Training your astronomy robots to work as a team

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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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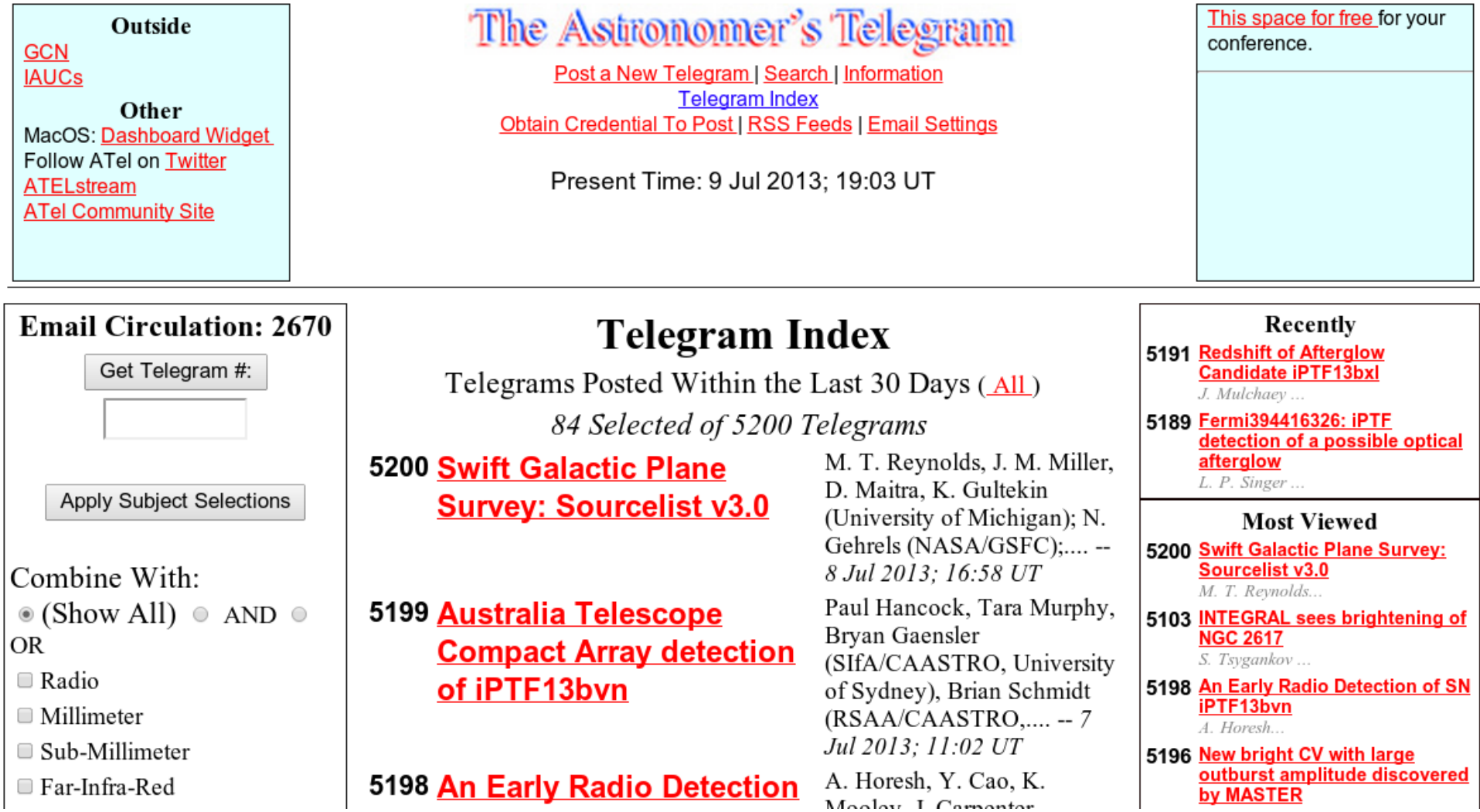
The astronomer’s telegram



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- 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

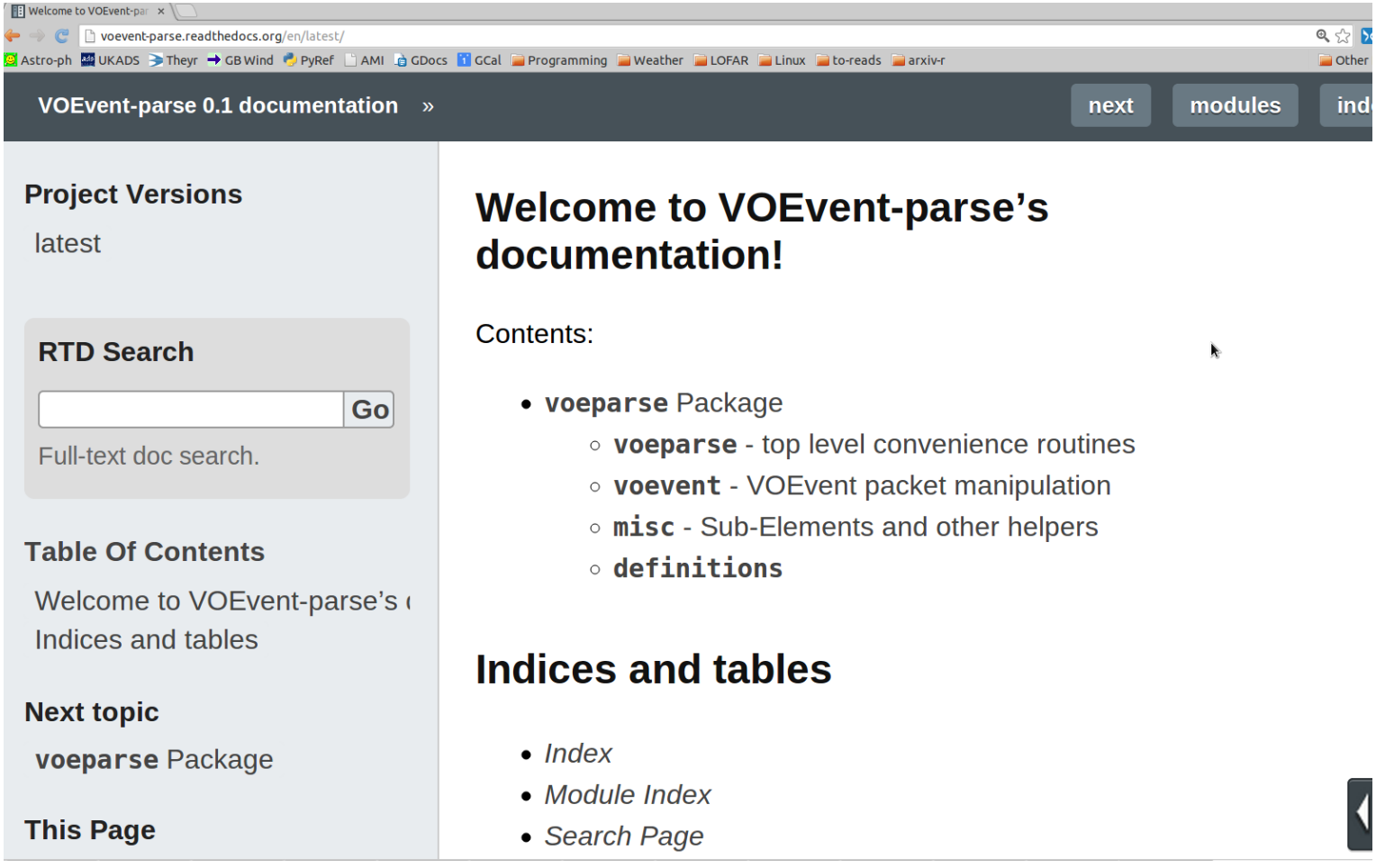
- A super-lightweight python wrapper / library built on lxml.
- **https://github.com/timstaley/voevent-parse**
- **pip install voevent-parse**

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/



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?).

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

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- 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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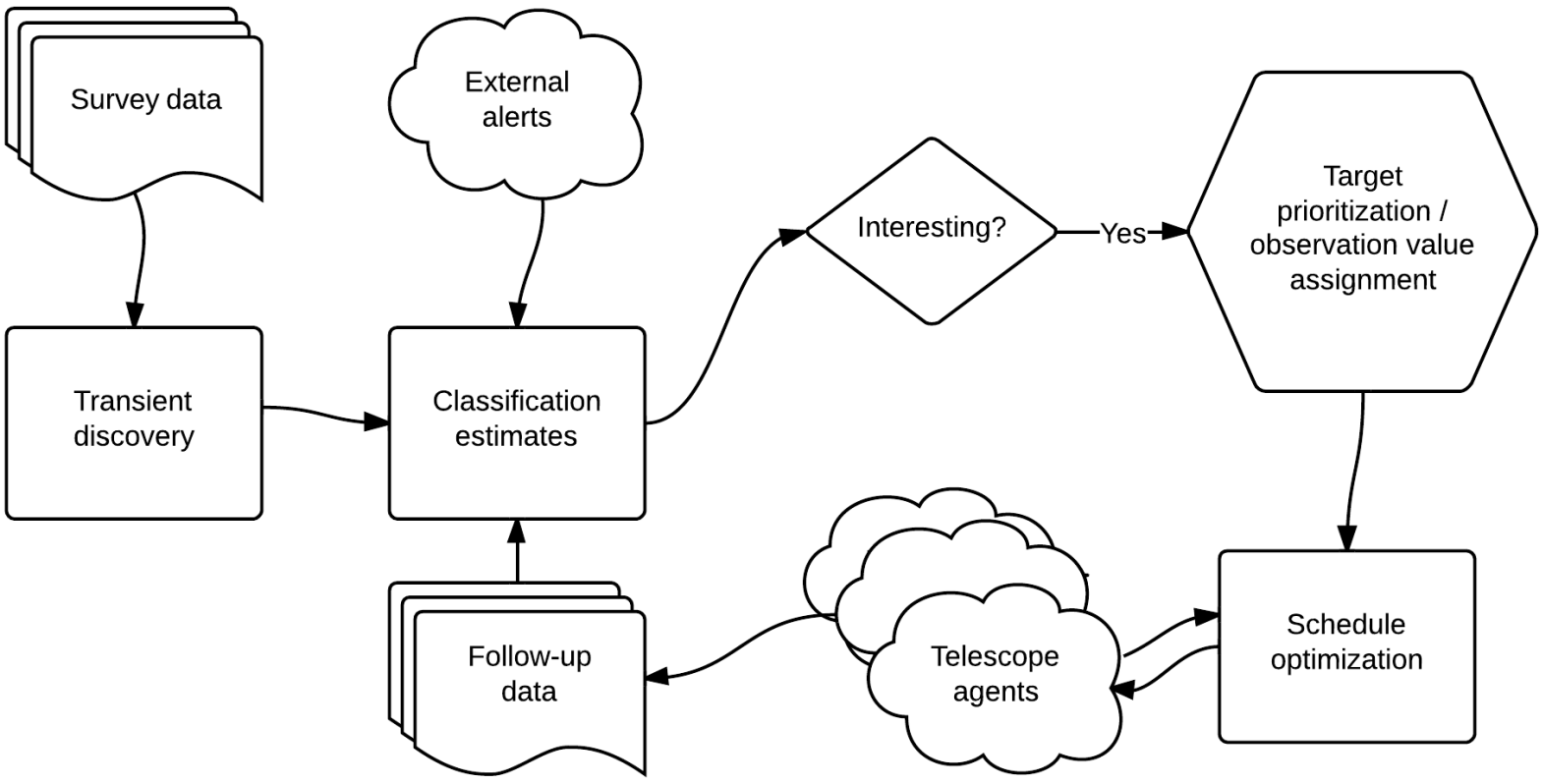
Negotiation is hard

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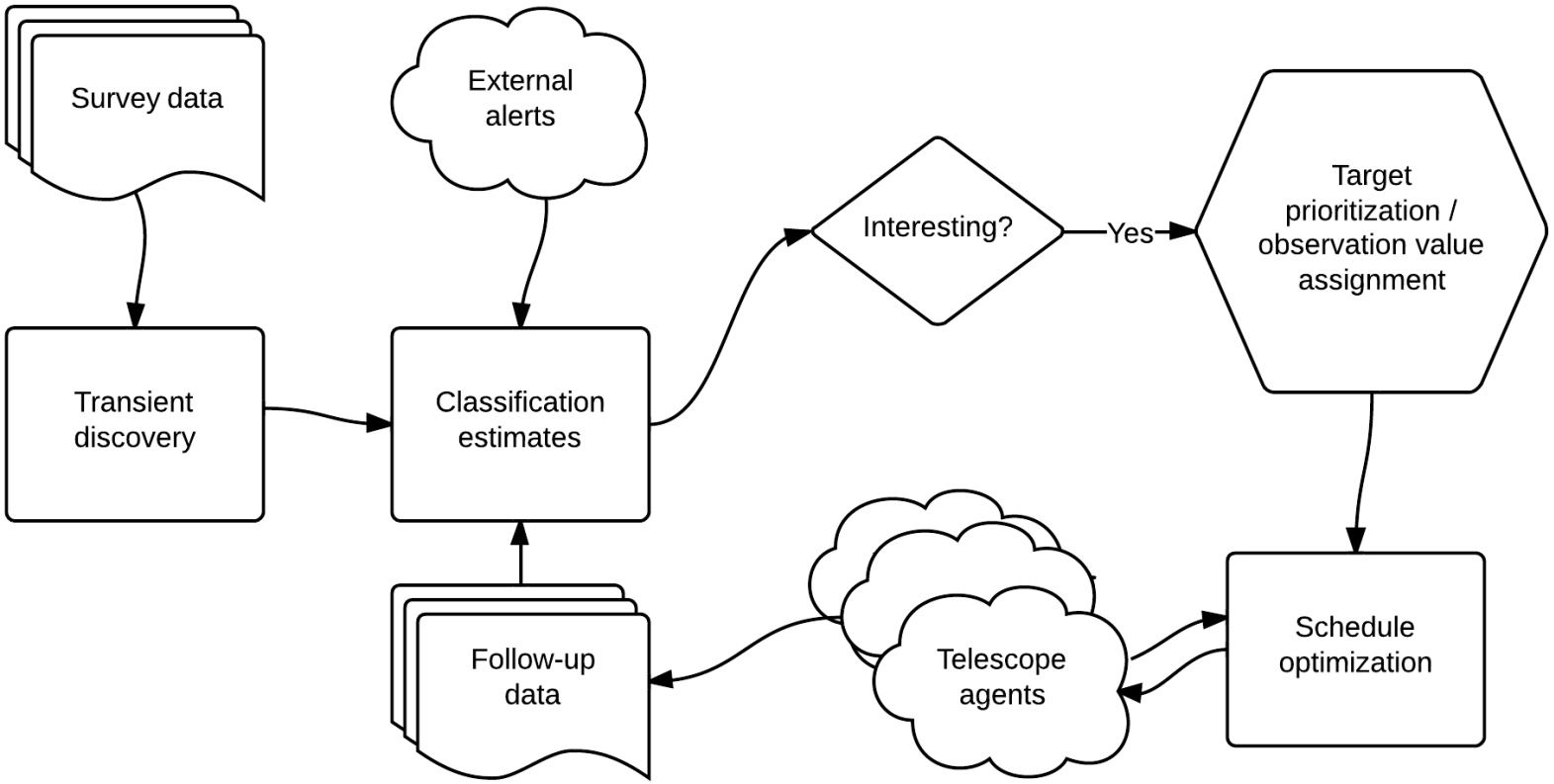
- Large collaboration
- Scheduling: E. Saunders (small world)
- Currently being deployed

One block is missing



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Science value

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Science value

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How do we assign a science value — when we don’t know what it is yet?

Guessing at science value

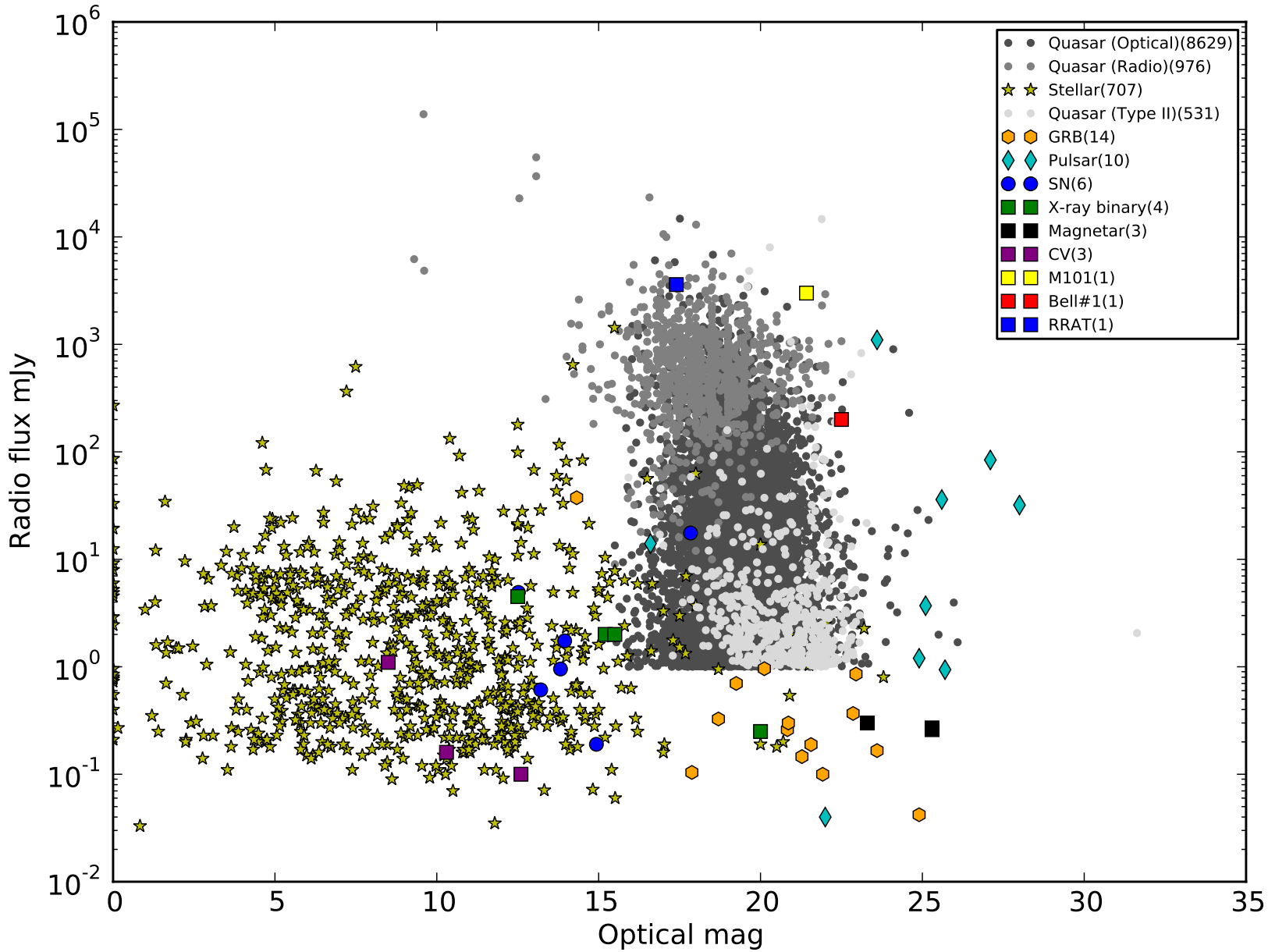
- Suppose we have a tentative set of classification probabilities.
- Choose follow-up observations with best chance of refining probabilities.
- Assign expected science values to transients based on those **potential** outcomes.
- Hence, assign science value to planned observations, feed to scheduler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

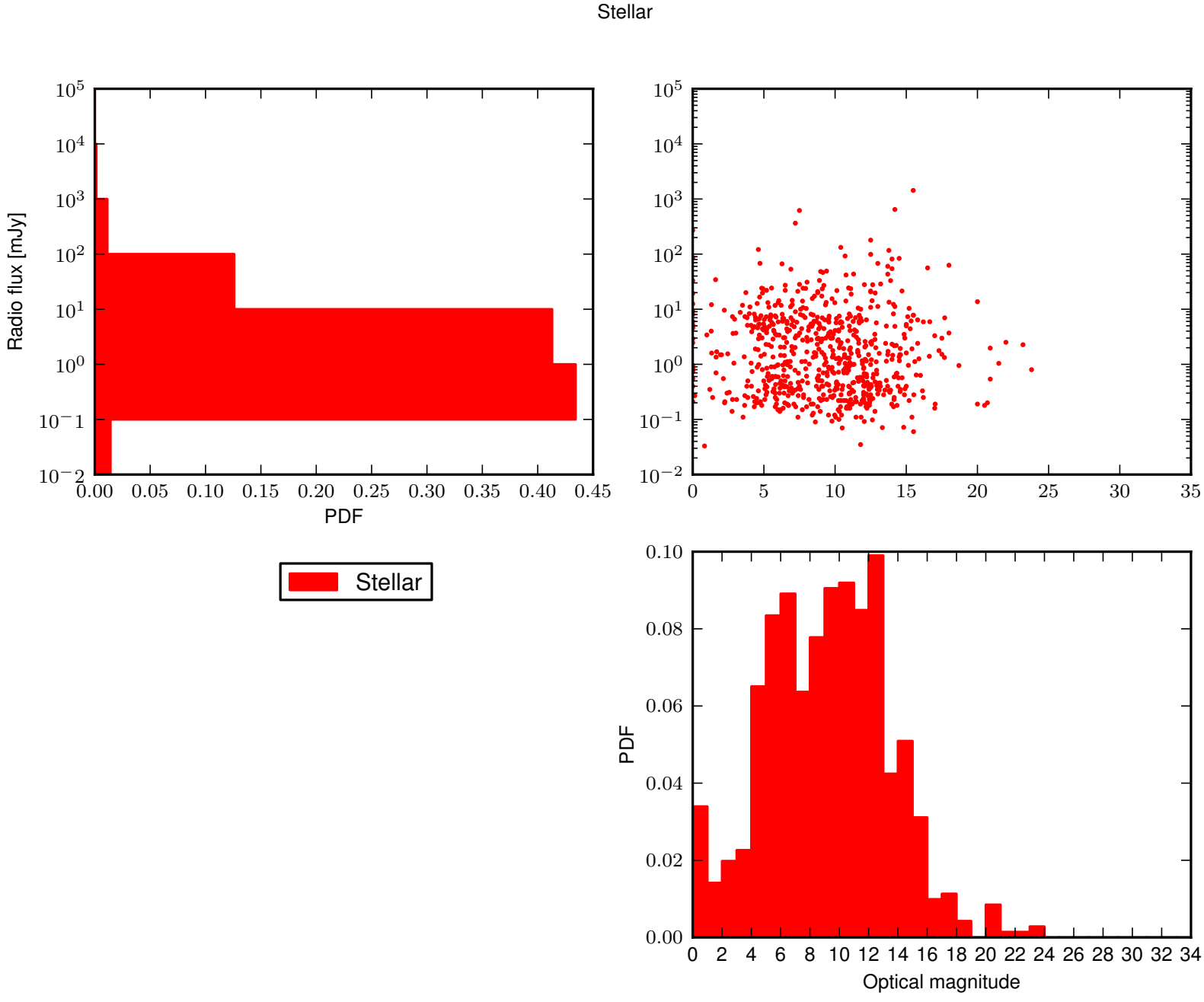
Representing information gain

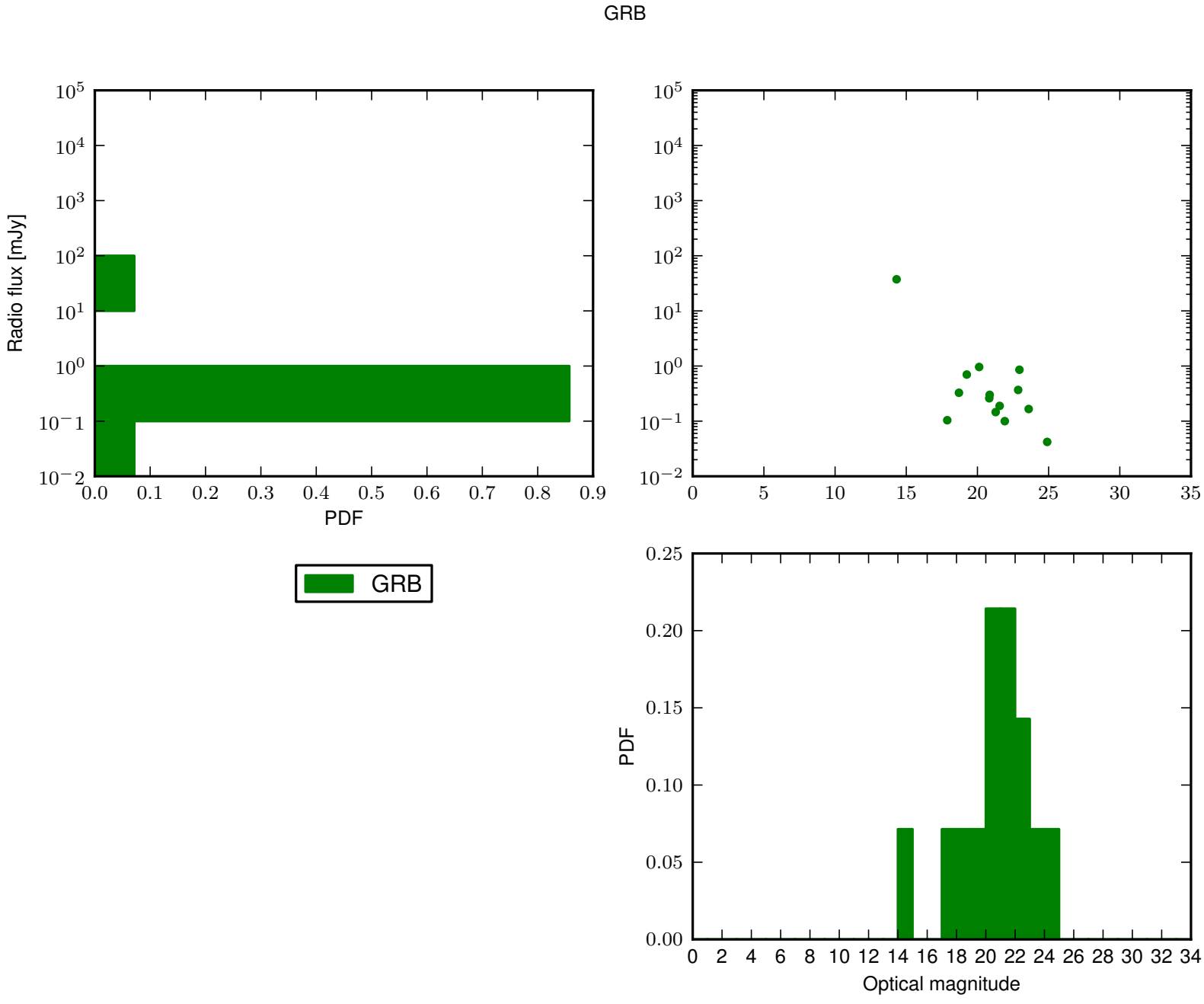
Assign ‘confusion matrices’ to a given observation.
. . . and the rest is ‘just’ computer science (hopefully).

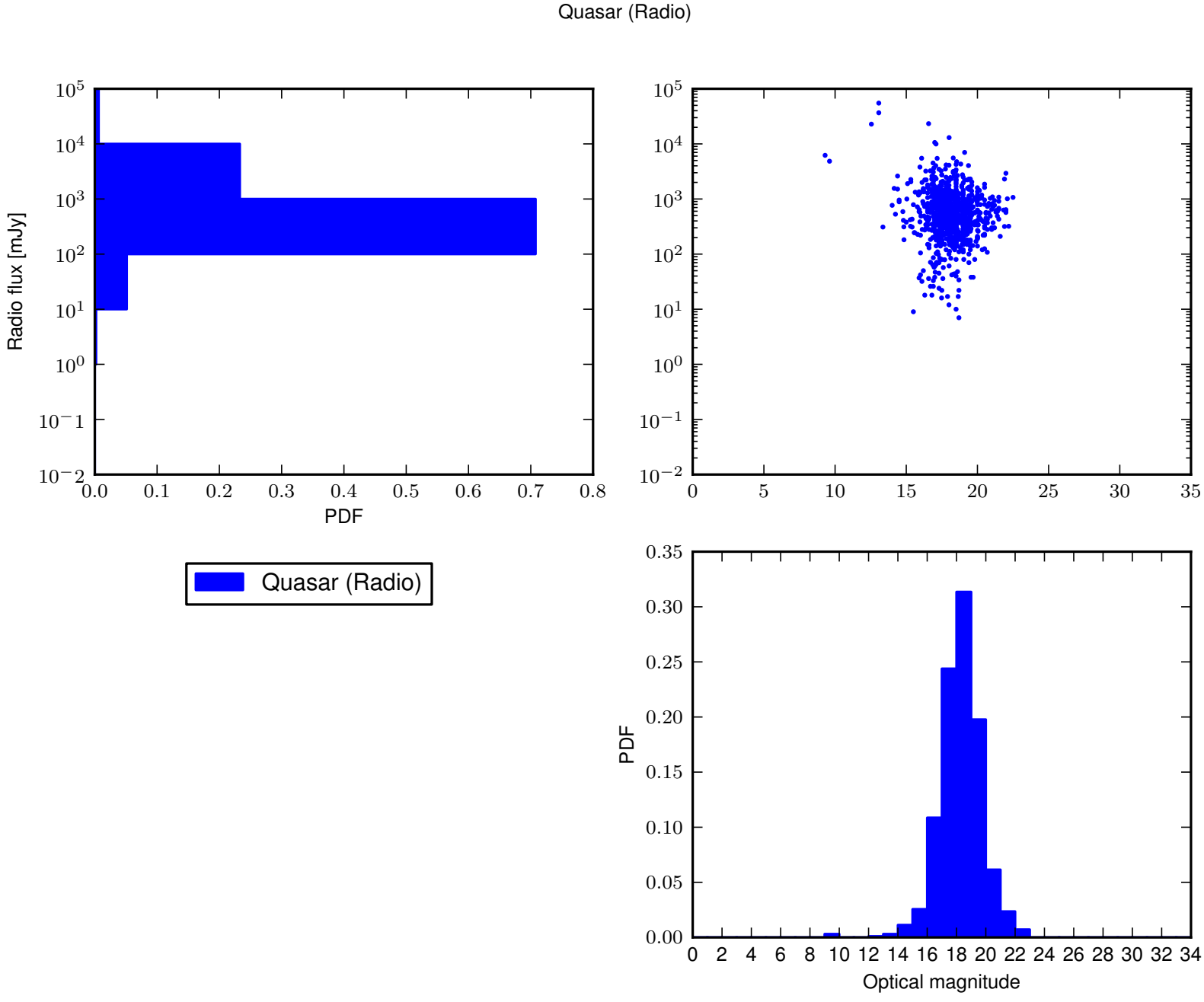
Need to determine e.g. how well an optical observation separates classes.

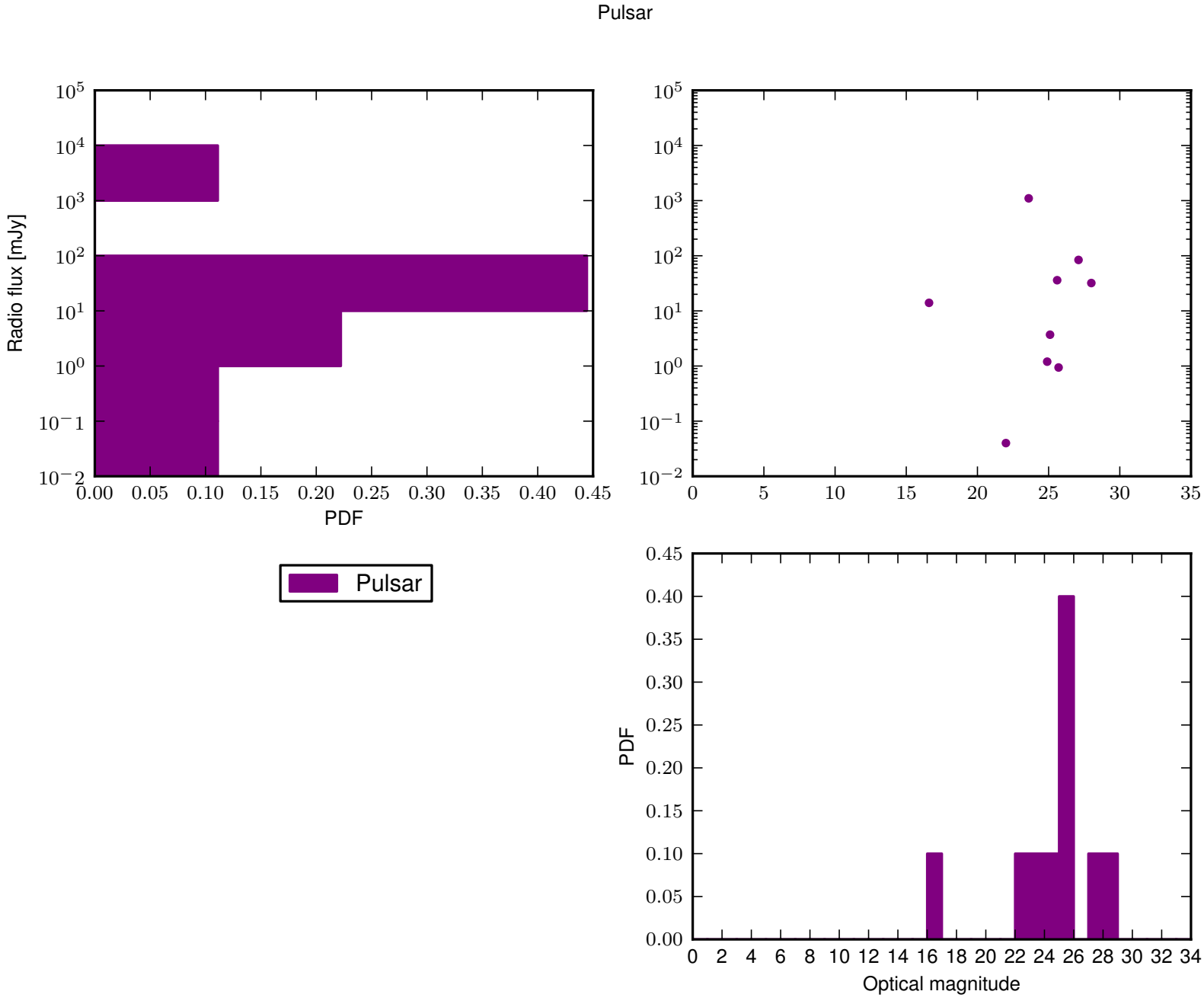
Start with the training data

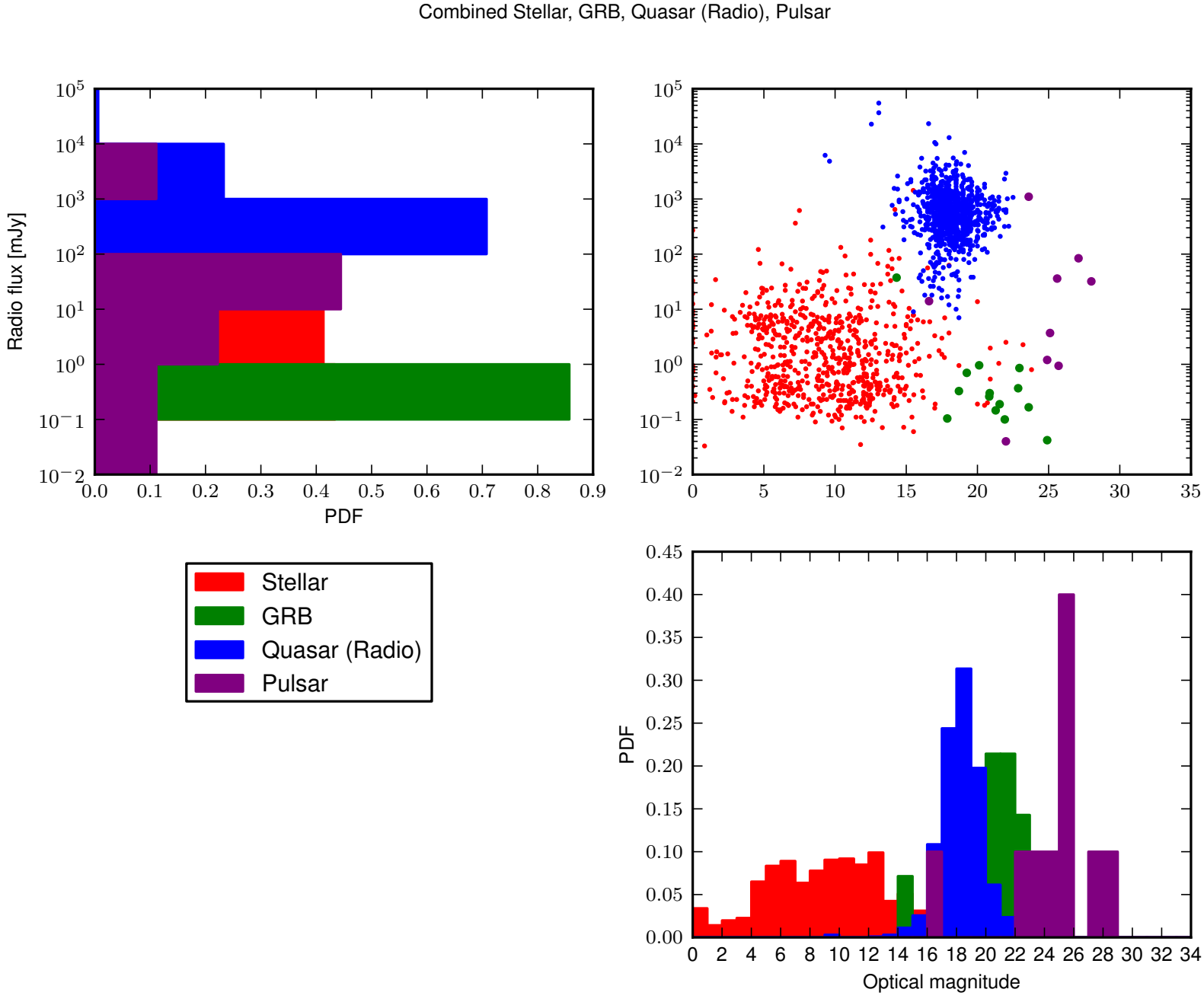


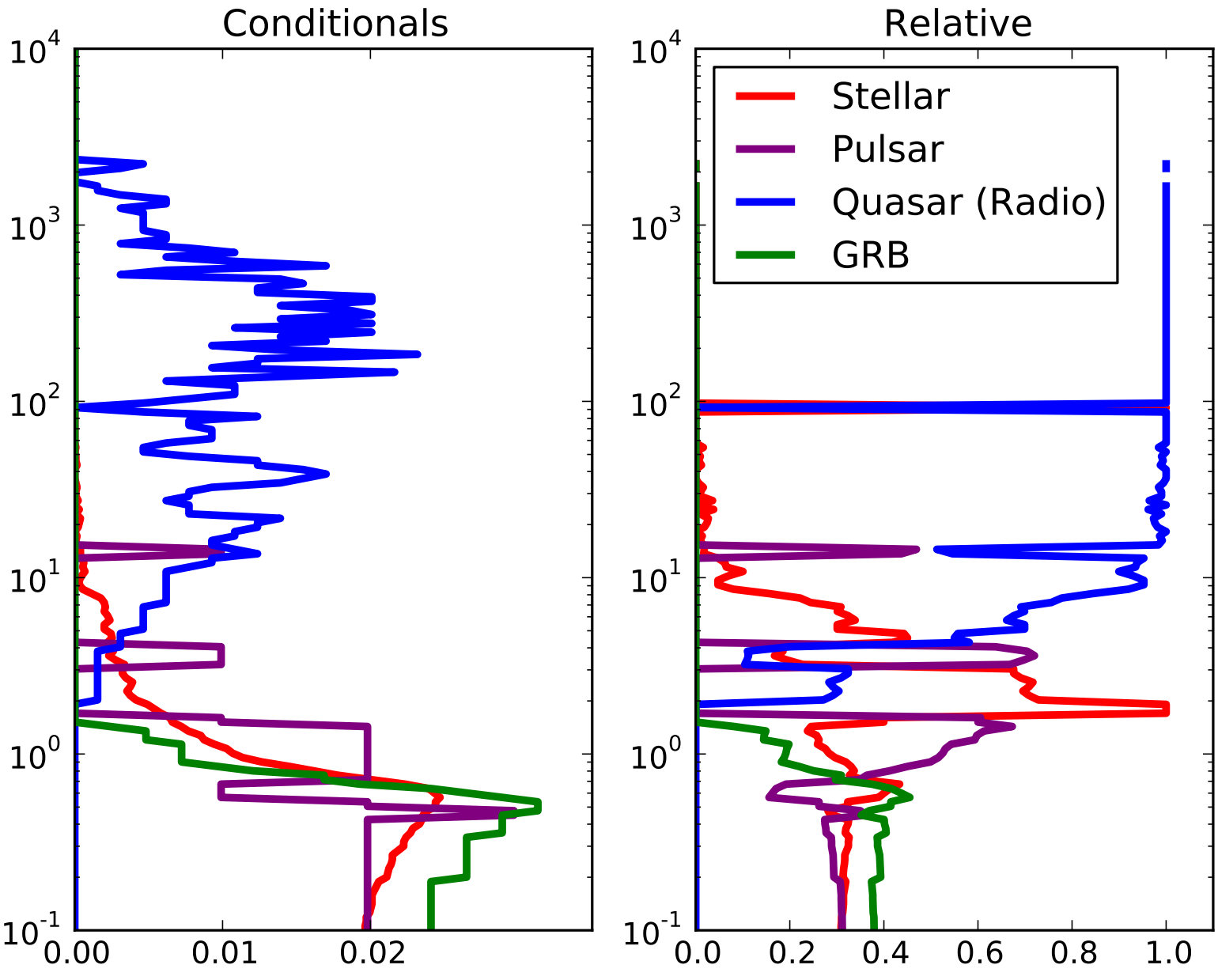

Stellar
Radio flux [mJy]
PDF
Stellar
PDF
Optical magnitude

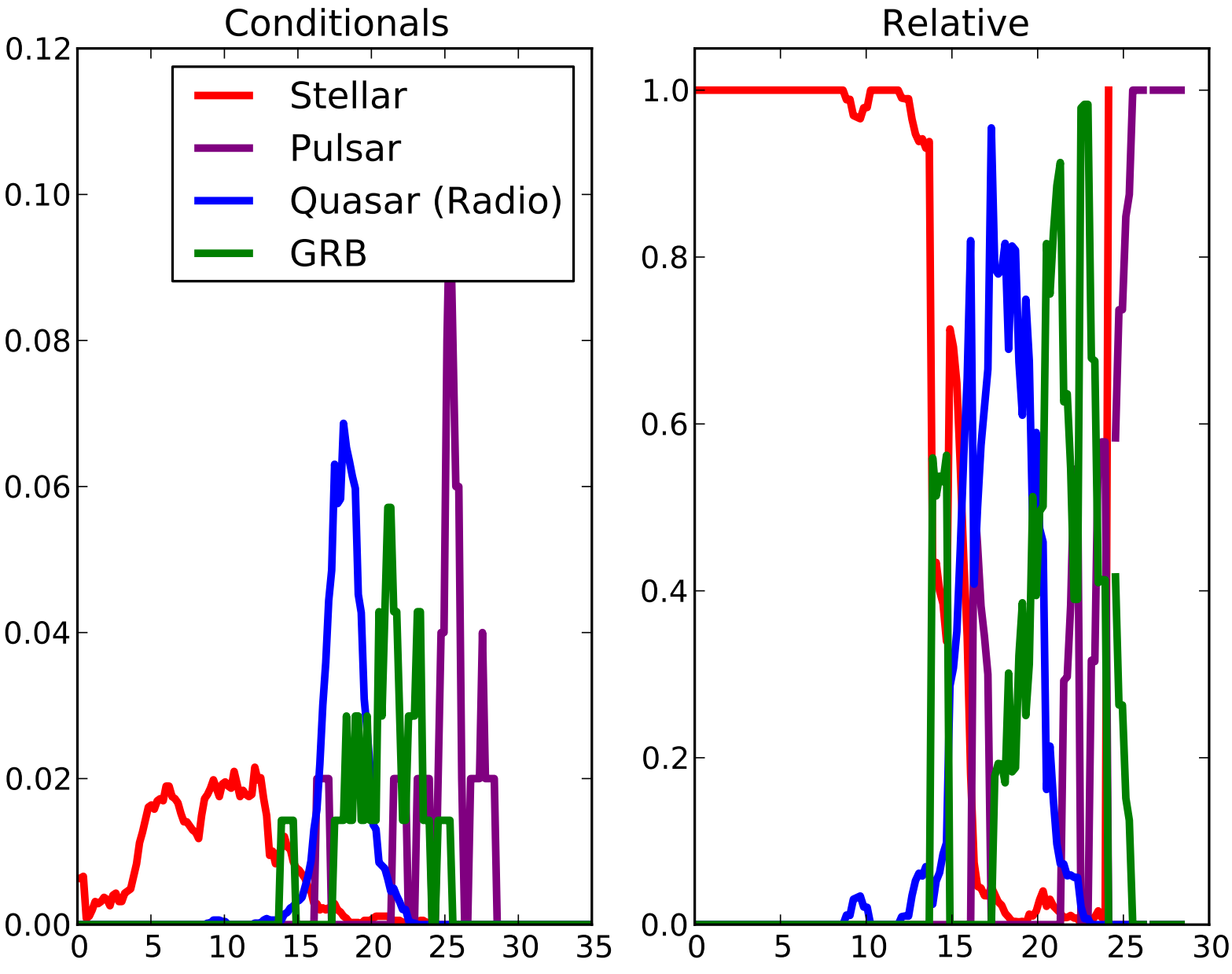

GRB
Radio flux [mJy]
PDF
GRB
PDF
Optical magnitude

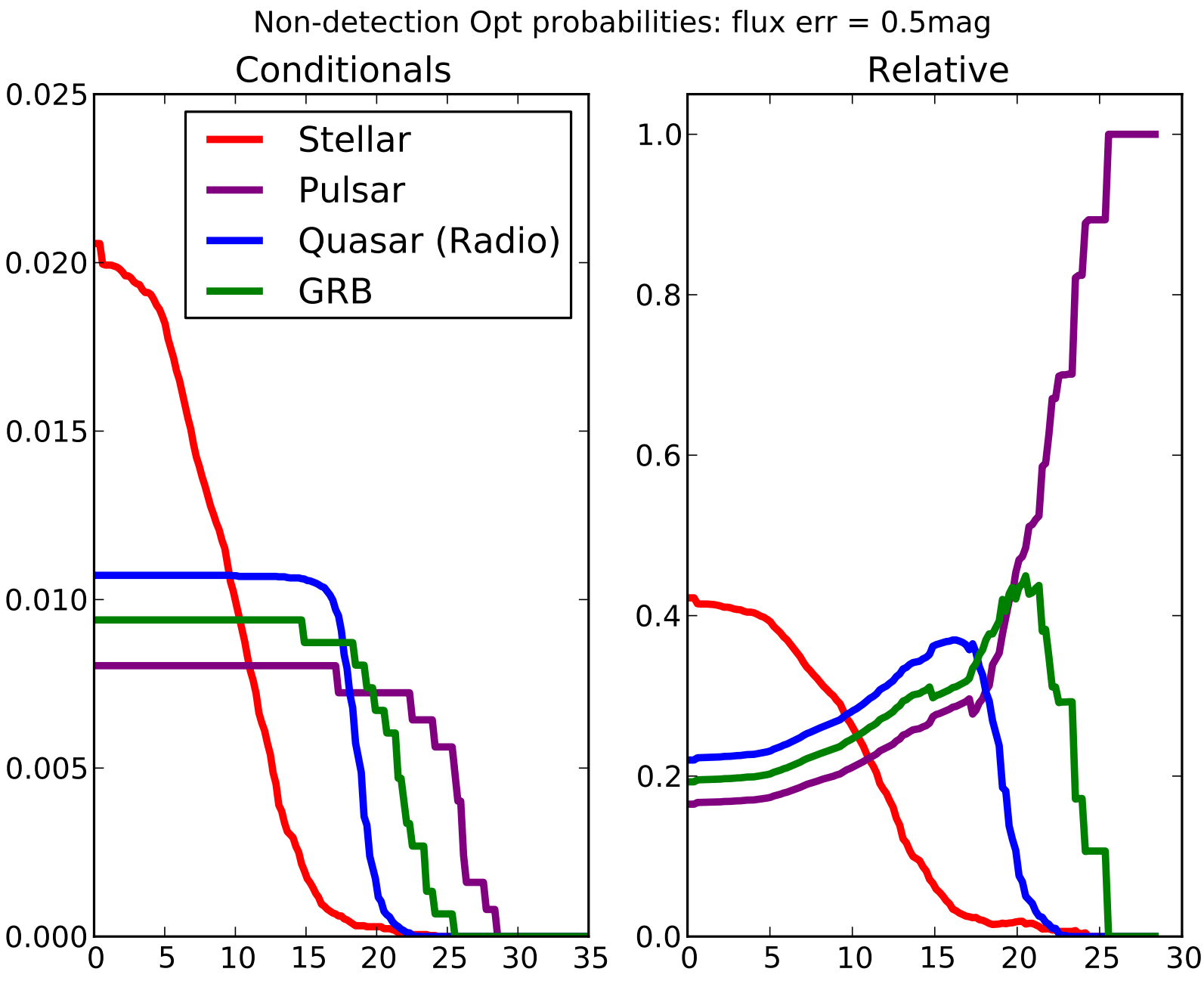

Quasar (Radio)
Radio flux [mJy]
PDF
Quasar (Radio)
PDF
Optical magnitude


Pulsar
Radio flux [mJy]
PDF
Pulsar
PDF
Optical magnitude


Combined Stellar, GRB, Quasar (Radio), Pulsar
Radio flux [mJy]
PDF
Stellar
GRB
Quasar (Radio)
Pulsar
PDF
Optical magnitude


Radio probabilities: flux err = 0.5mJy
Conditionals
Relative
Stellar
Pulsar
Quasar (Radio)
GRB
10^4
10^3
10^2
10^1
10^0
10^{-1}
0.00
0.01
0.02
0.0
0.2
0.4
0.6
0.8
1.0


Non-detection Opt probabilities: flux err = 0.5mag
Conditionals
Relative
Stellar
Pulsar
Quasar (Radio)
GRB
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35


Non-detection Opt probabilities: flux err = 0.5mag
Conditionals
Relative
Stellar
Pulsar
Quasar (Radio)
GRB
0.025
0.020
0.015
0.010
0.005
0.000
0
5
10
15
20
25
30
35
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30

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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.