

Training your astronomy robots to work as a team

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4 Pi Sky group
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UNIVERSITY OF
Southampton



Radio Transients with SKA Pathfinders
South Africa, July 2013

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Outline

The “second grade soccer” problem

A quick plug

But...

The centralized approach

Classifiers to schedulers

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The astronomer's telegram

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5200 [Swift Galactic Plane](#)

[Survey: Sourcelist v3.0](#)

M. T. Reynolds, J. M. Miller,
D. Maitra, K. Gultekin
(University of Michigan); N.
Gehrels (NASA/GSFC);.... --
8 Jul 2013; 16:58 UT

5199 [Australia Telescope](#)

[Compact Array detection
of iPTF13bvn](#)

Paul Hancock, Tara Murphy,
Bryan Gaensler
(SIfA/CAASTRO, University
of Sydney), Brian Schmidt
(RSAA/CAASTRO);.... -- 7
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5198 [An Early Radio Detection](#)

A. Horesh, Y. Cao, K.
Mooley, J. Camarero

Recently

5191 [Redshift of Afterglow Candidate iPTF13bxl](#)

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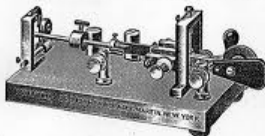
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Combine

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OR

- ☐ Radio
- ☐ Millime...
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- ☐ Far-Infra-Red

The astronomer's telegram

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- ▶ High latency results in significant duplication of effort.
- ▶ Requires significant astronomer / observation time ratio.

The GRB microcosm

- ▶ GRB community has overcome latency issues using GCN.
- ▶ Works well, but narrow in scope.
- ▶ Automated system is one way (NASA → World); follow-up reverts to manual.

How does VOEvent help?

- ▶ Fast.
- ▶ Flexible.
- ▶ Allows for automated creation, collation, filtering ...

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VOEvent-Parse

- ▶ A super-lightweight python wrapper / library built on lxml.
- ▶ **`https://github.com/timstaley/voevent-parse`**
- ▶ **`pip install voevent-parse`**

VOEvent-Parse

```
import voeparse
v = voeparse.load('path/to/voevent_packet.xml')
#Prints ivo://nasa.gsfc.tan/gcn
print "AuthorIVORN:", v.Who.AuthorIVORN
#Alters the XML value.
v.Who.AuthorIVORN = 'ivo://i.heart.python/lxml'
```

VOEvent-Parse

http:
//voevent-parse.readthedocs.org/

The screenshot shows the VOEvent-parse 0.1 documentation page. The browser address bar displays 'voevent-parse.readthedocs.org/en/latest/'. The page has a dark header with the title 'VOEvent-parse 0.1 documentation' and navigation buttons for 'next', 'modules', and 'ind'. The left sidebar contains sections for 'Project Versions' (latest), 'RTD Search' (with a search box and 'Go' button), 'Table Of Contents' (listing 'Welcome to VOEvent-parse's Indices and tables'), 'Next topic' (voe parse Package), and 'This Page'. The main content area features a 'Welcome to VOEvent-parse's documentation!' message, a 'Contents:' section with a bulleted list of links (voe parse Package, voe parse - top level convenience routines, voe event - VOEvent packet manipulation, misc - Sub-Elements and other helpers, definitions), and an 'Indices and tables' section with links to Index, Module Index, and Search Page. A small navigation arrow is visible in the bottom right corner.

welcome to VOEvent-parse

voevent-parse.readthedocs.org/en/latest/

Astro-ph UKADS They GB Wind PyRef AMI GDocs GCal Programming Weather LOFAR Linux to-reads arxiv-r Other

VOEvent-parse 0.1 documentation » next modules ind

Project Versions
latest

RTD Search
 Go
Full-text doc search.

Table Of Contents
Welcome to VOEvent-parse's Indices and tables

Next topic
voe parse Package

This Page

Welcome to VOEvent-parse's documentation!

Contents:

- **voe parse** Package
 - **voe parse** - top level convenience routines
 - **voe event** - VOEvent packet manipulation
 - **misc** - Sub-Elements and other helpers
 - **definitions**

Indices and tables

- *Index*
- *Module Index*
- *Search Page*

Other VOEvent tools

See also:

- ▶ <http://comet.transientskp.org/> — Connect to the VOEvent backbone!
- ▶ <https://github.com/timstaley/pysovo> — Email people! Do stuff!
- ▶ Generate a VOEvent, (and a templated GCN / Atel!) from your web browser— *Coming soon? (Would anyone use it?)*

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Loud noises!

- ▶ Faster communication by itself only gets you so far (HFT disasters?).



How can we facilitate collaboration?

- ▶ At a minimum: Need to be open about what we are doing. Better yet: Share / trade observations.

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- ▶ At a minimum: Need to be open about what we are doing. Better yet: Share / trade observations.
- ▶ Minor hurdle: Astronomy community has no universal standard for ‘observation requests.’
- ▶ Major hurdle: Political will / rewards system for observers releasing open data. (Or; only share with your friends? Trust vs. potential benefits.)

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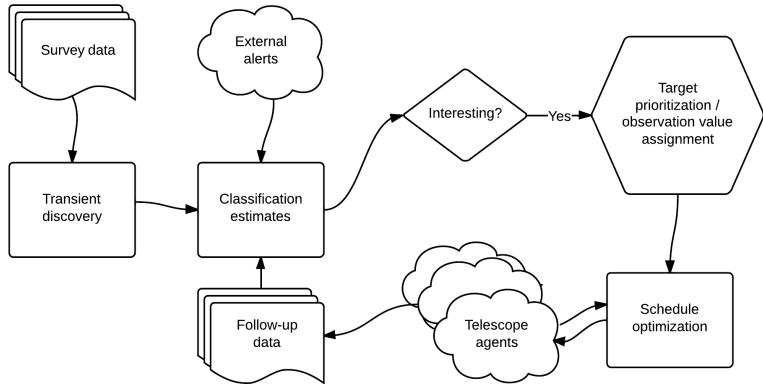
Classifiers to schedulers

Negotiation is hard

- ▶ Negotiation and decentralization adds complexity.
- ▶ Trade off: Freedom and robustness vs. efficiency, single set of priorities at any one time.
- ▶ e.g. GCN community vs. PTF, LCOGT.

An optimal response system

Something like this, perhaps?



Agent based systems

These have been seen before...



- ▶ A. Allan,
E. Saunders et
al.
- ▶ c.f. 2003–2007
- ▶ (RIP Estar)

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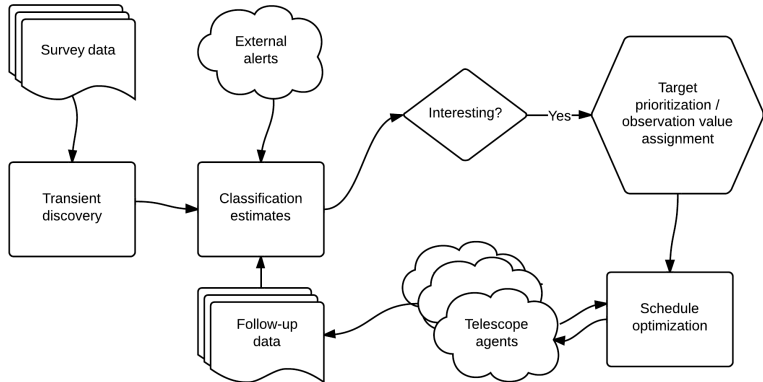
The logo for eSTAR, featuring a red stylized 'e' followed by the word 'STAR' in black capital letters.

- ▶ A. Allan,
E. Saunders et
al.
- ▶ c.f. 2003–2007
- ▶ (RIP Estar)



- ▶ Large
collaboration
- ▶ Scheduling: E.
Saunders
(small world)
- ▶ Currently
being
deployed

One block is missing



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What are we optimizing for?

Science value

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{ Subject to cost constraints }

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{ Subject to cost constraints }
{ And telescope availability }

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Science value

{ Subject to cost constraints }
 { And telescope availability }
 { And ... }

What are we optimizing for?

Science value

{ Subject to cost constraints }
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How do we assign a science value — when we don't know what it is yet?

Guessing at science value

- ▶ Suppose we have a tentative set of classification probabilities.
- ▶ Choose follow-up observations with best chance of refining probabilities.
- ▶ Assign expected science values to transients based on those **potential** outcomes.
- ▶ Hence, assign science value to planned observations, feed to scheduler for optimization.

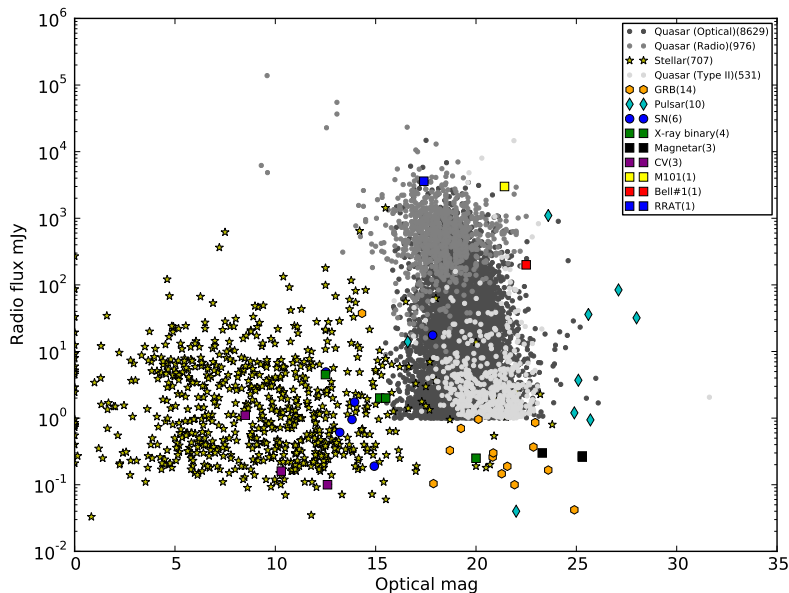
Representing information gain

Assign ‘confusion matrices’ to a given observation.

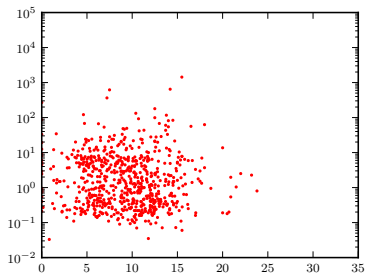
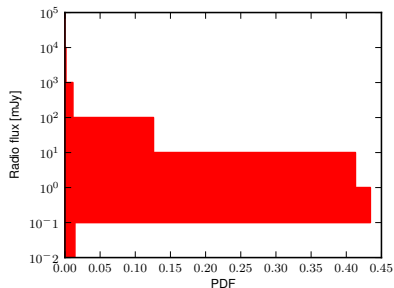
... and the rest is ‘just’ computer science (hopefully).

Need to determine e.g. how well an optical observation separates classes.

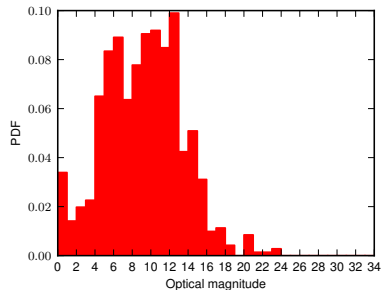
Start with the training data



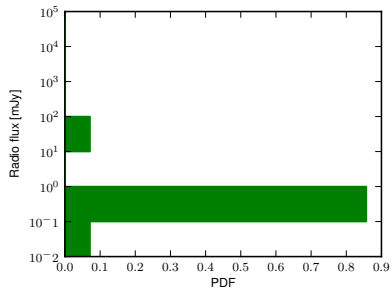
Stellar



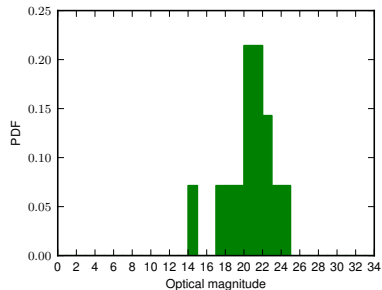
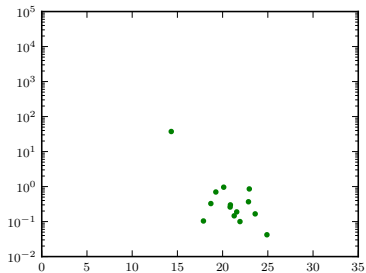
Stellar



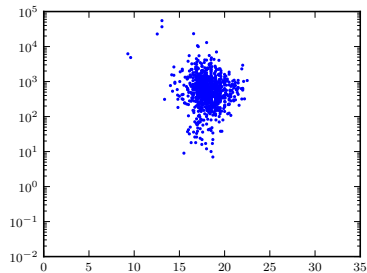
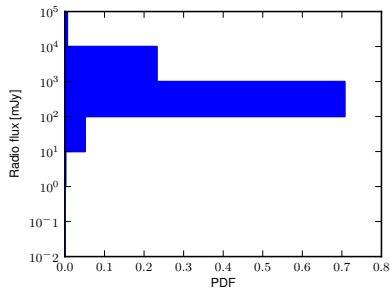
GRB



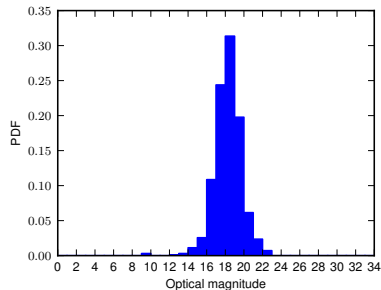
GRB



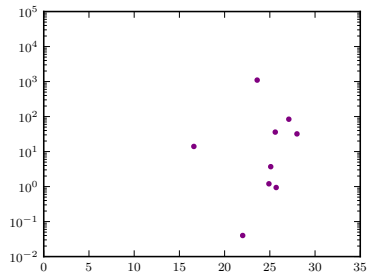
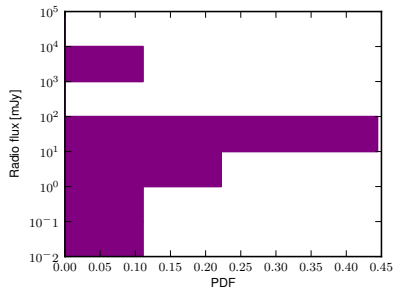
Quasar (Radio)



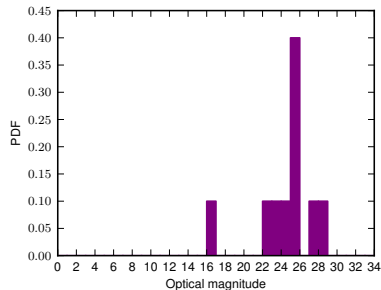
■ Quasar (Radio)



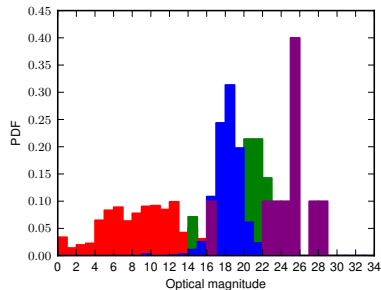
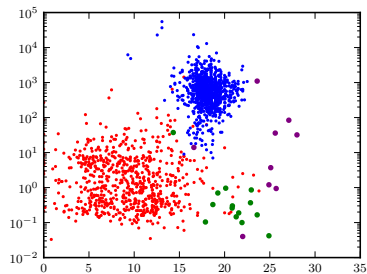
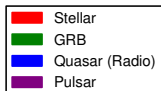
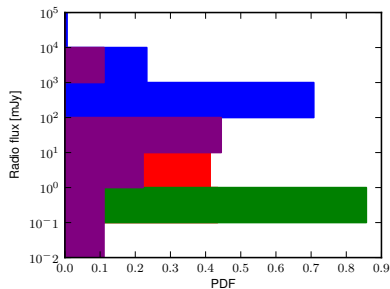
Pulsar



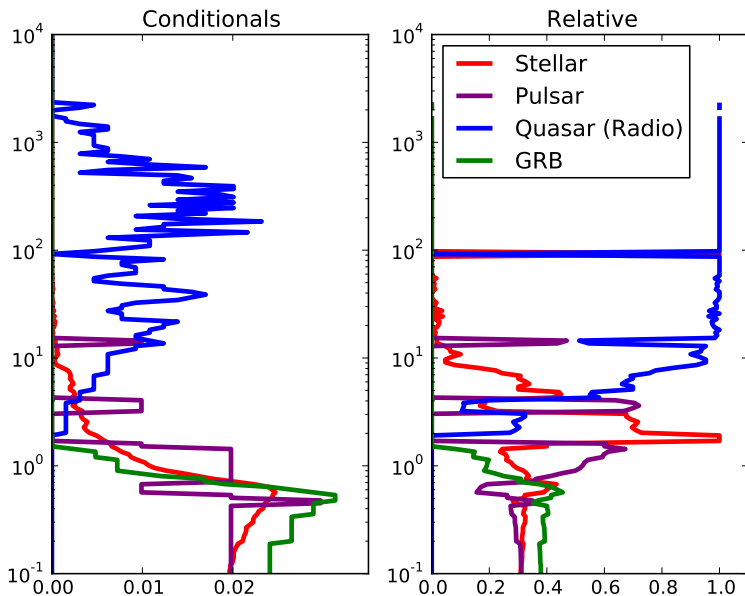
Pulsar

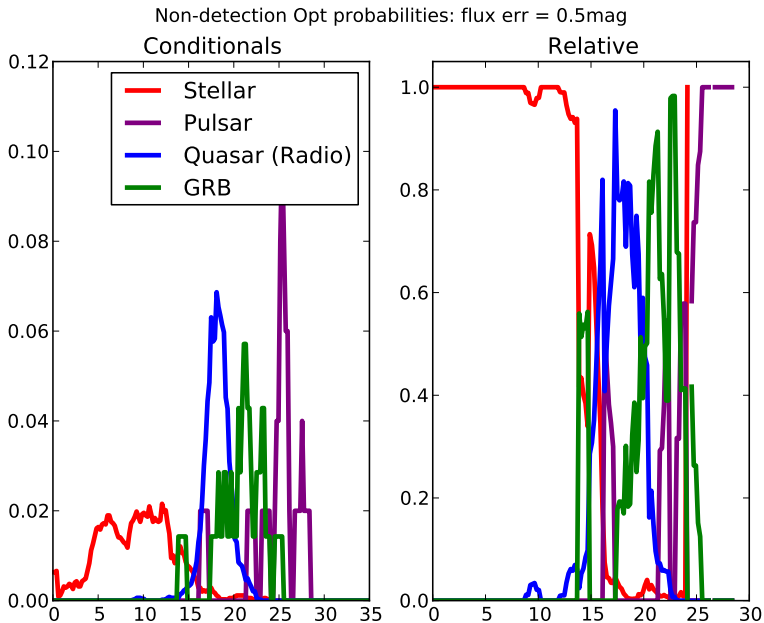


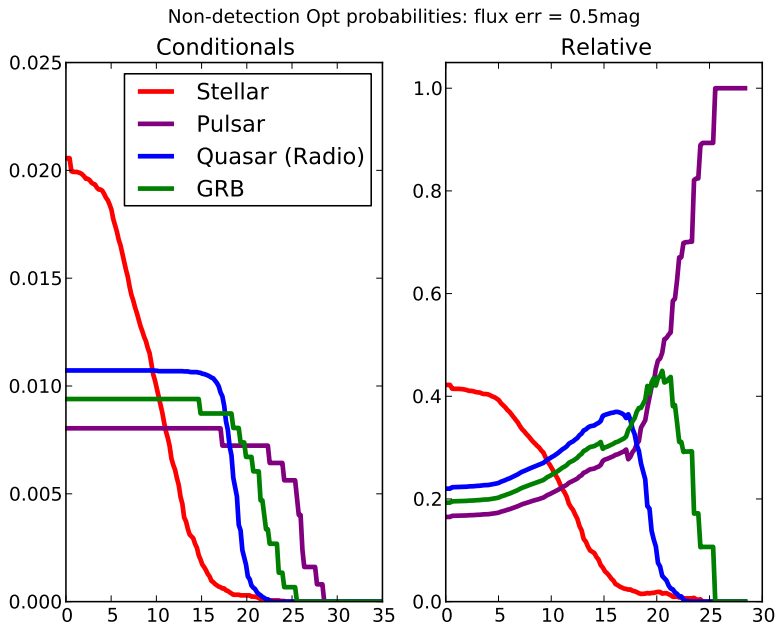
Combined Stellar, GRB, Quasar (Radio), Pulsar



Radio probabilities: flux err = 0.5mJy







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- ▶ Open source VOEvent tools are here, **now**. Do what you want with them.

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- ▶ Political will and manpower may be the limiting factors? (cf. eStar)

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- ▶ The rise of the robots will likely be a slow and progressive one.
- ▶ Political will and manpower may be the limiting factors? (cf. eStar)
- ▶ If you have experience in schedulers I'd like to hear the gritty details.