Building Models

Lesson 8 overview

- Modeling concepts and tools
  - Why build models?
  - Binary suitability models
  - Weighted suitability models
    - The methodology
- Reclassify and Weighted Overlay tools
- Exercise 8

Modeling spatial problems

- **Models help us understand and solve complex problems**
  - **Simplify reality**
  - **Combine geographic layers to answer questions**
    - **Like, “Where should we build our next store?”**

Types of models

- Representation models
  - Describe the landscape (your GIS data layers)
- Suitability models
  - Use GIS layers to find best place for something (businesses, vineyards, evacuation centers)
  - Relatively easy; standard methodology
- Process models
  - Show the landscape as conditions change (fire spreads, rivers flood, oil slicks move)
  - Often difficult; no standard methodology
- Automated work flows
  - Data processing

Binary suitability models

- **Use for simple problems**
  - Like a query
- **Classify layers into good (1) and bad (0)**
  - Combine with AND, addition, or multiplication:

```
[Ski] = [Snow] & [Slope] & [Sun]
```

- **Advantages:**
  - Easy
- **Disadvantages:**
  - No “next-best” sites
  - All layers have same importance
  - All good values have same importance

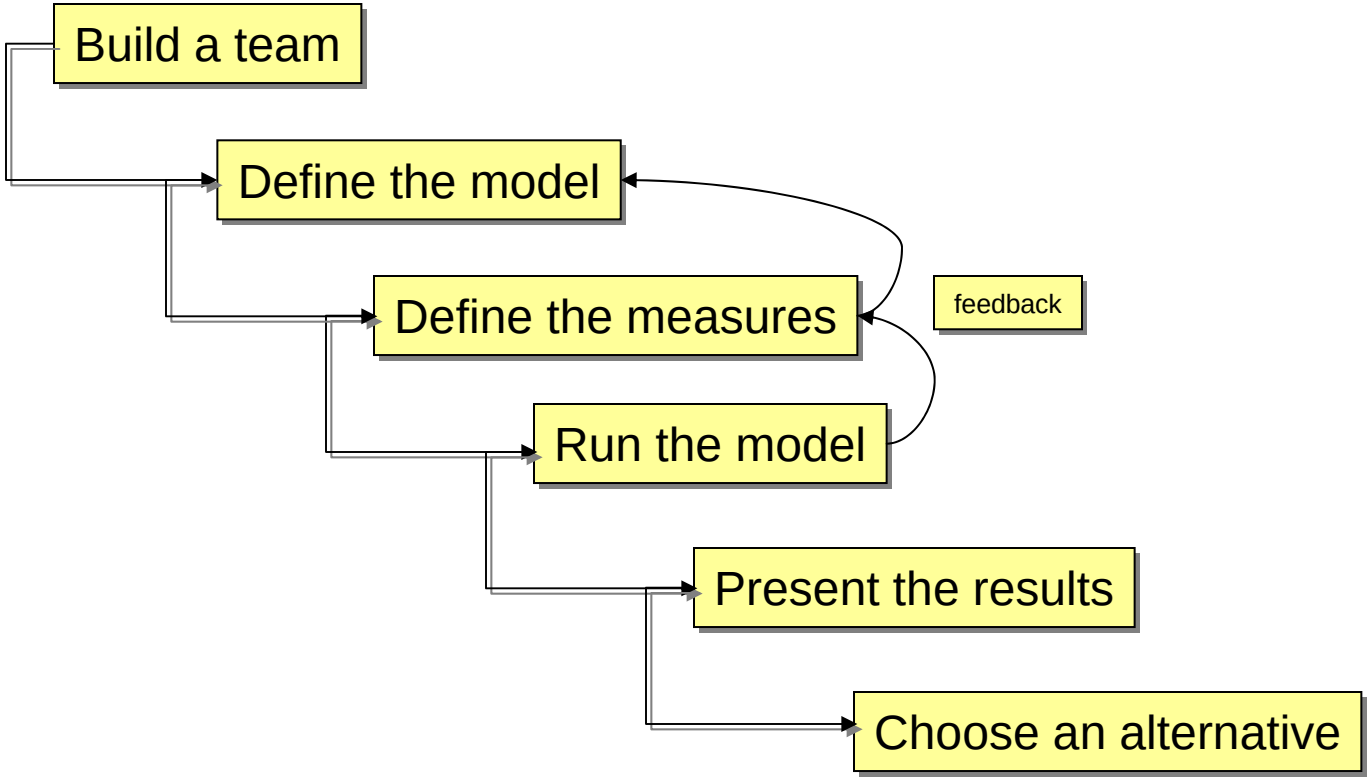
Weighted suitability models

- Use for complex problems
- Classify layers into suitability 1-9 (9 = best)
  - Weight and add together:

    Ski = ([Snow] * 0.5)
    + ([Slope] * 0.3)
    + ([Sun] * 0.2)
- Advantages:
  - All values have relative importance
  - All layers have relative importance
  - Returns suitability on a scale 1—9
- Disadvantages:
  - Preference assessment is harder

The weighted suitability methodology

- **There is a fairly standard methodology to follow:**

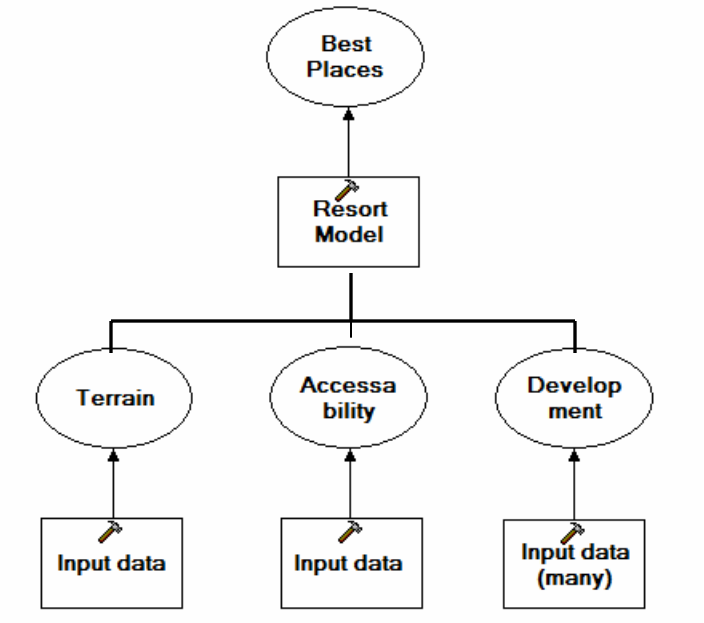


Define the model

- This is a team activity
  - Stakeholders, decision makers
- Define the problem
  - “Locate a ski resort”
- Identify issues
  - “Accessible to skiers”
- Determine how to measure
  - “Drive time to the city”
- Obtain GIS data
  - Like TIGER roads

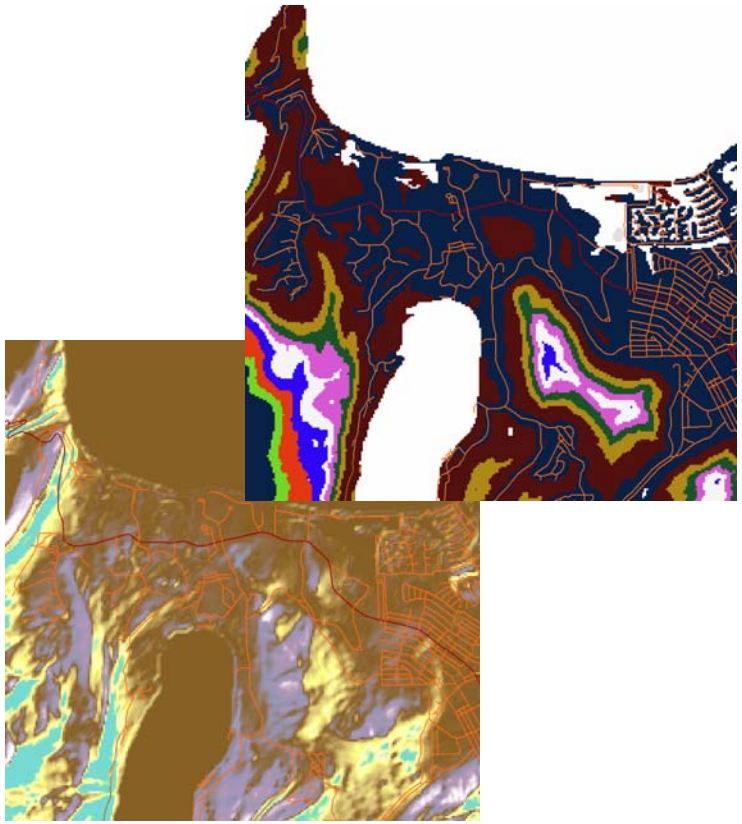
Break big models into sub-models

- Helps clarify relationships, simplifies problems



Decide how to measure the issues

- **Base data is not useful for measuring issues**
  - Need to measure access, not road location
- **May be very easy:**
  - ArcGIS Spatial Analyst tools
  - Like distance to roads
- **May be harder:**
  - Require another model
  - Like travel time to roads



Data types and math in modeling

- Valid math depends on the data type

Type	Examples	Legal math
Nominal	ID, Landuse Code, Phone Number	=
Ordinal	Importance, order of ocmpletion	<, =, >
Interval	Time of day, Temperature, pH level	<, =, >, +, -
Ratio	Age, Distance, Weight, Counts	<, =, >, +, -, *, /

Runner	Tom	Sam	Joe	Nominal
Finished	3rd	2nd	1st	Ordinal
Time	4:05:09	4:05:07	4:05:03	Interval
Elapsed Time	81 seconds	79 seconds	75 seconds	Ratio

Define a scale of suitability

- **You must define a scale for suitability**
  - Many possible; typically 1 to 9 (worst to best)
  - Use the same scale for all layers in the model
- **For each layer: Map values onto the scale**

	Travel Time
Best	9 – 0 minutes off ramp
	8
	7
	6
	5 – 15 minutes off ramp
	4
	3
	2
Worst	1 – 45 minutes off ramp

	Soil grading
Best	9 – Recent alluvium, easy
	8
	7
	6
	5 – landslide; moderate
	4
	3
	2
Worst	1 – exposed bedrock

Determine suitability and weights

- **Preference assessment process**
  - **Suitability assignment:**
    Sandy soil is better than clay soil
  - **Weight assignment:**
    Soil is more important than slope
- **Normally done by a team**
  - **Use various techniques: Delphi, others**
- **This is the hard part of model development**

Convert measures into suitability

- Cannot combine different measures:

  `[RoadDistance] + [PowerDistance] = Nonsense`

- Must transform into same units (suitability)

  Reclassify layer values into relative suitability

  [RoadDistance] into Accessibility, 1 to 9

  [PowerDistance] into Accessibility, 1 to 9

  Scale each layer into the same units

  [RoadAccess] * 0.7 = RoadSuit

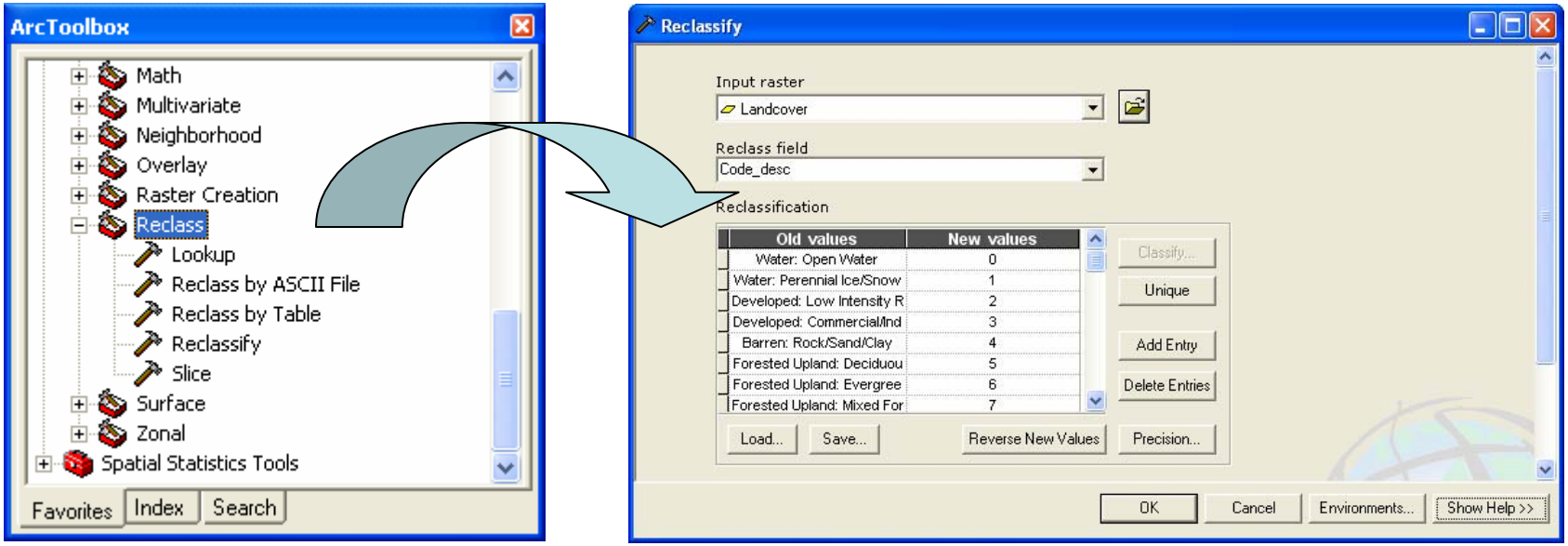
  [PowerAccess] * 0.3 = Powersuit

- Now you may add layers together

  [RoadSuit] + [PowerSuit] = SkiSuit

The Reclassify tool

- May use to convert measures into suitability



Reclassify with equations

- An option with ratio data
- Need a mathematical relationship between data and suitability
- Example: Suitability decreases with distance to roads
- Implement with Map Algebra or a mode):

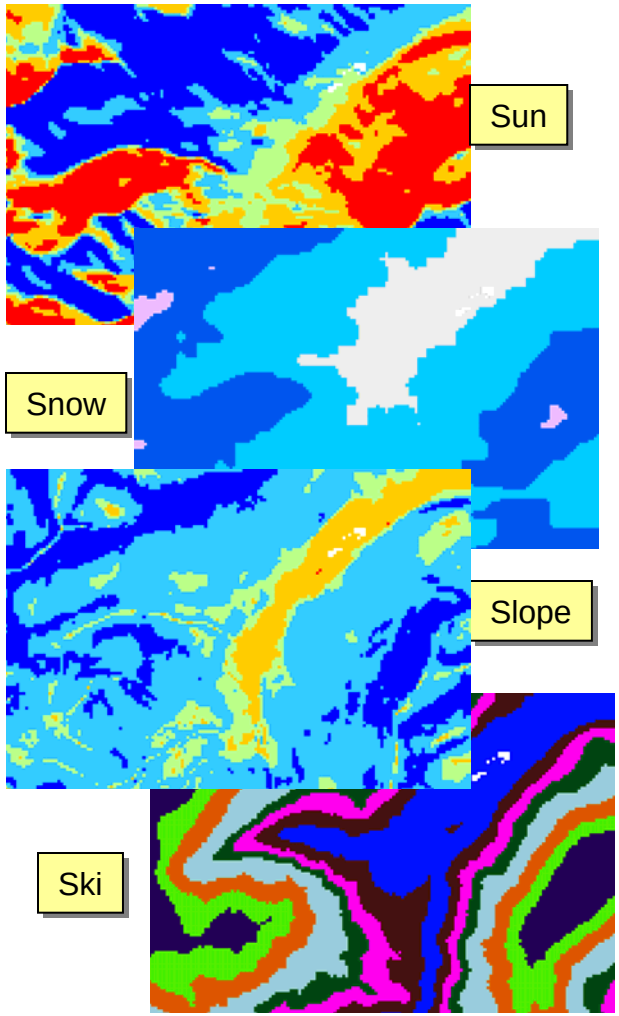
```
RoadSuit = S + ( -0.0018 fRoadDist]
```

Weight and combine the layers

- For each submodel
  - Multiply suitability layers by weights
    - Weights must add up to one
  - Add the weighted layers together
- Repeat to combine sub-models

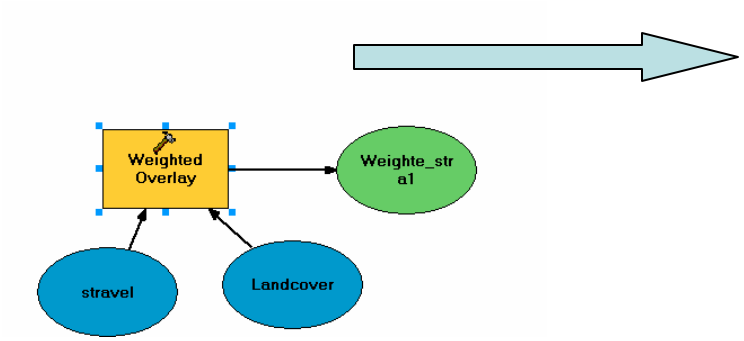
- Use the Weighted Overlay tool
- Or, use a Map Algebra expression

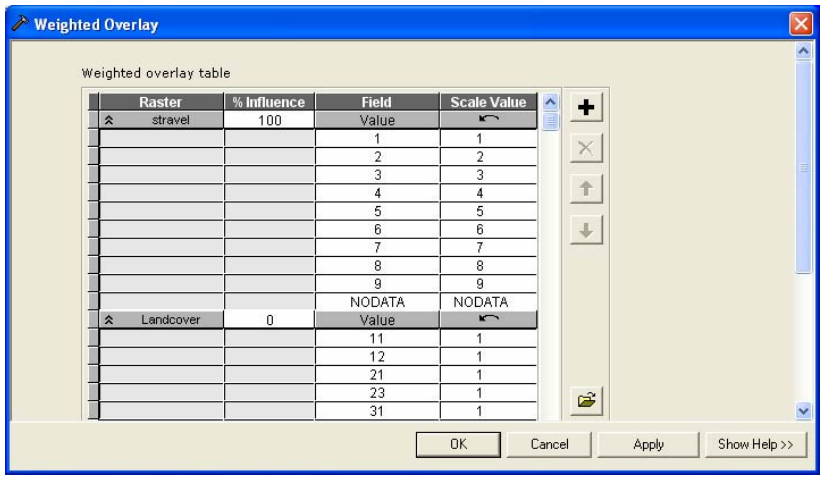
```
Ski = ([snow] * 0.5) + ([slope] * 0.3) + ([sun]* 0.2)
```



The Weighted Overlay tool

- Weights and combines multiple inputs





Find the best locations

- **Model returns a suitability "surface"**
  - Often does not return a perfect 9
- **Create candidate sites**
  - Select cells with highest scores
  - Define regions with unique IDs
  - Eliminate regions that are too small
- **Choose between the candidates**
  - Another modeling problem?