 2

1*1 +
5*3 +
2*2 = 11

Assign a suitability-related score to each category in each layer.
Determine a weight (importance) for each layer.
Multiply each polygon's score times its layer's weight.
Overlay the three input layers with GIS.
Add the weighted scores for each small polygon.
The resulting small polygon outlined in blue then
   has an overall suitability score of 11.