Outline

• CAS Team
• CAS Intro
• Data Storage
• Data Loading
• Data Access
• CAS for SDSS-IV
• SciServer DIBBS project
• SDSS-IV website
## CAS Team

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>~ FTE</th>
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</thead>
<tbody>
<tr>
<td>Deoyani Nandrekar-Heinis</td>
<td>Software developer (ImgCutout, SkyServer, JPEG generation, VO services)</td>
<td>0.5</td>
</tr>
<tr>
<td>Dmitry Medvedev</td>
<td>Software developer (CasJobs, SkyServer)</td>
<td>0.5</td>
</tr>
<tr>
<td>Sue Werner</td>
<td>Software developer (DB tuning, partitioning)</td>
<td>0.25</td>
</tr>
<tr>
<td>Victor Paul</td>
<td>Database administrator, storage management</td>
<td>0.5</td>
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<tr>
<td>Jordan Raddick</td>
<td>Documentation lead, press officer, website lead</td>
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<tr>
<td>Bonnie Souter</td>
<td>Website developer (SDSS.org, SkyServer)</td>
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<tr>
<td>Rich Ercolani</td>
<td>IT support lead</td>
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<tr>
<td>Alex Szalay</td>
<td>Oversight, DIBBs (SciServer) PI</td>
<td>0.05</td>
</tr>
<tr>
<td>Ani Thakar</td>
<td>Management, data loading, logging (SDSS/VO), SciServer integration</td>
<td>0.25</td>
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</table>
CAS Intro

• History
  – Original CAS an OODBMS
  – Migrated to SQL Server in 2001
    • The SkyServer was born in 2001
• Design based on analysis of logs
  – 3 main types of users:
    • Lots of quick queries
    • A few “power” users
    • Visual data browsers (astro)
  – Power users slowed everyone down
    • Need to segregate query workloads on separate servers
  – Increasing SQL usage
• Minimizing data movement
  – Bring the analysis to the data, not vice versa
CAS Design

- Based on relational DBMS: MS SQL Server
- Layer of science schema built right into the DB
  - Extensive use of UDFs/SPs
  - HTM spatial index in C# CLR
- 3 pillars of data access
  - Synchronous: SkyServer
  - Asynchronous: CasJobs
  - Visual: ImgCutout
- sqlLoader data loading pipeline
Reusable Building Blocks

- **SkyServer**
  - Extensive built-in science, query, metadata support
- **CasJobs batch query workbench**
  - Adapted and deployed in several (non) astro projects
- **ImgCutout visual JPEG browsing service**
  - Recently adapted to display 2MASS JPEGs
- **sqlLoader data loading pipeline**
- **Hierarchical Triangular Mesh spatial index**
  - CLR library written in C#, ported to Java, C++
- All downloadable from skyserver.org
- All MS SQL Server based, at present
SkyServer Web Interface

- The public portal to CAS data since 2001
- Supports several levels of user access
  - Simple to complex form queries
  - CrossID search with upload capability
  - Visual browsing of individual objects
  - Raw (filtered) SQL query
- Includes client for ImgCutout service
  - Finding Chart page
  - Google Maps-style Navigate page
  - Queryable Image List page for multiple cutouts at a time
- Schema Browser, extensive SQL help
- Virtual Observatory services (VO standards/protocols)
- Rich educational projects section (K-12+)
- Every web hit and SQL query recorded in logs
SkyServer Usage Logging

• All web hits and queries logged since day 1 (2001)
• **SkyServer traffic page** shows up-to-the-hour logs
  - 1.43 billion hits, 263 million SQL queries to date
  - Currently averaging 15M hits and 1.5M queries/mth
• Logging overview document at skyserver.org/doc
• 3 published papers on SkyServer traffic:
CasJobs

- Batch query workbench (launch 8/2003)
- Web application + web service backend
  - ASP.NET/C# development platform
- Workhorse of CAS data access
  - SDSS-II CasJobs: 9300 users, 6.1M jobs
  - SDSS-III CasJobs: 3800 users, 8.8M jobs
- Every user has their own SQL “MyDB”
  - Default size 0.5 GB, increased on request
- Quick (1min sync) & Long (8hr async) modes
- Complete searchable job history
- Schema browser, MyDB table browser
- Data Import, Groups feature to share data

SDSS-IV Data Review, October 15-16, 2014
Ani Thakar, JHU
ImgCutout

• ASP.NET/C# web service
• Client: SkyServer Visual Tools
  – Finding Chart
  – Navigate (Google Maps-style interface)
  – Image List upload with user query input
  – Explore and Quick Look object browsing
• JPEGs served from Frame table in DB
  – 3-color JPEGs generated from FITS
Data Storage

• Multiple instances of each DR
  – For redundancy, load-balancing and performance (workload segregation)
  – As many as 6 copies of most active DR!
    • For smooth ops and optimal performance
    • SkyServer, Quick CasJobs, Long Public CasJobs, Long Collab CasJobs, Imgcutout and development/backup/restore copy

• Currently ~ 120 TB of DR8-11 DBs
BestDR12 Schema

- Photo, Spectro largest group
- Meta tables for SB and xmatch
- APOGEE, WISE, MARVELS in own groups
## Data Table Sizes

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<th>Name</th>
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- Size > 10 GB
- PhotoObjAll largest table by far, most heavily indexed
- PhotoProfile has max rows but is thin and much less used
Data Loading

• Data products that go into CAS
  – Photo: SDSS, BOSS
  – Spectro: SDSS, BOSS, SEGUE,APOGEE
  – Window, Resolve, Region, Tiling etc.
  – Xmatches: USNOB, 2MASS, 2DF, ROSAT, FIRST, WISE All Sky
  – Galaxy Zoo 2 classifications

• Ingested in CSV format by sqlLoader
sqlLoader Data Ingest Pipeline

• System of SQL and VB scripts controlled by ASP client application (Load Monitor)
• Automates tedious data loading tasks
• Thoroughly checks data integrity
• Enables parallelism in data loading
• Provides complete history and log for each loading task
• Tracks statistics for loading performance
Loader Data Flow and Validation

- Load-Publish-Finish main stages
- Data first loaded into temp “task” dbs
  - Can be parallelized for fast loading
- Publish stage writes data to final db
- Finish stage creates indices, computed tables

Data correctness, consistency and integrity checks built into loading process
- Uniqueness checks, cardinality checks, relationship checks
- Have proven invaluable in the past in finding problems upstream of CAS
sqlLoader Screen Shots
CAS Data Release Cycle

- Detailed list of steps is in overview doc
- Cycle must be repeated for each data product (photo, spectro, APOGEE etc.)
- Most steps involve multiple actions
- Testloads are usually a small subset of DR data
- Entire cycle can take ~ 2 months
- Objective is to give collab a few months preview of data
- Steps in gray are only done once when all data products are in
CAS Admin Site: skyserver.org

- All CAS data/software downloadable
- Data releases downloadable as compressed SQL Server backups
  - Smaller subsets available for testing
- CAS mirror sites resource page
  - Mirrors can download latest updates here
- CAS/SkyServer documentation page
  - Skyserver.org/doc (data review docs here)
- SkyServer site download
- CasJobs download
- HTM spatial index doc and download
CAS Mirrors

• Official SDSS-III mirror: Brazil (LIneA)
  – Also hosts CasJobs mirror

• Other mirrors:
  – China (LAMOST)
  – Portsmouth

• SDSS-II mirrors worldwide
  – UK, Germany, Russia, China, Japan, India

• VO sites (NED, CDS)
CAS for SDSS-IV

• Continue current procedures, best practices
• Data volume increases manageable
  – Expect 2-4 TB per DR through 2020
• APOGEE-2, eBOSS data not radically different
  – Apply current tools, processes with tweaks
• MaNGA data will be biggest challenge
  – Both for complexity/novelty and size of data
  – Will need to develop new tools from scratch
• MaNGA data visualization in SkyServer
  – Tier 1 targeted for DR13 (mid-2016)
  – 0.5 FTE additional dev effort through 2018
SciServer

• JHU DIBBs project (sciserver.org)
• Generalize and extend SkyServer/VO framework
  – Reengineer/refactor SDSS data access tools for maximum reuse and extensibility
  – Port ASP SkyServer code to ASP.NET/C#
  – Convert CasJobs web services from SOAP to RESTful
  – Reengineer SkyQuery (VO service) on GrayWulfl platform
  – Integrate CasJobs and SkyQuery
  – Integrate SciDrive DropBox-like (VO) service with CasJobs/MyDB
  – Keystone SSO for access to all services
• Take ownership of legacy SDSS datasets
  – Integrate multiple SDSS phases: new sdss.org website
• Additional 1 FTE development on SDSS software (thru 2015)
• Additional dev hardware and storage
• Project management 1 FTE (M Rippin)
  – Formalized software development processes
Thank you!

• All documents and links to published articles about the SDSS CAS can be found at [http://skyserver.org/doc/](http://skyserver.org/doc/)

• Happy to take questions after Jordan Raddick’s SDSS website overview
SDSS.org Integration and Rebranding

Jordan Raddick, JHU