Flow Modeling on Massive Grids

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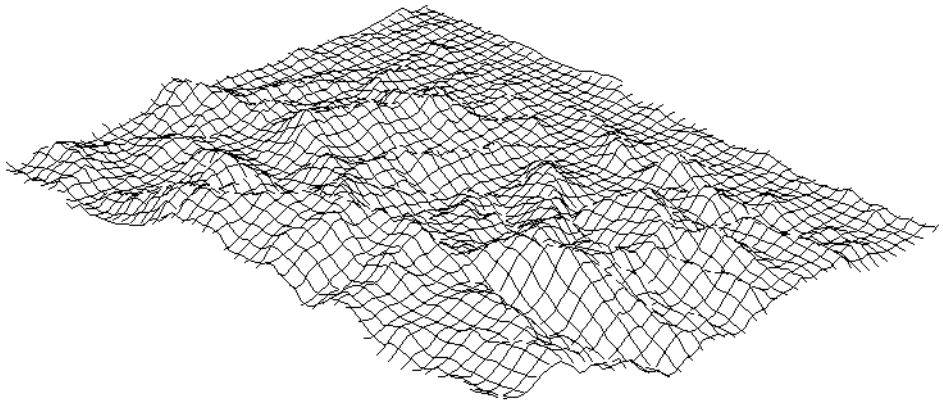
Applications

- Automatic estimation of terrain parameters
  - watersheds
  - drainage networks
  - topographic index
- Surface saturation
- Soil water content
- Erosion, Deposition
- Forest structure
- Species diversity
- Sediment transport

Modeling Flow

- Terrain modeled by grid of elevations



- Flow direction
  - direction water would flow from each cell
  - what does it mean on flat areas?

Massive Data

- Remote sensing data available today
  - NASA-SRTM (whole Earth: 5TB)
  - USGS (entire US at 10m resolution)
- Typical grid
  - East coast USA
  - 11,000 x 25,000 grid
  - 0.5 GB

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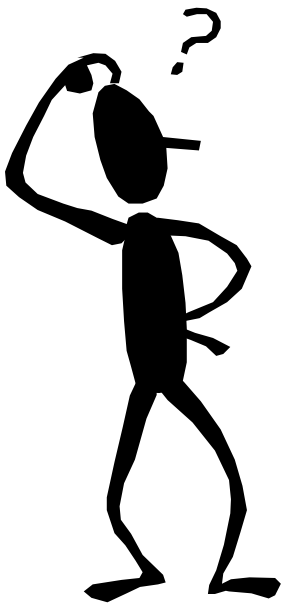
Scalability

- Current GIS software minimizes CPU time
- I/O is bottleneck
- Total time does not scale



- ArcInfo
  - more than 3 days on East coast USA grid
- TARDEM
  - 2 days on 1/4 East coast USA grid

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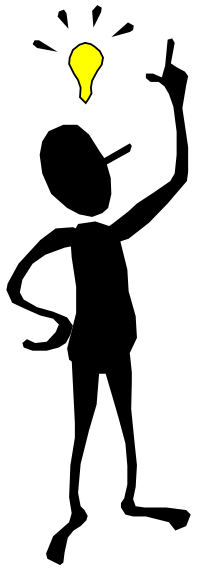
Theoretical Results

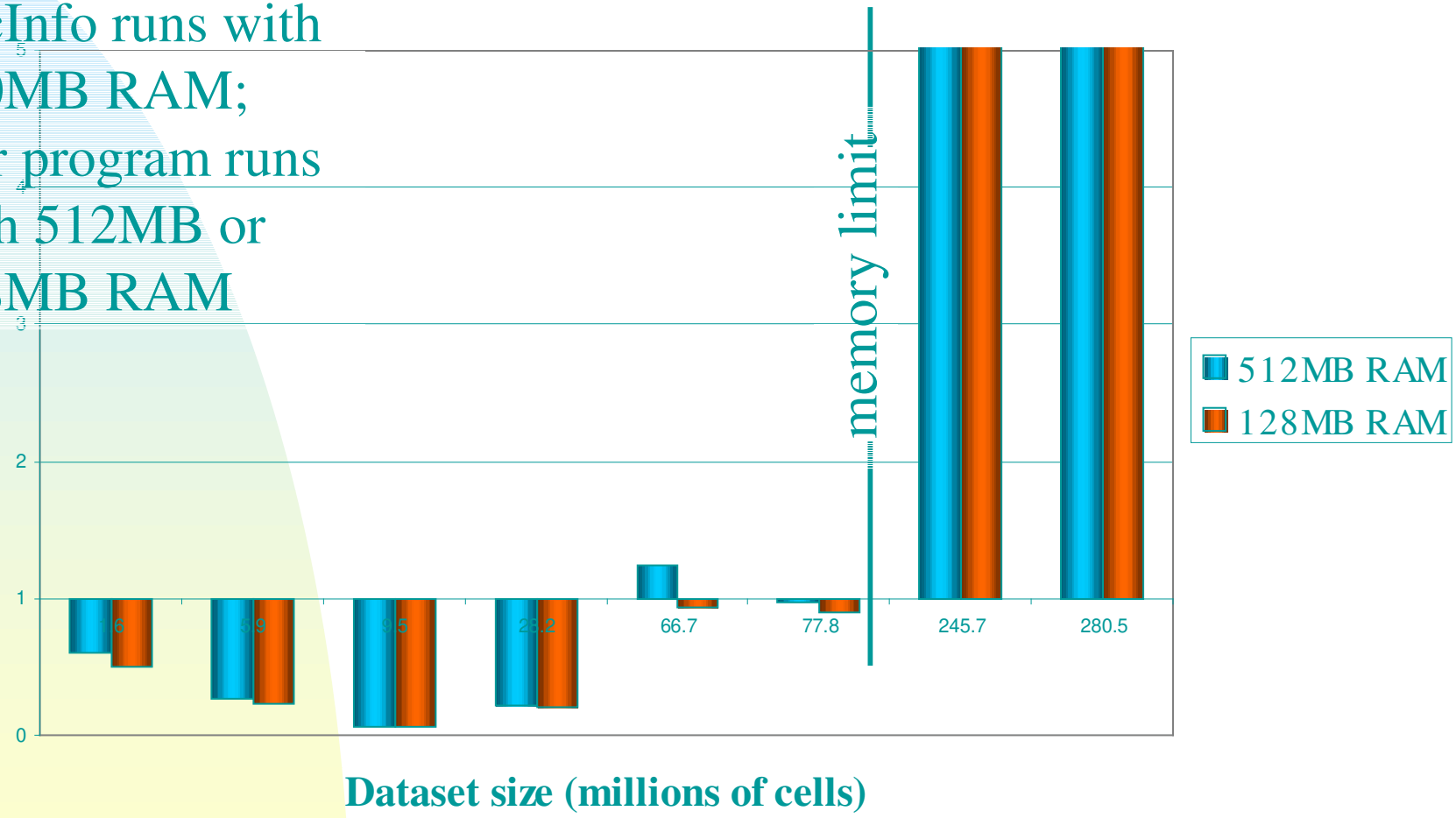
- I/O Model
  - disk much slower than CPU
  - count number of I/O operations (rather than CPU time)



- I/O Efficient Algorithms
  - identifying flat areas
  - assigning flow directions on plateaus
  - identifying watersheds
  - filling depressions/sinks
  - assigning flow directions on terrains
  - flow accumulation

Speedup over ArcInfo

ArcInfo runs with 750MB RAM; Our program runs with 512MB or 128MB RAM



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