Measurement Errors
Statistical Analysis
Topographic Maps

ASM 215

January 27, 2010
No measurement is exact

- All contain some degree of error
- Can never know the TRUE value of a measurement
Types of Errors

- **Blunders**
  - Mistake caused by carelessness or poor judgment
  - Ex: recording 10.10-ft instead of 10.01-ft

- **Systematic Errors**
  - Mean of many separate measurements differs significantly from the actual value of the measured attribute
  - Ex: imperfect calibration of instrument

- **Random Errors**
  - Measured values being inconsistent when repeated measures of a constant attribute or quantity are taken
  - Ex: Malfunctioning equipment, or environmental interference
Sources of Random Error

- **Natural errors**
  - Wind
  - Temperature
  - Humidity
  - Refraction
  - Magnetic fields
  - Gravity

- **Instrument errors**
  - Imperfections in construction or adjustment of the measuring equipment
  - Can be reduced or eliminated by adopting proper surveying procedures

- **Personal errors**
  - Human limitations, such as sight
Accuracy & Precision in Measurements

- **Precision**
  - The consistency of a group of measurements
  - "Degree of refinement"

- **Accuracy**
  - The nearness of a measurement to its true value

- **Discrepancy**
  - Difference between two measured values of the same quantity

Source: ESRI.com
Keys to High Accuracy & Precision

- Eliminate Blunders
  - Take care in recording data
- Eliminate/Correct Systematic Errors
  - Frequent calibration/adjustment
- Minimize Natural Errors
  - Follow good field procedures
- **Probability**

  - Expression of the belief that something has happened or will happen

  Mathematically: number of times a result should occur divided by the total number of possibilities

  Ex: Probability of rolling a 2 with a die: 1/6
- **Most Probable Value (average)**
  \[ \bar{M} = \frac{\sum M}{n} \]

- **Residual (error)**
  \[ V = M - \bar{M} \]

- **Standard error or standard deviation**
  \[ \sigma = \pm \sqrt{\frac{\sum v^2}{n-1}} \]
<table>
<thead>
<tr>
<th>Length</th>
<th>Residual (v)</th>
<th>$v^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>538.57</td>
<td>+0.12</td>
<td>0.0144</td>
</tr>
<tr>
<td>538.39</td>
<td>-0.06</td>
<td>0.0036</td>
</tr>
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<td>538.37</td>
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<td>538.47</td>
<td>+0.02</td>
<td>0.0004</td>
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<tr>
<td>538.55</td>
<td>+0.1</td>
<td>0.01</td>
</tr>
</tbody>
</table>

$\Sigma M = 5384.5 \quad \Sigma v = 0.0 \quad \Sigma v^2 = 0.0554$

$\bar{M} = 5384.5 / 10 = 538.45$

Standard deviation $\sigma = \pm \sqrt{\frac{\Sigma v^2}{n-1}}$

$= +/- \sqrt{0.0554/9} = +/-0.078$
Background

- **Cartography**
  - The art and science of graphically expressing information about the earth's surface by means of maps and charts
  - The term applied to the overall process of map production

- **U.S. Geological Survey**
  - USGS began publishing topographic maps in 1886 as an aid to scientific studies
  - Standard sheets cover 7-1/2 or 15 minute quadrangles and show detailed features
  - Standard scale is 1:24,000
  - Standard equivalence scale is 1 in = 2,000 ft
  - 24,000 inches in 2000 feet
Scale Classification

- **Large**
  - More detail, less area
  - 1:1,200 (1 in = 100 ft) or larger

- **Medium**
  - 1:1,200 to 1:12,000 (1 in = 100 to 1,000 ft)

- **Small**
  - Less detail, more area
  - 1:12,000 (1 in = 1,000 ft) or smaller
Map Types

☐ Planimetric

- Shows position features such as roads, rivers, and boundaries

Source: National Park Service, nps.gov
Map Types

☐ Topographic

- Shows position features and elevation contours

Source: USGS
Map Types

- **Shaded-relief**
  
  - Topography shaded to produce a 3-dimensional appearance

Source: geology.com
Map Types

- **Slope map**
  - Shaded to indicate differing percent slopes

Source: Michigan State University, msu.edu
Map Types

- Orthophotography
  - High-resolution aerial photography

Source: ESRI
Map Types

- Thematic Maps
  - Depict information about a particular topic, such as population

Source: geodata.statcan.ca
Map Types

- Geologic Maps
  - Position, structure, composition, etc.

Source: lib.utexas.edu
Map Types

- **Hydrologic Maps**
  - Water resources, flood plains, watersheds, etc.

Source: in.gov/dnr
Map Types

- Land Use Maps
  - Agriculture, forest, commercial, industry, etc.

Source: cityofwestokoboji.org
Color on Topographic Maps

- Black - constructed features (buildings, dams, etc.)
- Blue - water features
- Green - wooded areas
- Brown - contour lines
- Red - important roads, range lines
- Red tint - urban areas
- Purple or Purple tint - revisions since last map edition
End of Lecture 6

Tomorrow’s lab: Using Topographic Maps