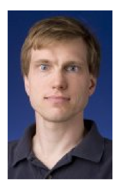
ObsTac: automated execution of the Dark Energy Survey



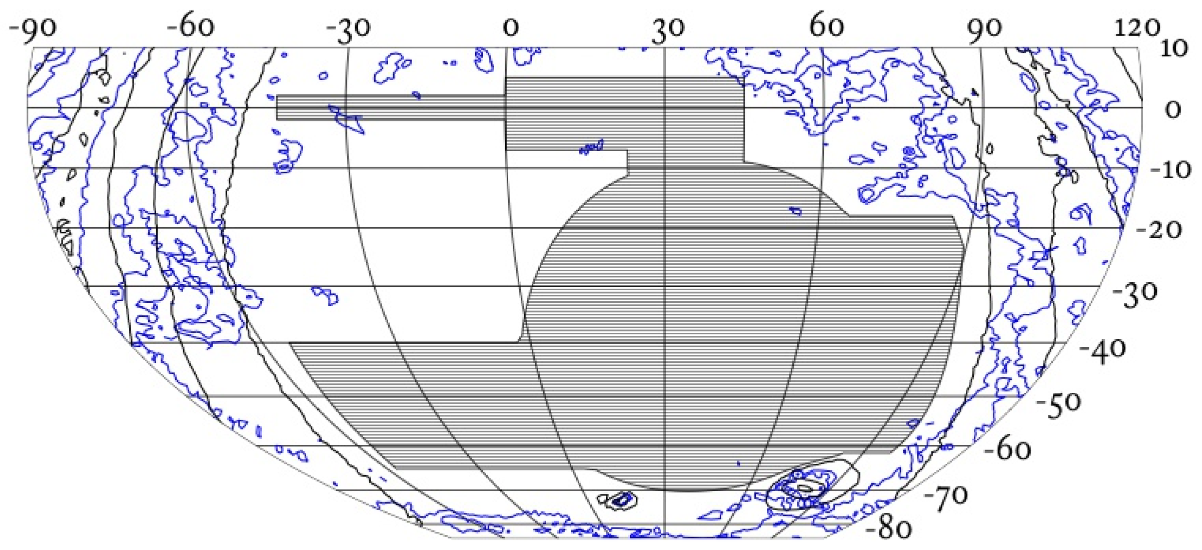
Eric H. Neilsen, Jr.
Fermi National Accelerator Laboratory
http://home.fnal.gov/~neilsen
neilsen@fnal.gov

James Annis
Fermi National Accelerator Laboratory
http://home.fnal.gov/~annis/
annis@fnal.gov

The Dark Energy Survey (DES) is an astronomical survey being taken with DECam, a new 2.2° wide field of view camera on the 4-m Victor Blanco telescope at the Cerro Tololo Inter-American Observatory. The survey is designed to measure the dark energy equation of state parameters using four methods, requiring two sets of data.

ObsTac selects the exposures to be completed at any given time, reacting dynamically to achieved progress and observing conditions.

DES Wide Survey Footprint



The blue contours mark the extinction from Schlegel et al. (1998ApJ...500..525S).
The black contours mark the stellar density from NOMAD (2004AAS...205.4815Z).

Data Sets

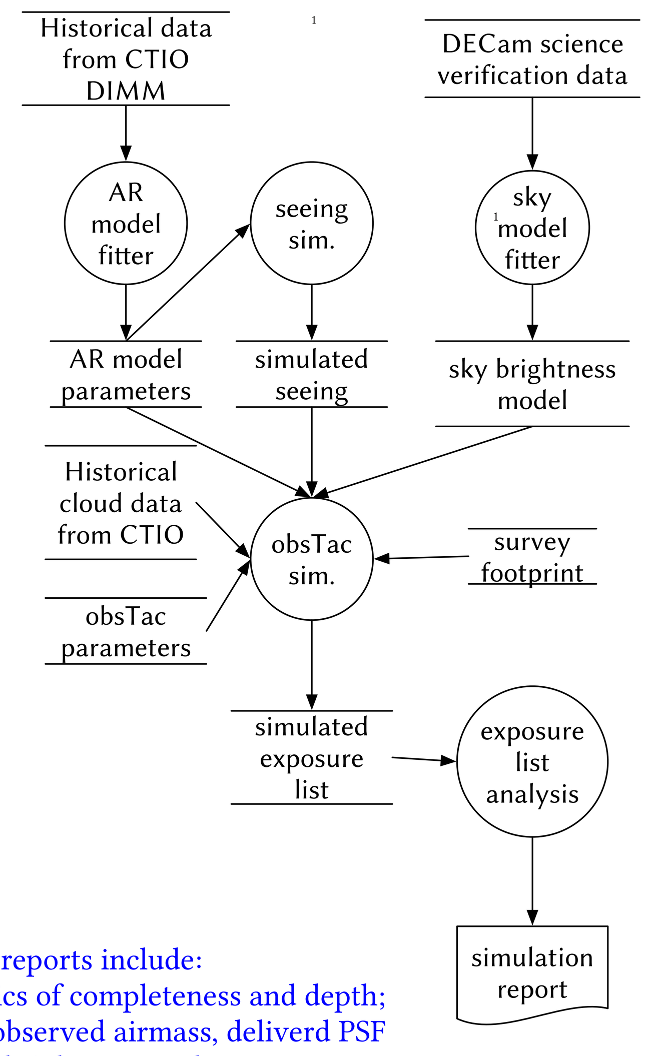
Data set	Coverage	Filters	Tilings	Method
wide-survey	5000 square degrees	g, r, i, z, Y	10 over 5 years	Baryon Acoustic Oscillations galaxy clusters weak lensing
time-domain	10 pointings	g, r, i, z	approx. weekly	type Ia supernova

ObsTac in simulation

An auto-regressive (AR) model is a generalization of a random walk: values at a given time step are considered to be a weighted mean of values at several previous times, the global mean, and a random value. See Neilsen 2012 (2012ASPC..461..201N) for more details on obsTac seeing and sky brightness models.

Examples of obsTac configuration parameters explored through simulation include:

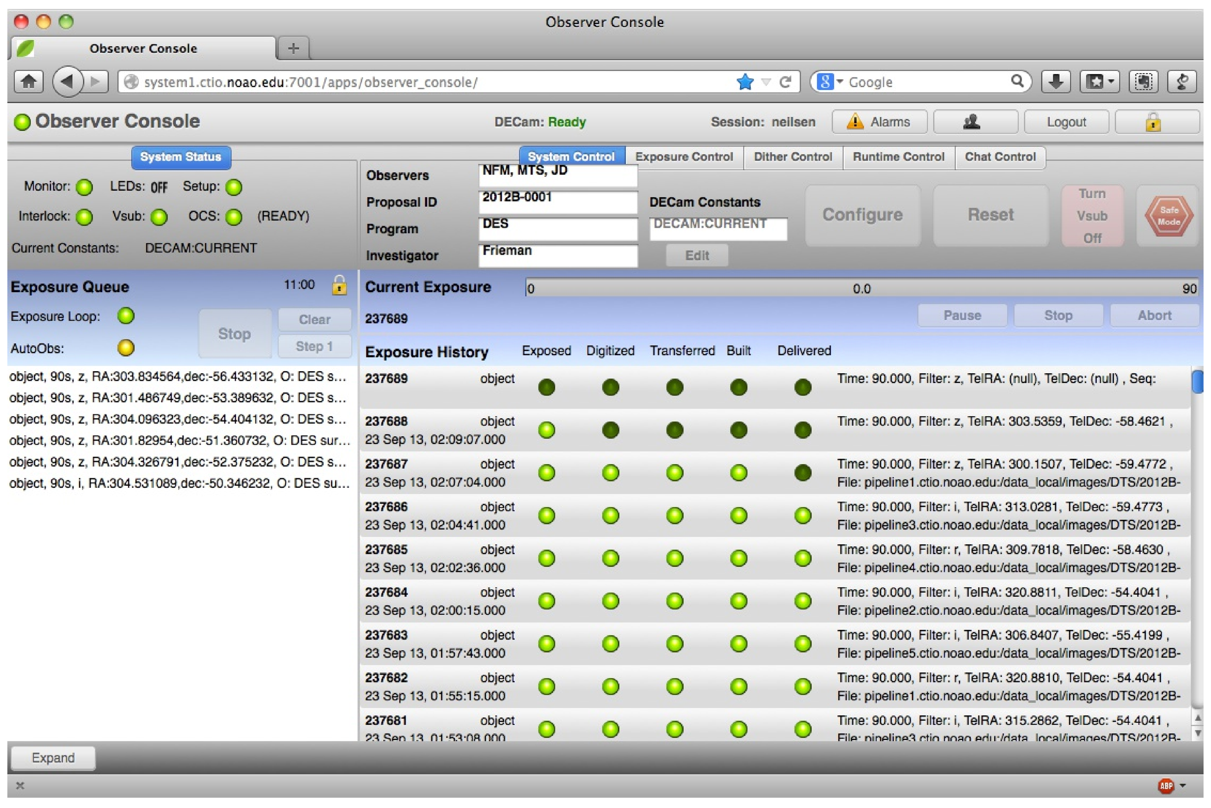
- limits on estimated seeing, sky brightness, and S/N for selection
- airmass limits
- time-domain observing windows
- limits on achieved seeing, sky brightness, S/N, and cloud-cover to avoid repeated attempts



ObsTac simulation reports include:

- maps and statistics of completeness and depth;
- distributions of observed airmass, deliverd PSF FWHM, and sky brightness; and
- time-domain sequence cadence plots and statistics.

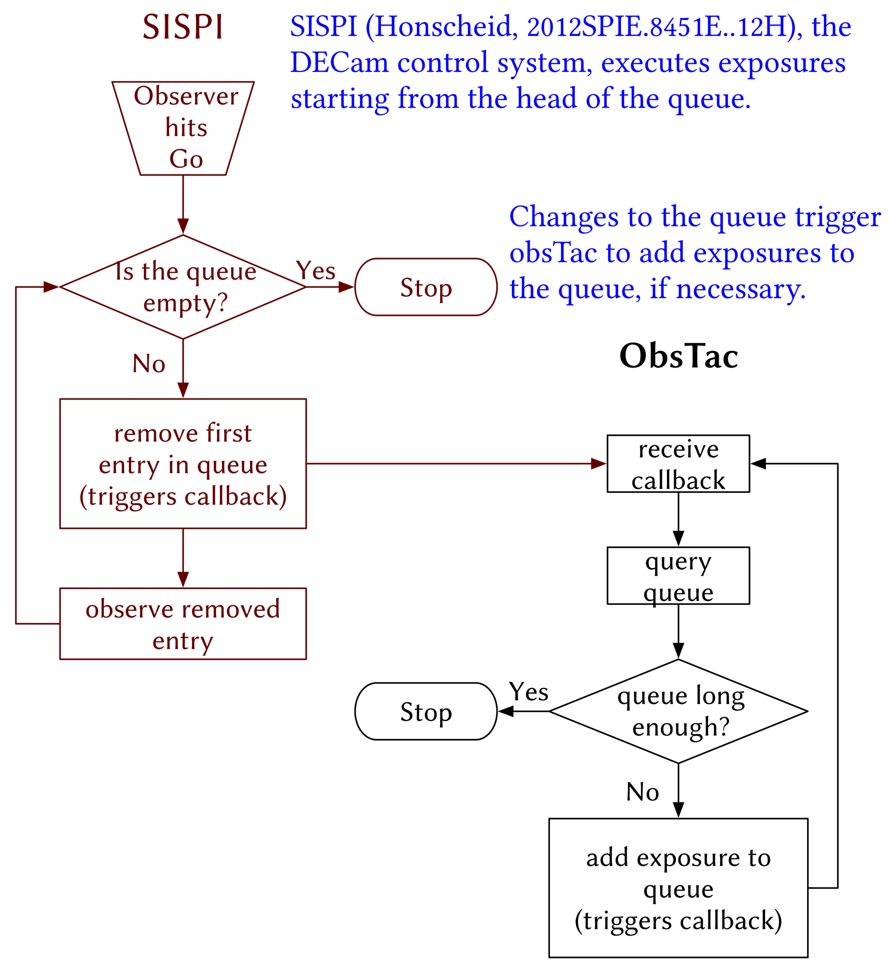
Observing with ObsTac



The SISPI user interface provides displays and controls for human observers to examine and edit the observing queue.
Although it isn't shown on the flow-chart, human-initiated changes to the queue also trigger the obsTac callback.

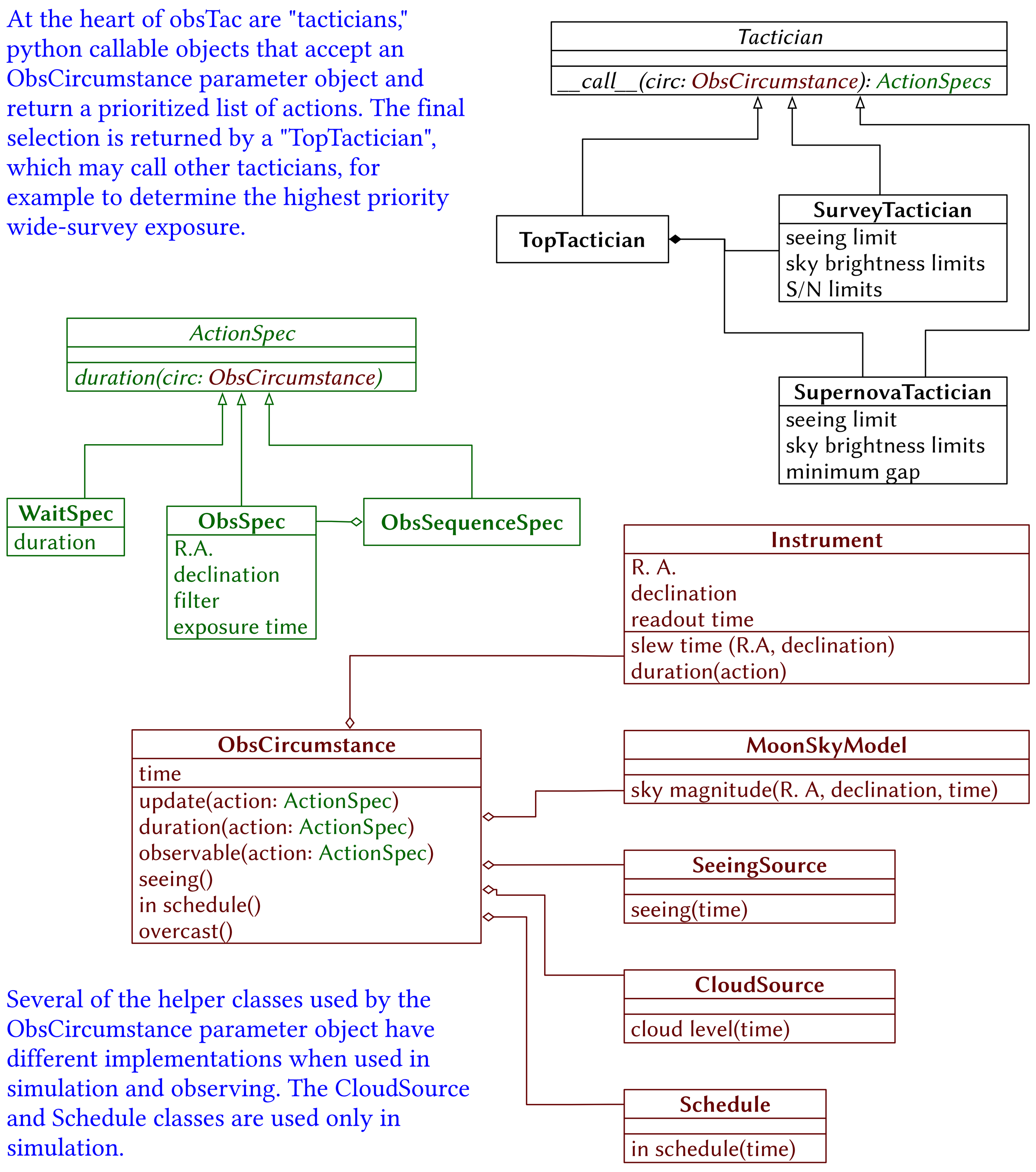
SISPI (Honscheid, 2012SPIE.8451E..12H), the DECam control system, executes exposures starting from the head of the queue.

Changes to the queue trigger obsTac to add exposures to the queue, if necessary.



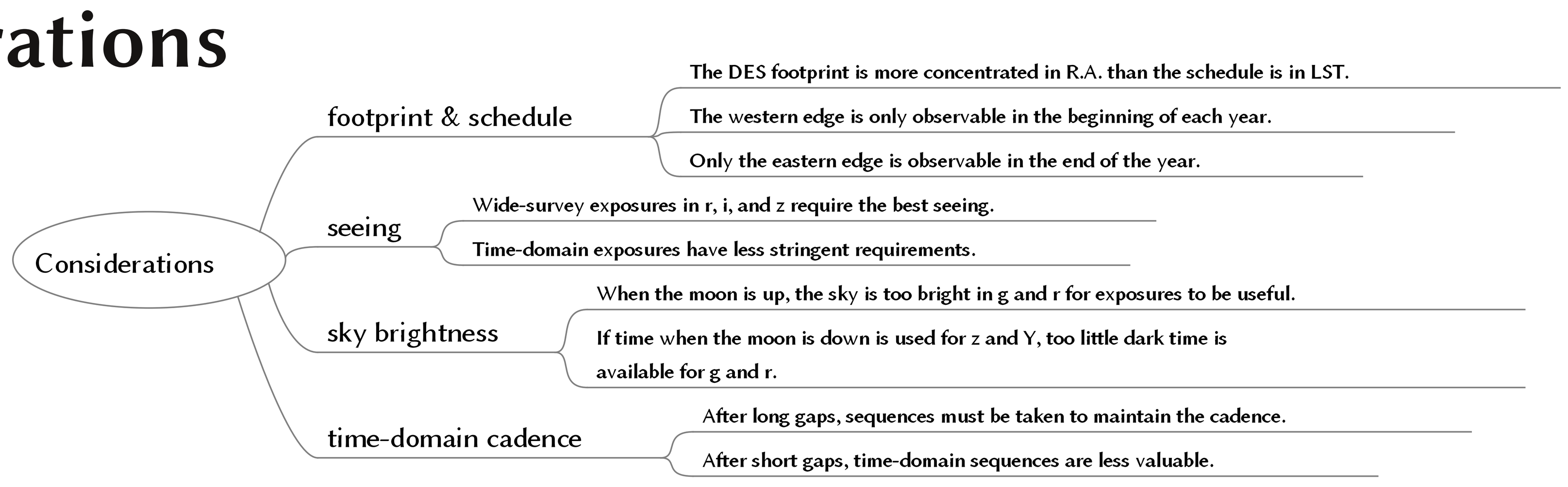
Internal architecture

At the heart of obsTac are "tacticians," python callable objects that accept an ObsCircumstance parameter object and return a prioritized list of actions. The final selection is returned by a "TopTactician", which may call other tacticians, for example to determine the highest priority wide-survey exposure.



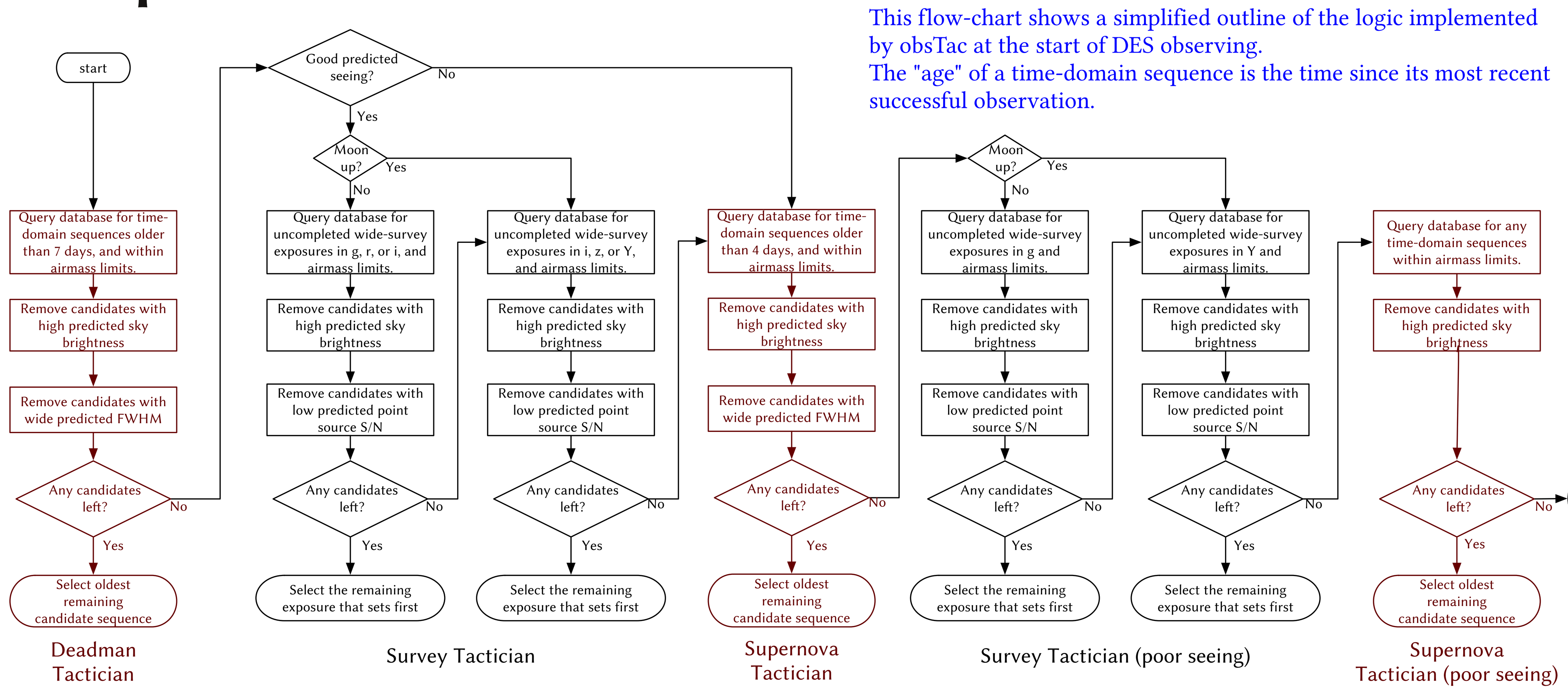
Several of the helper classes used by the ObsCircumstance parameter object have different implementations when used in simulation and observing. The CloudSource and Schedule classes are used only in simulation.

Considerations



Sample tactics

This flow-chart shows a simplified outline of the logic implemented by obsTac at the start of DES observing.
The "age" of a time-domain sequence is the time since its most recent successful observation.



Future work

ObsTac will be continually refined based an the progress made by the survey, new data on seeing and sky brightness statistics, and improved understanding of the impact of different data features on dark energy measurements.
Furthermore, additional aspects of observing may be automated by obsTac. A prime candidate for this is the observation of photometric standard stars, currently performed manually by the human observers.

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DARK ENERGY SURVEY