



Footprint Services for Everyone

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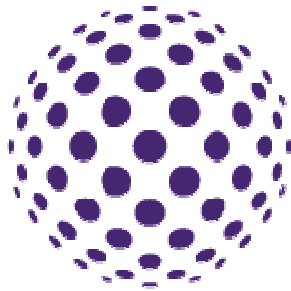


The Sphere





The Sphere



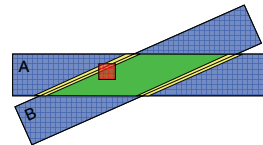
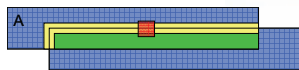
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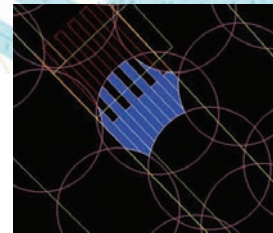
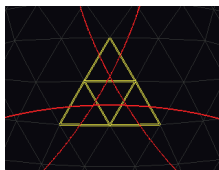
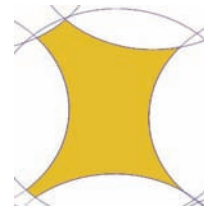
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Complex Geometry



Green area: $A \cap (B - \epsilon)$ should find B if it contains an A and not masked
Yellow area: $A \cap (B \cup \epsilon)$ 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 :-)

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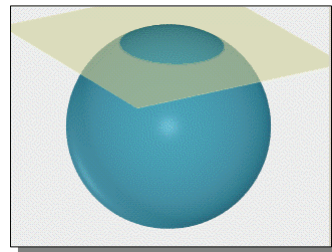
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The Math of Painting the Sphere

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



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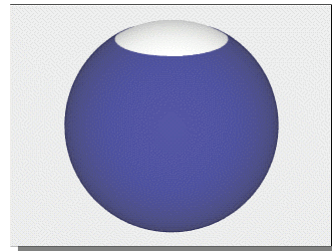


The Math of Painting the Sphere

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The Math of Painting the Sphere

- Many ways of describing shapes

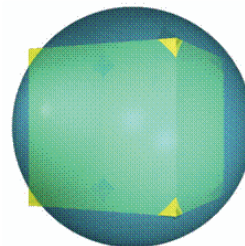
- Useful 3D concepts

- Halfspace \rightarrow Circle/Cap

- Convex \rightarrow ???

- We use 3D but solve geometry on surface

- Patch and Region



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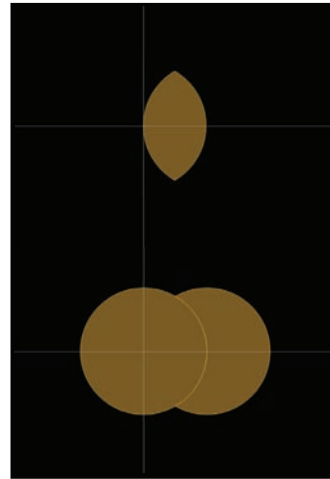
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Operations

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



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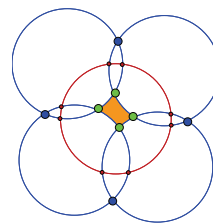
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Simplification

- 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



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SphericalLib .NET

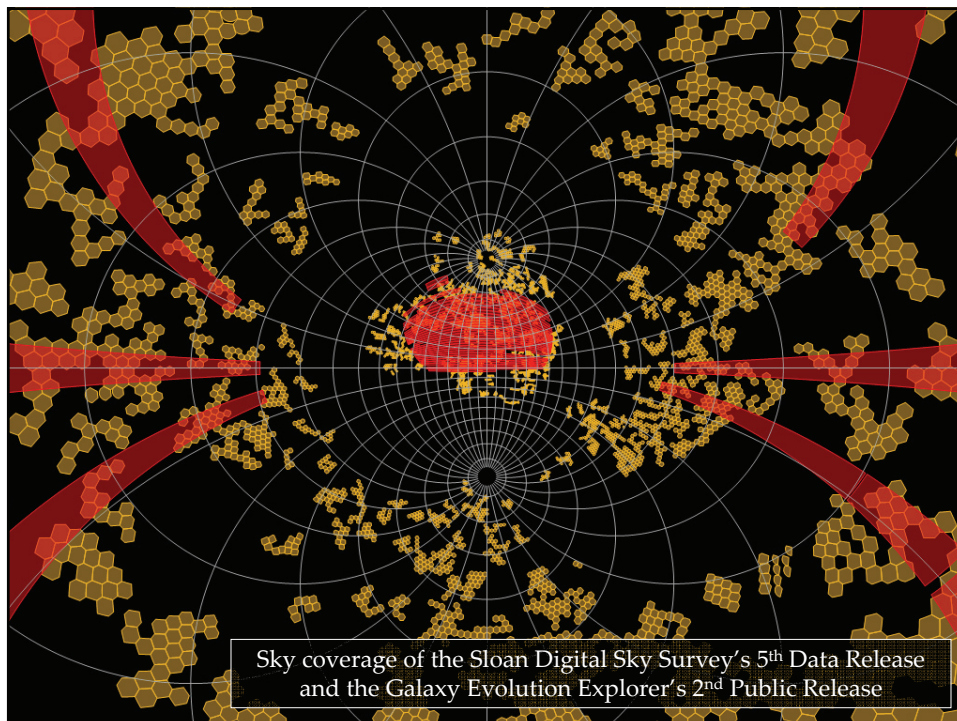
- 8,500 lines of C# code – 20k total
 - OS independent (Windows, Un*x w/ Mono)
- Some of the functionalities
 - Full Boolean operations, fast point searches
 - Double precision sets resolution, $\sim 0.001''$
 - Hand in hands w/ HTM indexing
- Great performance
 - Sloan Digital Sky Survey in 10s



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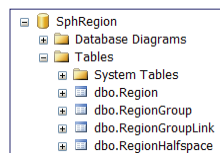




Database Integration

● 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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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



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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>

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Search results - Windows Internet Explorer

http://voservices.net/footprint/search_let.aspx?source=5&mode=keyword&keyword=&operator=and&page=0&ord=area&...

Search results

NVO National Virtual Observatory

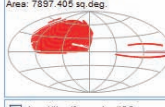
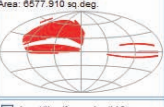
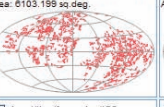
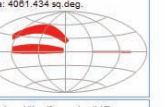
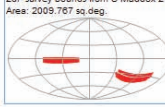
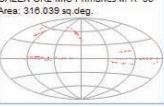
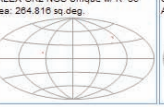
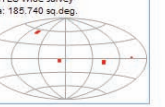
Footprint Service

home search editor my footprints programming documentation user

not logged in
login register

Search results

order by: Area Descending | First Prev 1 Next Last

<input type="checkbox"/> ivo://jhu/footprint#38 SDSS DR5 PhotoPrimary Area: 7897.405 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#7 SDSS DR4 PhotoPrimary Area: 6577.910 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#35 GALEX GR2 AIS Primaries w/ R=30' Area: 6103.199 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#61 UKIDSS LAS Area: 4001.434 sq. deg. 
<input type="checkbox"/> ivo://jhu/footprint#32 2dF survey bounds from S Maddox 27 Area: 2009.767 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#18 GALEX GR2 MIS Primaries w/ R=30' Area: 310.039 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#52 GALEX GR2 NGS Unique w/ R=30' Area: 264.918 sq. deg. 	<input type="checkbox"/> ivo://jhu/footprint#47 CFHTLS Wide survey Area: 196.740 sq. deg. 

Process results:
Operation:

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☒ All regions ☐ Intersection

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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

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