Applied GIS (GEOG 489)

Week 3: Suitability Analysis
Slides of this class: https://git.io/vDvsA

Instructor: Yi Qiang

Email: yi.qiang@hawaii.edu

Suitability Modeling

- “Classic” example of applied GIS
- Very well established technique
- Applications in many different fields
- Other terms:
  - Multi-Criteria Evaluations (MCE)
  - Weighted Linear Combinations (WLC)
  - Site (location) selection

Example 1: finding suitable locations for development/infrastructure

Example 2: finding suitable habitat for animal or vegetation

Example 3: finding suitable site for business

Basic Steps

- Define criteria (factors that affect the suitability)
- Translate criteria into maps
- Standardize the criteria
- Determine relative importance (weight) of criteria
- Combine maps into a final map (using a logical order of map algebra)

Step 1: Define Criteria

- What makes a location suitable for something?
- List factors of suitability
- Specify and quantify your criteria

Question:

what makes a location suitable for a Starbucks?

What makes a location suitable for a Starbucks?

- Population density
- Accessibility (distance to road)
- Income in the neighborhood
- Land price
- Close to working people /students
- ……

Types of Criteria

- Binary criteria
- Discrete criteria
- Continuous criteria

Binary Criteria

- **Binary decision of Yes/no**
- **Represent solid requirements or constraints, e.g.**
  - must be in urban area
  - must not be on road
  - must be within 3km to river

Discrete/categorical Criteria

- Usually used for cagegorical data
- Similar to Likert scale
- Assign suitability scores for different categories

Land cover type	Suitability	Score
Water body	not suitable	0
Forest	most suitable	5
Grassland	very suitable	4
Shrubland	suitable	3
Bareland	maybe suitable	2

Continuous criteria

- Gradually changing suitability or preference
- The more ..., the better.
- Examples:
  - The further away from roads, the better
  - The higher prey density, the better
- Can be linear or non-linear

Step 2: Mapping Criteria

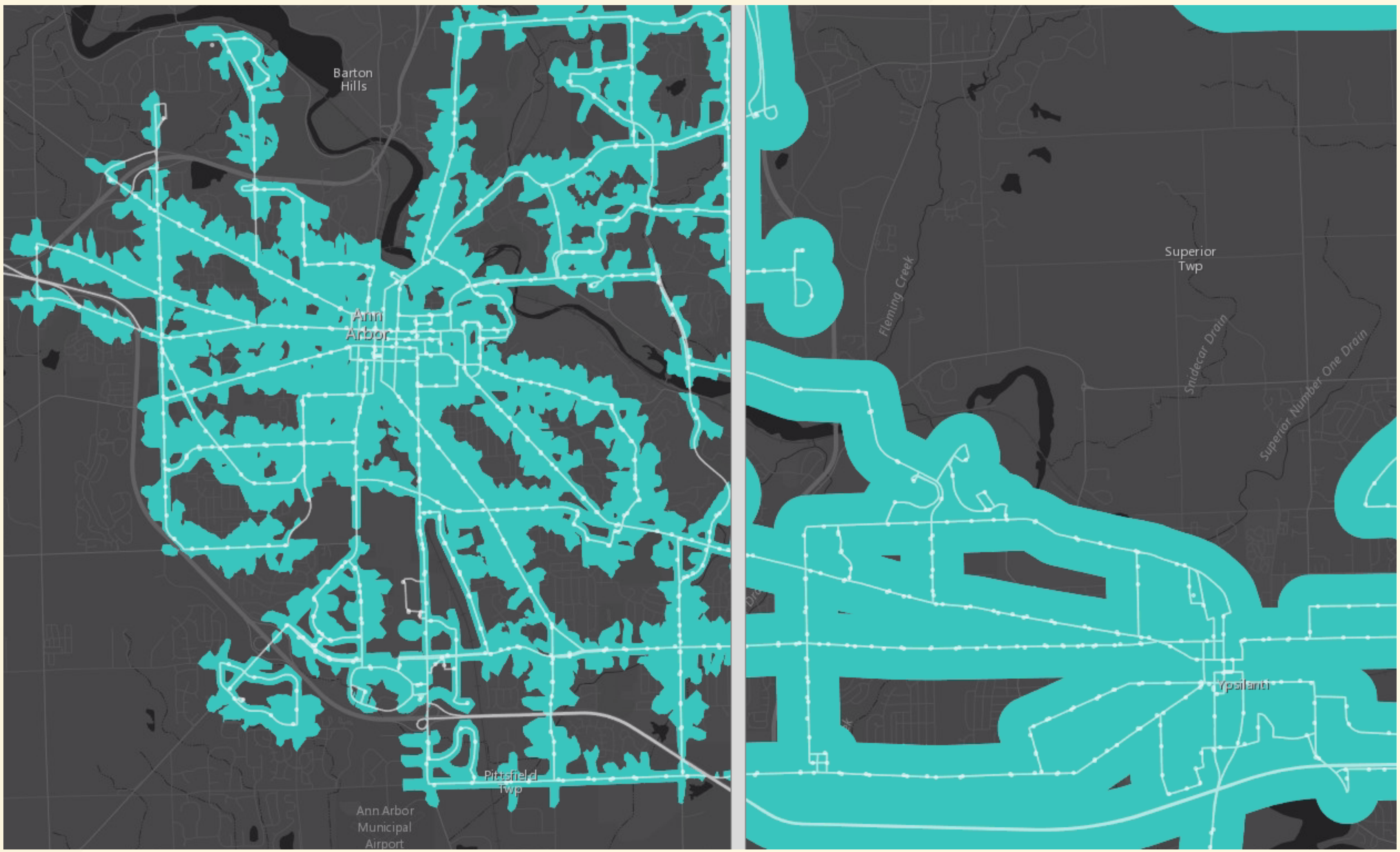
- Find GIS data related to criteria
- Converting GIS data into criteria maps using appropriate spatial analysis (geoprocessing tool)

Criterion A: must be within 100m of roads

What GIS data do you need?

Locations of roads (polylines)

- Translate roads into 'Within 100m of roads'
- Spatial analysis (Buffer)

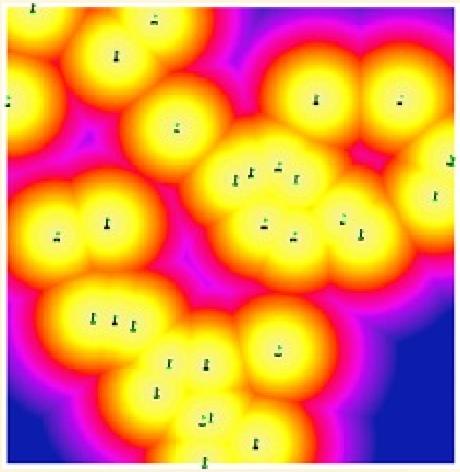


Criterion B: the closer to bus stops, the more suitable

What GIS data do you need?

Locations of bus stops (points)

- Translate bus stops into 'the closer to bus stops, the better'
- Spatial analysis: Euclidean Distance
- Spatial analysis: Reclassify/Raster Calculator



Question

What GIS datatype (raster or vector) do you use to map the three types of criteria?

- Boolean Criteria
- Categorical Criteria
- Boolean Criteria

Question

What GIS datatype (raster or vector) do you use to represent the three types of criteria?

- Boolean Criteria
  - Vector and Raster
- Discrete Criteria
  - Vector and Raster
- Continuous Criteria
  - Raster

Step 3: Standardize Criteria

- Rescale criteria to make them comparable
- Only for continuous and categorical criteria
- Easier to interpret
- You can attach importance using weight (Next step)

Step 3: Standardize Criteria

- Different types of standardized scores
  - Intervals
  - Continuous
- Different functions for standardization
  - Linear
  - Non-linear

Intervals Scores

- Divede criterion value into intervals
- Reclassify the intervals into discrete scores

0 - 500 feet -> 9
500 – 1000 -> 8
1000 – 1500 -> 7
1500 – 2000 -> 6
2000 – 2500 -> 5
2500 – 3000 -> 4
3000 – 3500 -> 3
3500 – 4000 -> 2
4000 - 4500 -> 1

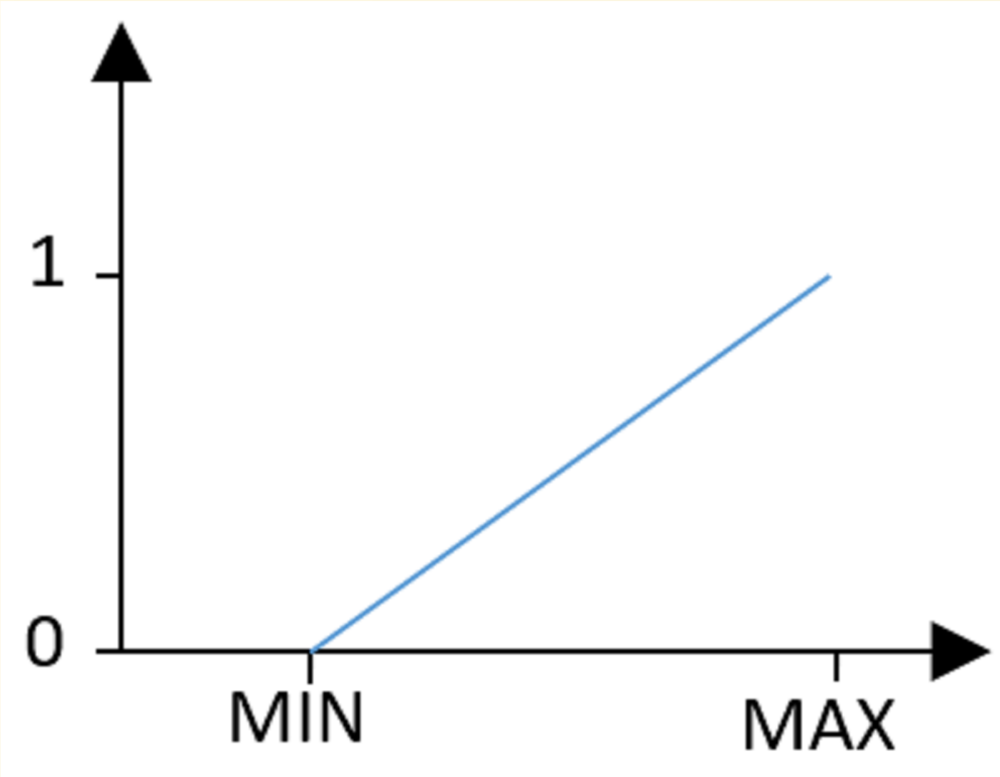
Continuous Scores

- Rescale the range of criterion value
- e.g. linear rescale into a range from 1 to 10

(X - Max)/(Max-Min) * 10

Linear standardization

(X - Max)/(Max-Min)



Non-linear standardization

- Suitability is not linearly related to the criteria
- For example, 1000m is the most suitable elevation for a vegetation species, suitability decrease when elevation either increases or decreases.

Determine relative importance (weight)

- Quantify the importance of factors as coefficients
- Assuming all factors are already standardized into a comparable range
- Usually based on empirical experience or personal opinion.
- Sometimes very subjective

Weights are relative

- Weights are usually represented as a ratio
- Sum of all weights is 1
- Shows how much the factor weighs among all factors
- Final score is in the same range as criteria

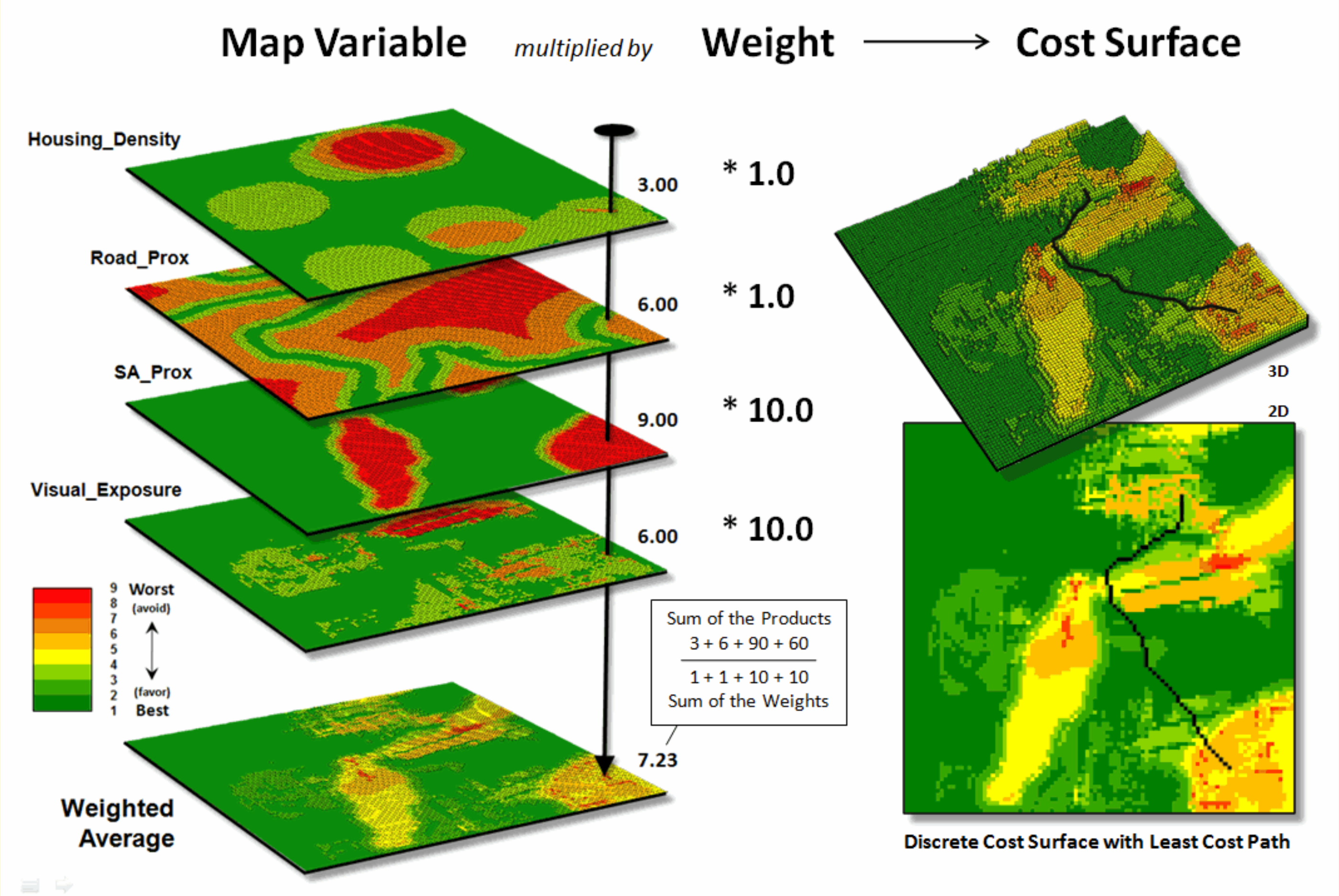
$$w(j) = \frac{X_j}{\sum_i^n X_i}$$

X_j : the importance of jth factor
n: total number of factors
$w(j)$: the weight of the jth factor

Calculating Weights

Factors	Importance	Weight
Distance to road	5	5/16 (0.3150)
Elevation	2	2/16 (0.0625)
Land cover type	3	3/16 (0.1875)
Prey distribution	6	6/16 (0.2500)
Total	16	16/16 (1)

Step 5: Combining Criteria Maps into Final Suitability Map



Step 5: Combining Criteria Maps to Final Suitability Map

- Combine criteria maps using a equation, e.g.

$$S = (w_1 C_1 + w_2 C_3 + \cdots + w_m C_m) \times ({C'}_1 \times {C'}_2 \times \cdots \times {C'}_n)$$

S : final suitability score

C_m: mth continuous/categorical criterion

C_n: nth boolean (restriction) criterion

w_m: weight of mth criterion

$+$: addition operator

$\times$: clip for vector / multiply for raster

Lab Exercise 2:

Please download the assignment from **https://git.io/vDeAZ**

You will do the exercises in this lab and next week's lab (no more assignment next week).

Submission due Feb. 17