A Flight Decision Tool for DC3

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Outline

Introduction: Decision-making using statistical decision analysis

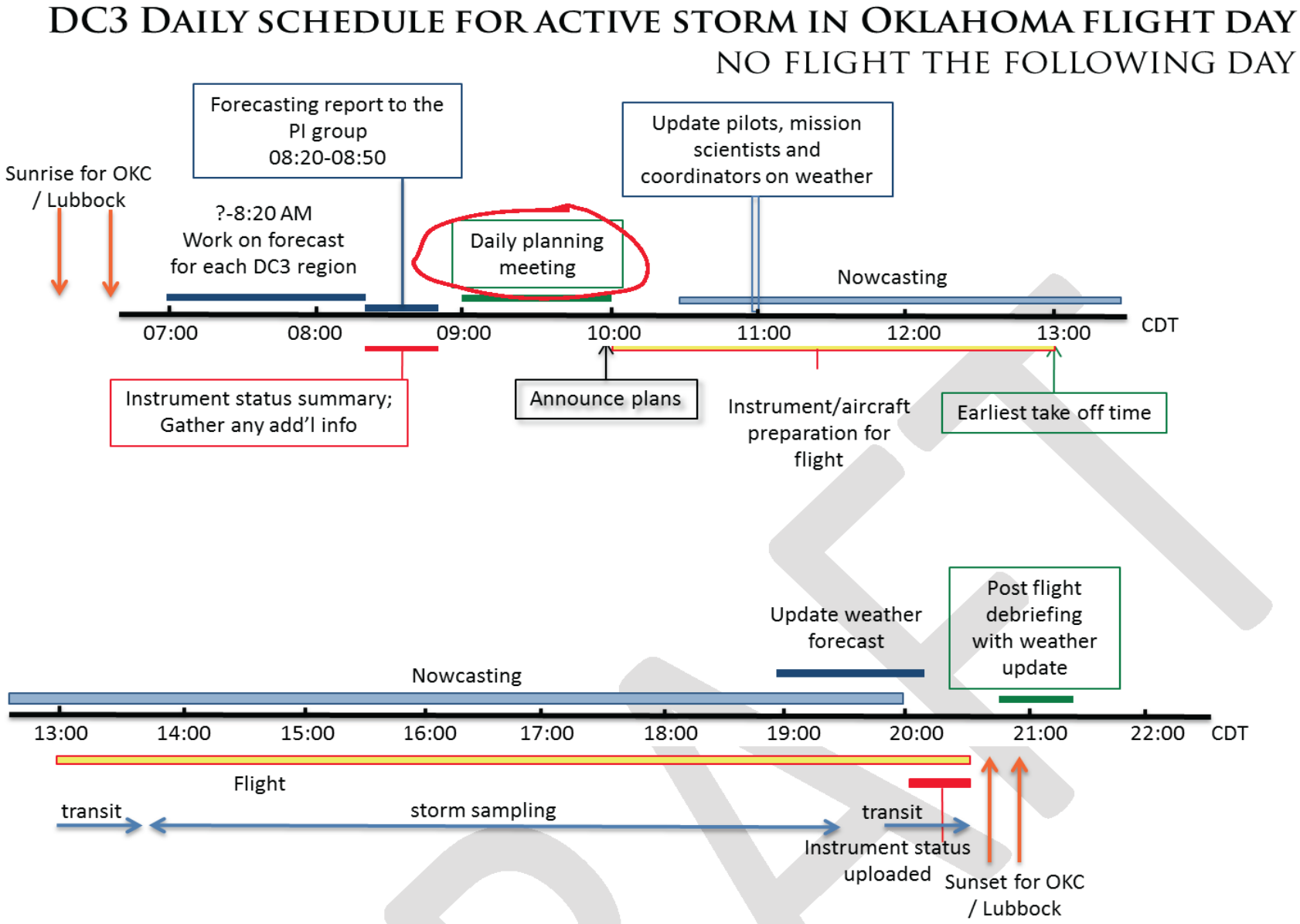
Example use case

First component: Algorithmic forecasting

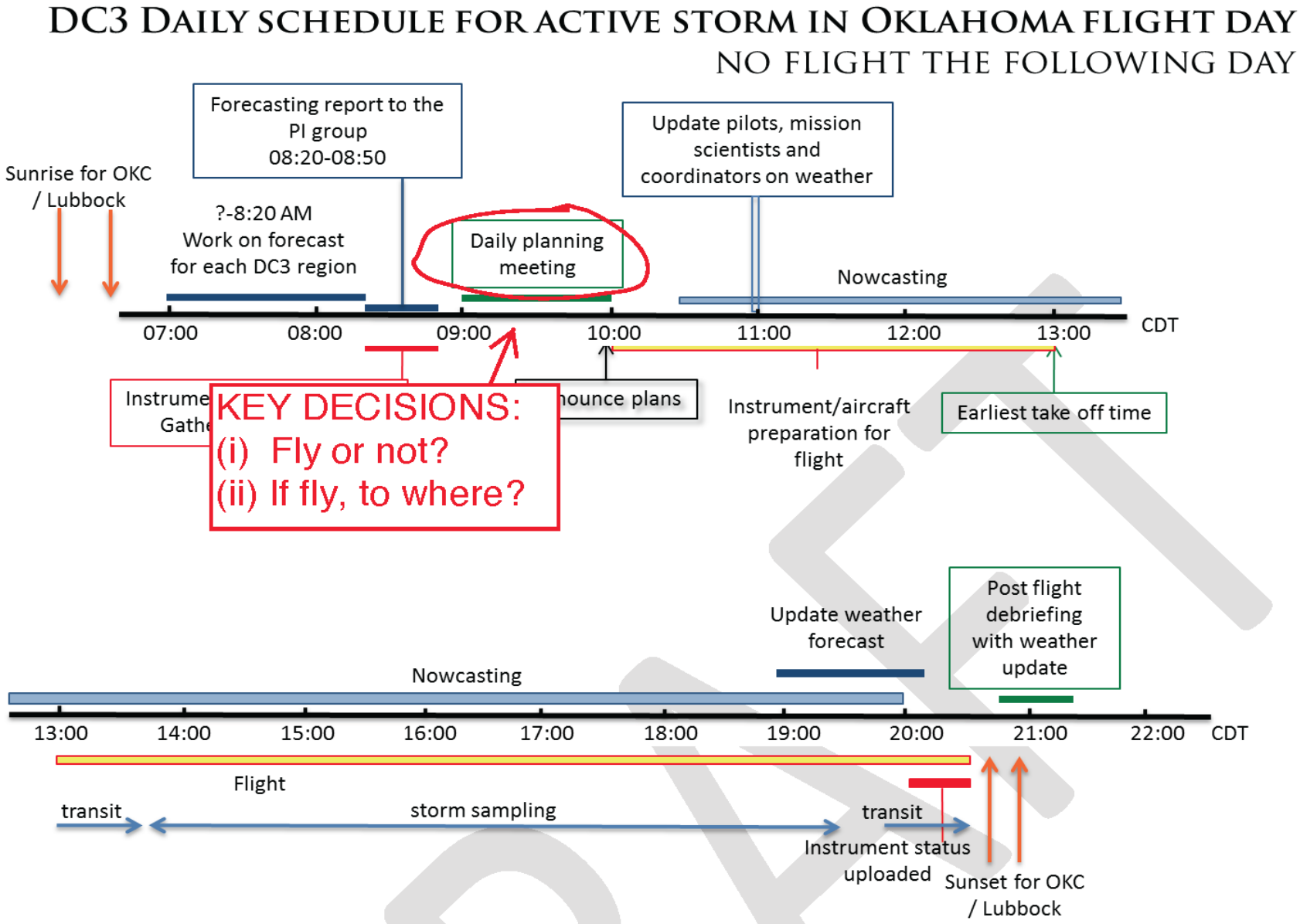
Second component: Optimization

Current status and next steps

Daily decision problem



Daily decision problem



Optimal decisions depends on several factors

Probabilities of suitable conditions:

- What is probability of good conditions today at CO, OK, AL?
- How likely that better conditions will emerge on future dates?

Investigators' goals:

- Are some locations more important than others?
- How important is *balance* in the data portfolio, with several days from each site?

Goal: Build an *algorithmic recommendation tool* to clarify stakes, illuminate trade-offs, suggest optimal actions.

Method: Statistical decision analysis: probabilistic forecasting + optimization

Example use case

Two days left in field season.

Eight flight hours (one flight) left.

Current score: CO 2, OK 0, AL 4

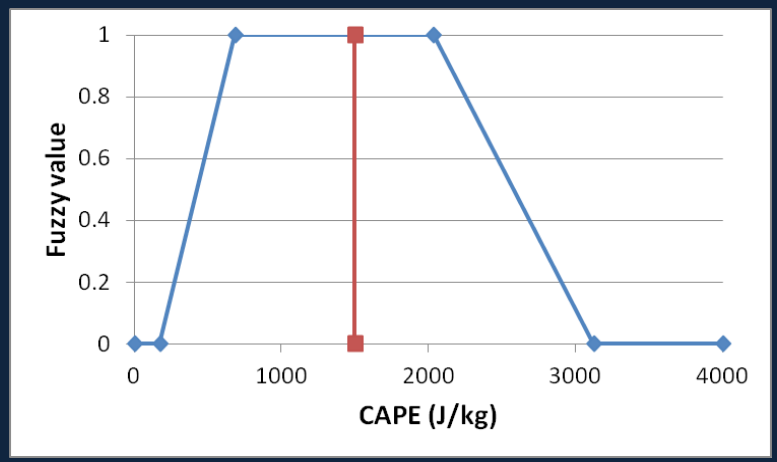
Success probabilities P_{CO}, P_{OK}, P_{AL} generated by algorithmic forecasting tool...

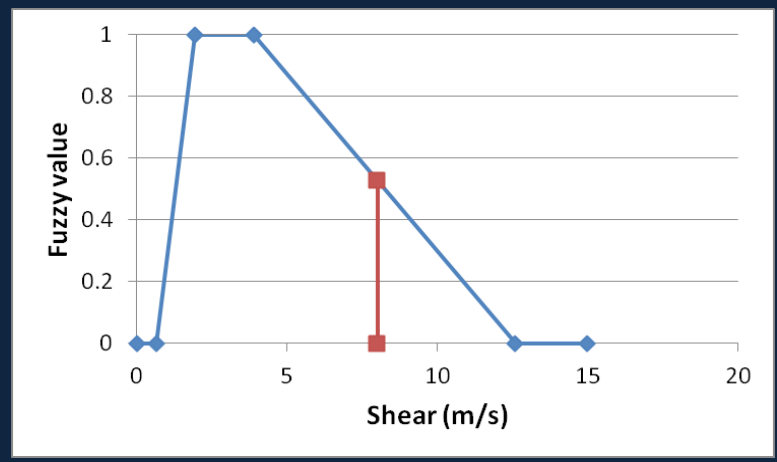
Forecast methodology

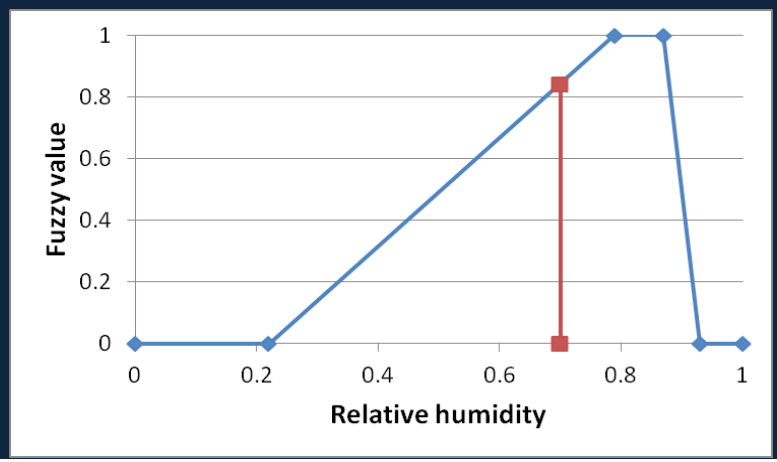
- Fuzzy Logic system predicts odds of suitable Wx
- WRF Predictors:
  - CAPE (region median)
  - 0-500m/0-6000m shear (region median)
  - $RH_{|700/500}$ (region median)
  - $W_{max|850/700}$ (region maximum)
- Predictors converted to values between 0 and 1 representing suitability
- Fuzzy Logic trapezoid tuned by Genetic Algorithm
- $P = \min(P_i)$ (other "and" operators possible)

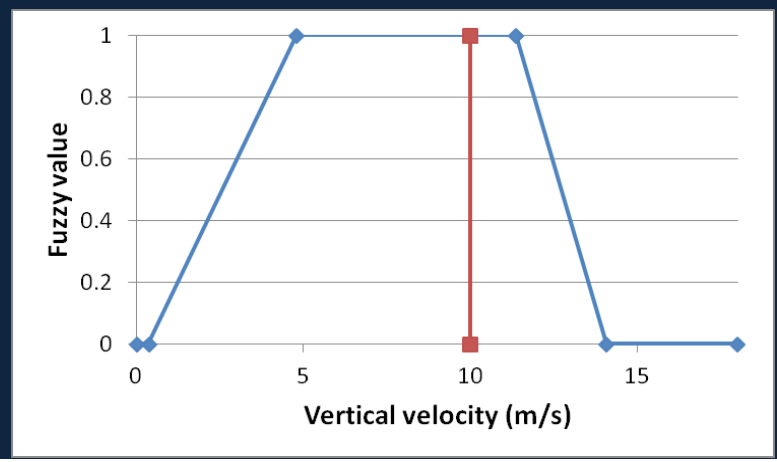
Fuzzy logic example

- OK Fx: median CAPE 1500 J/kg, median shear 8 m/s, median 700mb RH 70%, max 850mb w 10 m/s









Fuzzy logic example

- Fuzzy logic values:
  - CAPE: 1
  - Shear: 0.53
  - RH: 0.84
  - W: 1
- Pseudo-probability = min(values) = 0.53
- Use history of forecasts, verification to convert to conditional hourly forecast probability: 0.15

Example use case, continued

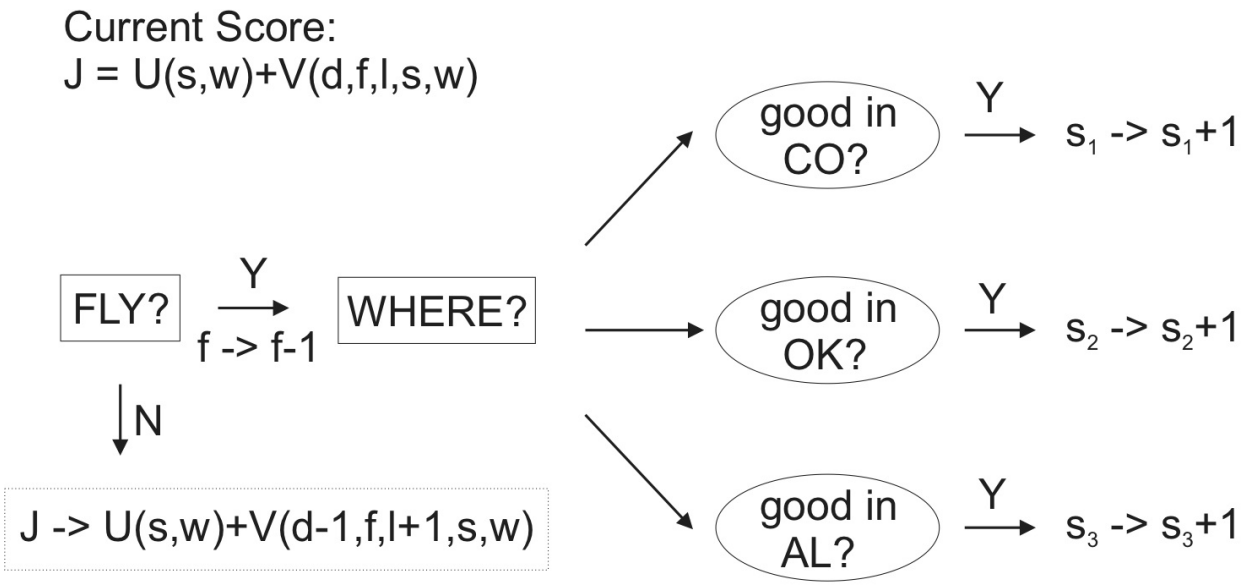
Two days left in field season.
Eight flight hours (one flight) left.
Current score: CO 2, OK 0, AL 4

Success probabilities P_{CO}, P_{OK}, P_{AL} generated by algorithmic forecasting tool: $P_{CO} = 0.5, P_{OK} = 0.3, P_{AL} = 0.75$

What to do?

- "Best site": CO
- "Balanced portfolio": OK
- "Safest choice": AL
- Or wait for tomorrow?

Model the decision problem, solve using tools from operations research, quantitative finance



J -> U(s+ s,w)+V(d-1,f-1,l+1,s+ s,w)

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J -> U+ U

Current status and next steps

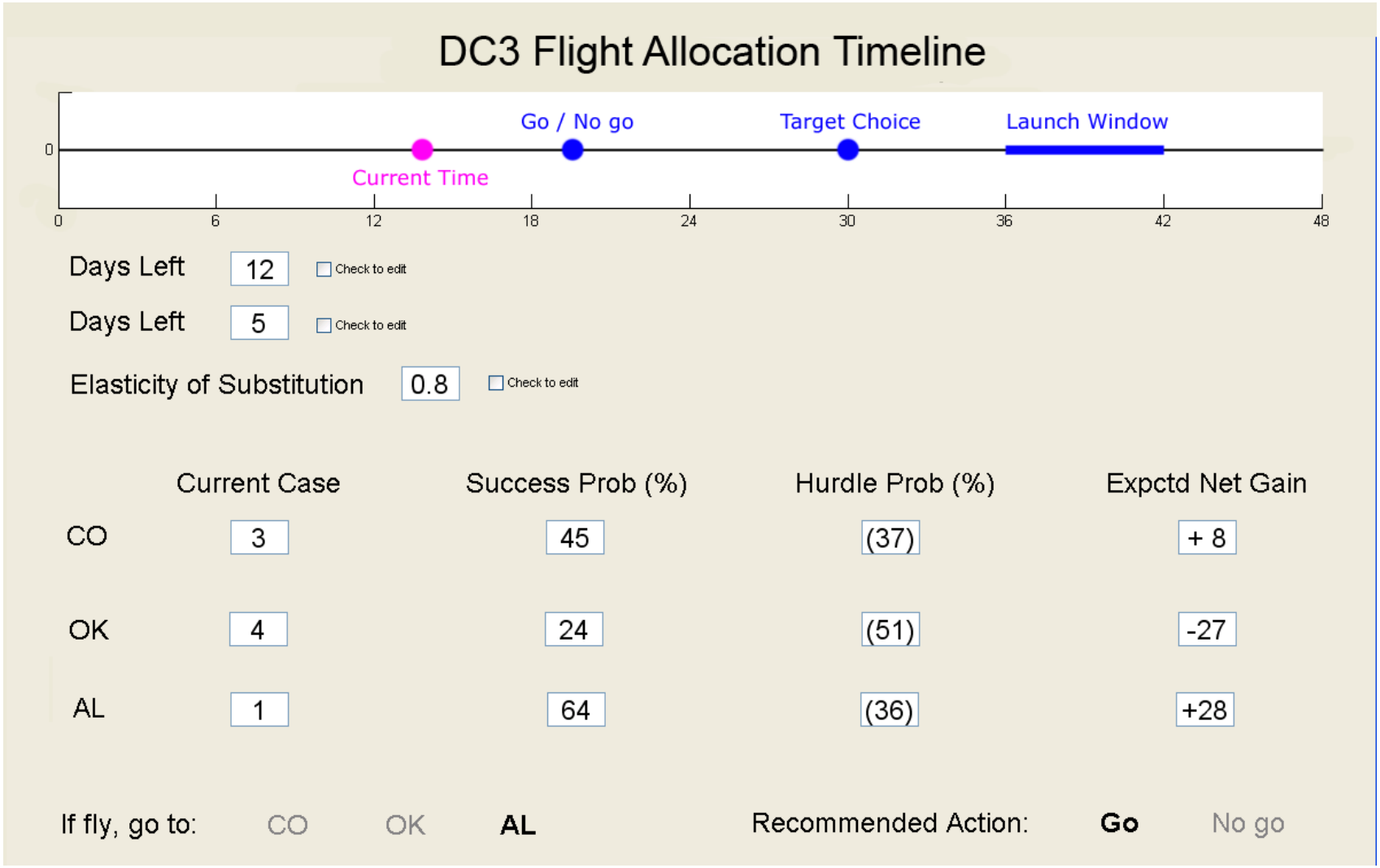
Probabilistic forecasting component: pretty much done.

Optimization component: currently generating decision rules covering all possible situations (brute force simulation).

Still to go:

- Elicit preferences from PI's
- Code up live version
- Create front-end decision dashboard

Initial mock-up for dashboard



Thanks!

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