Footprint Services for Everyone

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The Sphere

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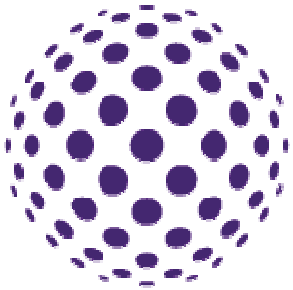
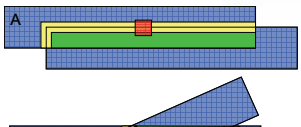
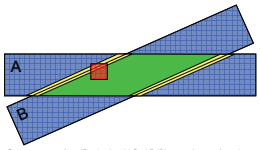
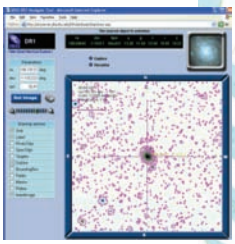


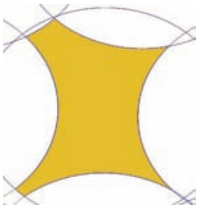
Complex Geometry

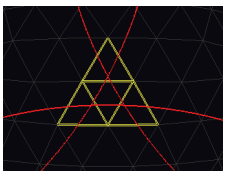


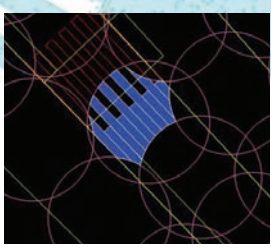


Green area: $A \cap (B- \varepsilon)$ should find B if it contains an A and not masked
Yellow area: $A \cap (B \pm \varepsilon)$ is an edge case may find B if it contains an A.







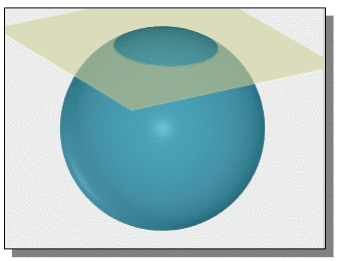


Motivations

- Sky coverage is always the first step!
  - Cross-matching catalogs
  - Looking for dropouts
  - Observation planning
  - Window function studies, etc…
- Not simple and missing from most astronomer's toolbox :-(

The Math of Painting the Sphere

- Many ways of describing shapes
- Useful 3D concepts
  - Halfspace → Circle/Cap



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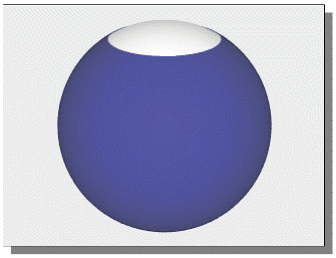
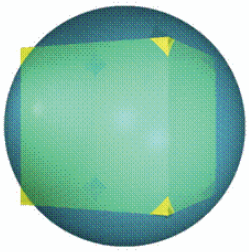


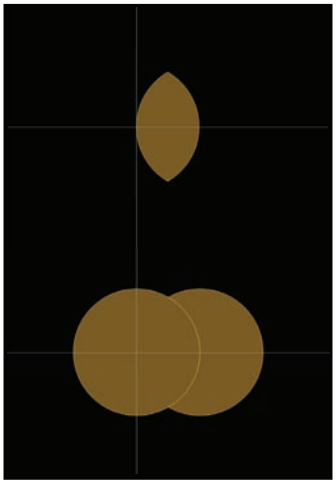
The Math of Painting the Sphere

- Many ways of describing shapes
- Useful 3D concepts
  - Halfspace → Circle/Cap
  - Convex → ???
- We use 3D but solve geometry on surface
  - Patch and Region



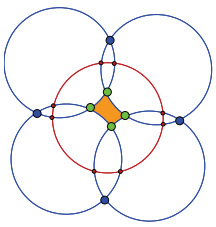
Operations

- Intersection
  - Concat halfspace lists
- Union
  - Concat convex lists
  - Unique coverage
  - Precise area
- Subtract
  - Etc…



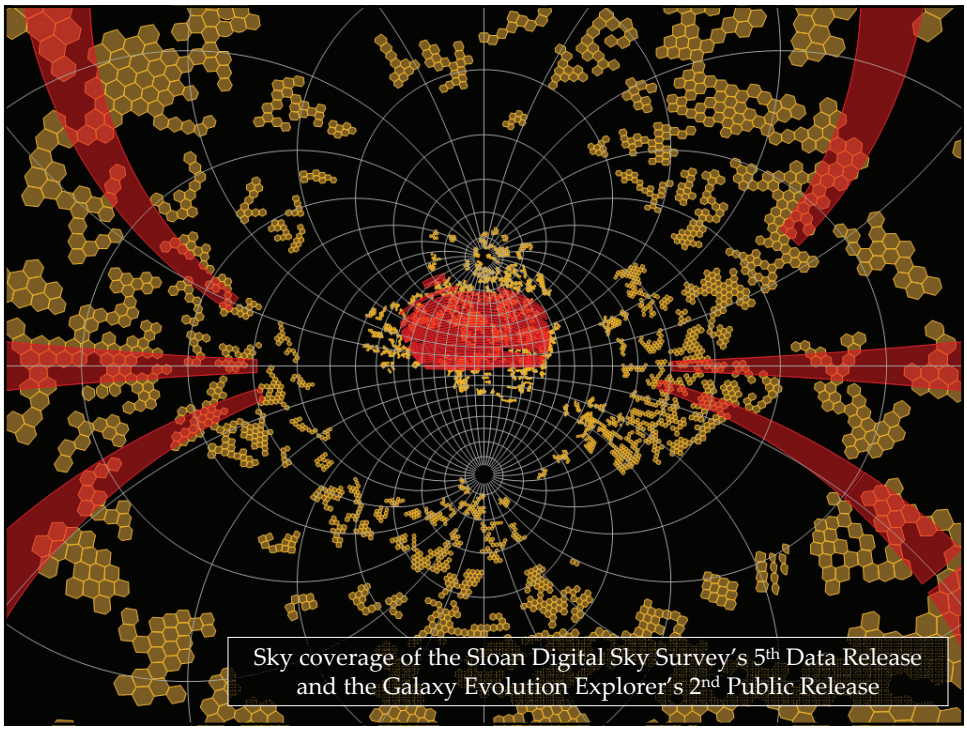
Simplification

- Eliminate redundant halfspaces
  - First handle trivial combinations of constraints
  - Then solve geometry on the surface
    - Derive Roots, Arcs, Patches
- Eliminate redundant convexes
  - Some trivial cases, but…
- Stitch together convexes
  - When possible



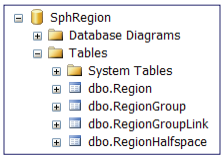
SphericalLib .NET

- 8,500 lines of C# code – 20k total
  - OS independent (Windows, Un*x w/ Mono)
- Some of the functionalities
  - Full Boolean operations, fast point searches
  - Double precision sets resolution, ~0.001”
  - Hand in hands w/ HTM indexing
- Great performance
  - Sloan Digital Sky Survey in 10s



Database Integration

- SQL Server 2005
  - Indexed tables of regions for fast searches
    - Halfspaces of convexes
    - Patches w/ minimal enclosing circles
  - Binary blobs to leverage the internal CLR
    - SQL procedures and functions for wrapping



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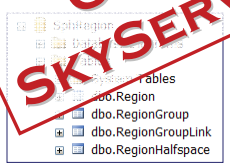
COMING SOON TO SKYSERVER NEAR YOU!

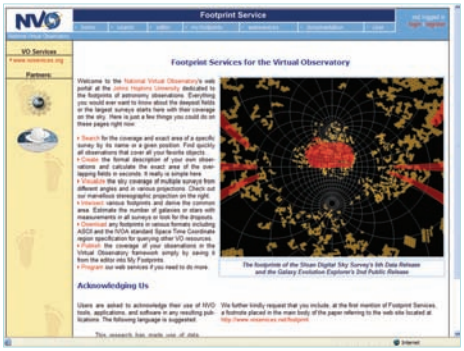


Space-Time Coordinate Regions

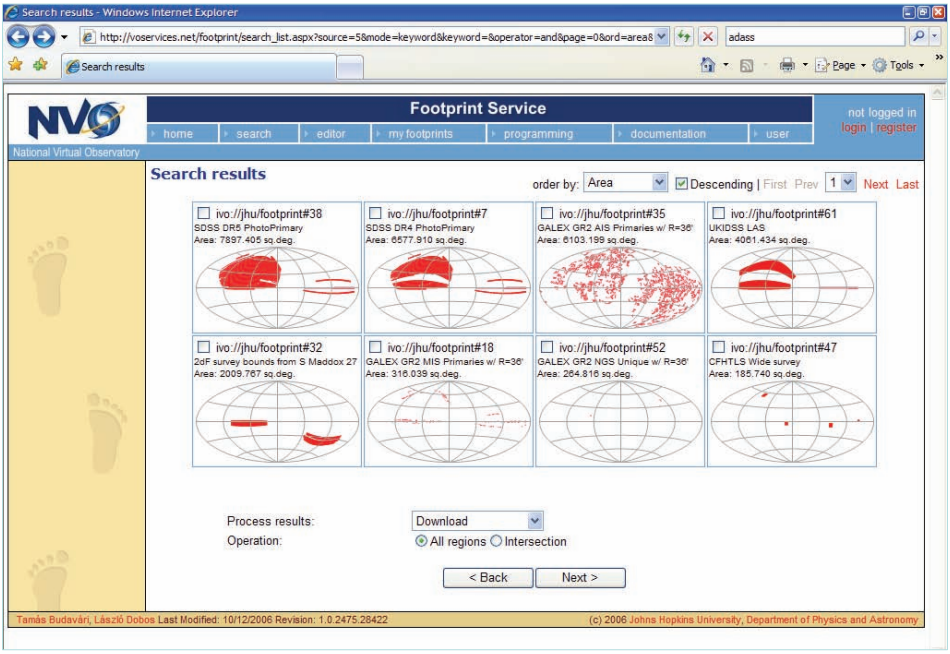
- STC of IVOA defines standard repr
  - Rich XML language of a variety of concepts
  - Proper XSD that works, see www.ivoa.net
- Basic building block for new services
  - Image and catalog archives
- Proper automated federation
  - For SkyQuery and the kind

Footprint Services

- All about coverage
  - Editor and calculator
  - Online public repository
  - On-the-fly visualization
  - STC translator, etc…
- Web services
  - Simple programming



http://voservices.net/footprint



Summary

- Lightweight framework
  - For footprints of arbitrary size and complexity
  - Independent of coordinate system and projection
  - Exact mathematical equations
- Running inside SQL Server 2005
  - Fully optimized searches in SQL and .NET
- Simple interfaces for everyone!
  - Programmer, DB user, Web browser