Viewsheds
Two related problems:
Is location x visible from location y?
“Can I see the house from here?”
What areas are visible from location y?
“What areas can I see from here?”
Opposite question is often important, too!
Is location x visible or not from y?
What areas are not visible from x?

Line of Sight Model
Position (elevation) of observer
Position (elevation) of target
Intervening landforms

Areas Hidden from Observer
Line of Sight may be calculated for all points
Identifies surface areas blocked by terrain

Changing Position
If the observer moves, viewshed changes

Questions
If the observer can see the target....
Can the target see the observer?
If the observer can't see the target....
Is the observer out of sight?

Applications
Building arrays of observation towers
Visual impact of new construction
Troop movement & surveillance
 Quantifying Scenic Content

Implementation on Raster DEMs
Observer:
A point, set of points, or polyline
Target:
Typically every cell in DEM
Assigned 1 if in viewshed, 0 if not
Additional Parameters
Height of observer above landscape
Direction faced by observer
Include / Exclude near / distant points

Computing Viewsheds
Consider near-1D case
What can observers see?
Computing Result
Treat DEM as a lattice of cell center points
For each point in the DEM:
   Step 1: establish Line of Sight (LOS) between observer and target point
   Step 2: Check each intervening point to see if it is below the LOS
Point is only visible iff Step 2 is true for all intervening points
Actual GIS implementations more complex
   Speed up solution time
   Deal with non-rook's case neighbors

Results for Observers 1 & 2

Example Observers for Susanville

Another Example
Observer altitude not correlated w/ larger viewshed!

Multiple Observers

Observers along a Road

Observer Height
Viewpoint not usually at ground level
Human height
   Add 2 m. to observer elevation
Tower / Building
   Add tower height
Aircraft
   Add altitude
Does increasing observer height always improve visibility?

Example of Observer Height Effect
Observer 3 on ground, & 10 m. above ground

Direction Observer is Facing
ArcGIS
May limit compass direction
   Only southward (90 – 270 degrees)
May limit vertical range
   i.e. plus/minus 15 degrees
Useful to constrain problem size
   Computationally intensive!

Blocking Objects
DEM's usually bare earth models
Features on the terrain impede visibility
   Trees
   Buildings
Can be modeled explicitly or not
   Raise entire DEM by a uniform amount
   Use landcover information to inform the increase
**Intervening Feature Example**  
Portion of Charlevoix County near Boyne City  
DEM & 1992 Land Cover from MCGI

**Boyne City Land Cover**  
Water: 0 ft; Developed: 15 ft; Forest: 25 ft; Shrubs/Orchards: 10 ft;  
Grasses/Ag: 2 ft; Woody Wetland: 10 ft; Emergent Wetland: 5 ft)

**Boyne City Viewshed Results**  
Yellow: DEM only (13,326 cells)  
Blue: DEM + Landcover (1,223 cells)  
Red: Both DEM only and DEM + LC (26,157 cells)

**Curvature**  
Earth's curvature enforces horizon!  
All points have a horizon  
Taller points have more distant horizon  
Tall features may rise above horizon  
Lower portions obscured by earth

**Curvature Example: Mt. Sunflower**  
Highest point in Kansas  
4,039 ft  
Nearly on Colorado Line  
'only' 262 km from Pikes Peak  
14,115 feet  
Speculation: can one see the Rockies from Mt. Sunflower?

**Two Possibilities**  
Were peaks high enough to be visible?

**Geometry**  
P: height of the peak above the surface  
B: base of peak  
A: antipode (AB is the diameter of the circle)  
V: Endpoint of a tangent segment extended from P  
on sphere, PV is the radius of the visible circle from P  
PA/PV = PV/PB  
Rearranging, we get:  
\[ PV = \sqrt{PA \times PB} \]

**Data**  
Peak Locations obtained from Wikipedia  
DMS converted to DD, entered in Generate files  
3’’ SRTM Downloaded from Seamless  
Projected to UTM zone 13, 90 m. cells  
1249 rows x 3490 cols  
Z: 1025 - 4300 m.
Results
Mt. Sunflower Viewshed: 215 km²
Pikes Peak Viewshed: 9,175 km²

The Geometry Solution
PV = sqrt(PA x PB)
PB: Height above base
  Let Mt. Sunflower be the base (1,231 m.)
  Pikes Peak is 4,302 m.
  PB = 3,071 m.
AB = Earth's diameter
  12,756,300 m.
PA =
PV =

Geometric Result

Related Viewshed Applications
Which locations are most visible?
  Calculate viewshed for each cell
  Store viewshed area in each cell
  Challenging problem computationally
Optimal Observer Siting
  Where is the location with the largest viewshed?
  Extensions to multiple observer case

Summary
Viewsheds
  Definition
  Applications
  Implementation
    observer(s)
    parameters
Related Viewshed Analysis