Arizona-NOAO Temporal Analysis and Response to Events System

Tom Matheson
NOAO
ANTARES
What It Is and Why We Need It

• ANTARES is an astronomical time-domain event broker
• A broker is an intermediary that sits between the source of the alerts and the consumers of the alerts while adding value
• LSST will compare each image with a reference and issue an alert for any $5\sigma$ change (brightness or position)
• LSST will generate 1-10 million alerts each night for the ten-year duration of the survey
• We need a system to rapidly winnow that number down to something commensurate with follow-up resources
• Rate and volume will be unprecedented
ANTARES
Need for a Broker

• One of the primary recommendations from the ‘Spectroscopy in the Era of LSST’ workshop (Matheson et al. 2013, astro-ph 1311.2496)

• Also one of the primary recommendations from the NRC report “Optimizing the U.S. Ground-Based Optical and Infrared Astronomy System” (Elmegreen report)

• Expected high-priority recommendation from ‘Maximizing Science in the Era of LSST,’ recent (May 2016) Kavli-funded workshop
• LSST problem is one of scale and rate
• Multidisciplinary with computer science
• Collaboration between NOAO and UA Computer Science
• NSF INSPIRE proposal was successful (IIA-1344024)
ANTARES
How it Fits in the Transient Ecosystem

- Alert generators find transients and assess validity
- ANTARES characterizes, annotates, and ranks
- Downstream brokers/users classify and follow up

UC, Tucson, June, 2016 (D1)
ANTARES
Overall Architecture

• Core flow for alerts
• Draws on local databases for annotation
• Various stages of filtering
• No alerts are lost, just diverted to other channels
• Prototype focuses on ‘rarest of the rare’
• Open source/open access
• Added value is critical
• Multiwavelength catalogs, including LSST itself
• Past history of alerts
• Other alert sources (e.g., LIGO)
• Theoretical predictions
• Derive features from alert and annotation data
• Use features to characterize (not classify) objects
• Alerts can be forked if more than one possibility
• Filter based on features/characterizations
• As alert numbers drop, more complex processing can occur
Databases for object association in place
Databases for annotation developed
Can predict Galactic stellar variability
Demonstration prototype operational
  - Increasingly complex test streams
  - Larger feature sets for comparison
  - UTILIZES major stages of architecture
  - Modular components can become more complex
  - Visualization of feature spaces
  - Visualization of processes
• Second astronomy post-doc hired
• Computer cluster purchased
  – Will be located at University Infrastructure and Technical Services on campus
  – Tests system reliability and recovery
  – Adequate storage capacity for databases
• Single-point characterization is hard
• Annotation (object association) helps
• More alerts yield distinct evidence
• Supernovae fill $\Delta t/\Delta m$ space depending on type
ANTARES: Next Steps

- Fully populate annotation databases
- Functional prototype in 2016
- Address scaling through 2016
- Run on live alert streams in 2017
- Workshop for broker development in 2017
- Next proposal will be to make ANTARES generic to handle the full breadth of user interests (2018-?)
- During LSST operations, will likely include NCSA collaboration
  - Operations will require support
ANTARES: Demo

ANTARES Logical System Architecture (02/15/2016)

UC, Tucson, June, 2016 (D1)
Detail Slides
• Tom Matheson (NOAO)
• Abhijit Saha (NOAO)
• Richard Snodgrass (UA Computer Science; PI of NSF proposal; database expert)
• John Kececioglu (UA Computer Science; algorithm expert)
• Carlos Scheidegger (UA Computer Science; data visualization expert)
• Gautham Narayan (NOAO/UA Postdoc)
• Monika Soraisam (NOAO Postdoc; starts Sept 1, 2016)
• Three UA CS grad students
Entity-Relationship Diagram
Welcome to Antares documentation.

API reference

Alert related

- General Alert (antares.alert.Alert)
- External Alert (antares.alert.ExternalAlert)
- Camera Alert (antares.alert.CameraAlert)
- Alert Replica (antares.alert.AlertReplica)
- Alert Combo (antares.alert.AlertCombo)
- Astro Object (antares.alert.AstroObject)

Context related

- Context (antares.context.Context)
- CA Context (antares.context.CAContext)
- AR Context (antares.context.ARContext)
- AO Context (antares.context.AOContext)