BLOCKSCIENCE

Updates: cadCAD Implementation, Parameter Selection Under Uncertainty

January 29, 2021

For Reflexer Labs

Outline

1. Status Updates
    - Code implementation (TWAP Oracle)
    - Code/Notebook Documentation
2. Parameter Selection Under Uncertainty
3. Parameter Sweeps and Monte Carlo

Parameter selection under uncertainty

- cadCAD workflow rests upon a standardized engineering template:
  - **System goals** are identified
  - **Control parameters** are identified
  - **Environmental parameters** (uncontrolled) are identified
  - **Key performance indicators** (KPIs) / **metrics** are identified
  - **Simulations** are conducted
  - **Optimal parameters** are selected

System Goals

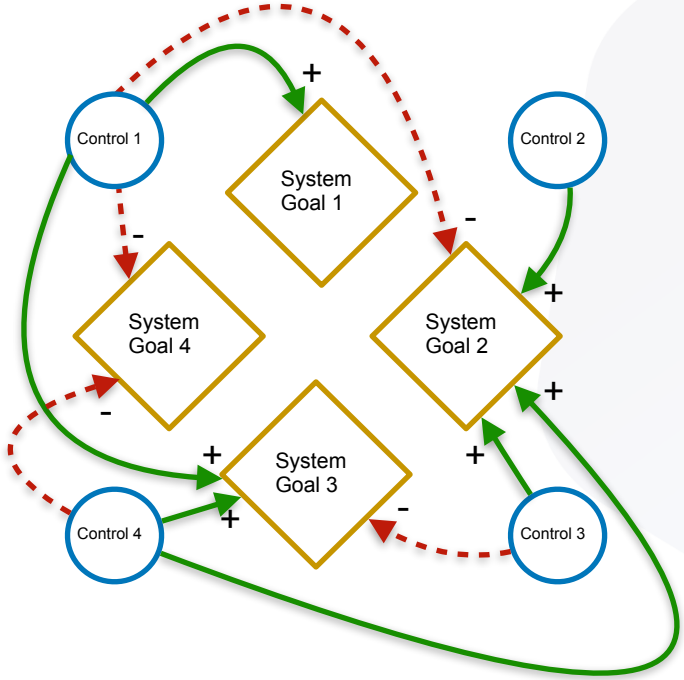
- **System goals** ensure the cadCAD simulation parameters and metrics are aligned with the overall objective
- RAI project system goals are:
  - **smoothing** of secondary market price movements without assuming a redemption price peg
  - **stability** of the controller for a range of exogenous shocks
  - **grace**ful startup and shutdown of controller in response to system events

Control parameters

- **Control parameters** specify critical features that can be selected by system designers to achieve system goals
- RAI project control parameters are:
  - controller-specific parameters:
    - K_p, K_i, leaky-integral anti-windup, controller period
  - debt market-specific parameters:
    - Liquidation ratio $\bar{L}$
  - TWAP Oracle parameters

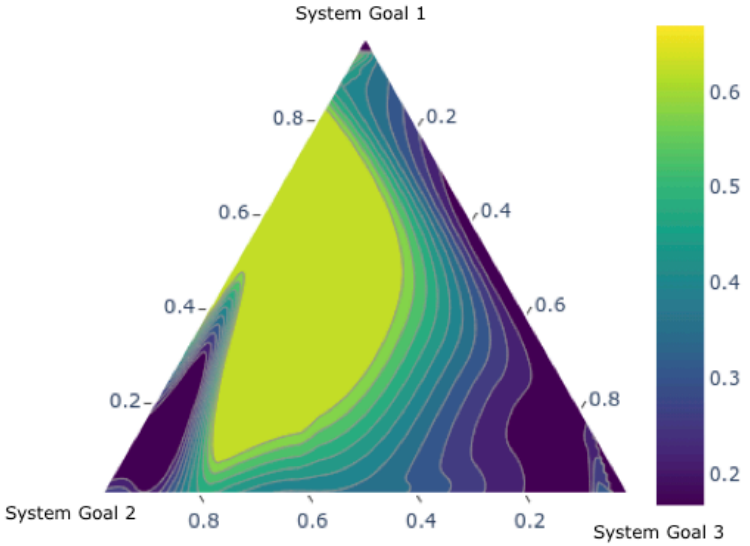
Control Parameters Balance System Goals

- It is generally not possible to select control parameters that support *every* system goal
- For example, changes to control parameters can have *countervailing* effects on system goal achievement



Control Parameters Balance System Goals

- There typically exist ranges of parameter values (basins of attraction) that support one or more system goals across many simulations
- Can e.g. visualize relative frequency of simulations that find parameter values supporting system goals



Environmental parameters

- **Environmental parameters** specify features that are external to the system, but affect the achievement of the system goals
- RAI project environmental parameters are:
  - price of Ethereum
  - demand for liquidity in Uniswap pool
  - initial conditions of the debt market (e.g. initial injection of collateral)
  - bootstrapping of liquidity into secondary market (e.g. fraction of minted RAI sent to pool)

KPIs/Metrics

- **Selection**: given environmental parameters, control parameters are selected in response to **KPIs/Metrics** that reflect system goals
- RAI project KPIs/Metrics are (so far):
  - **stability metric**: relative frequency of stable vs. unstable paths across simulations [stability; grace]
  - **volatility metric**: statistical dispersion of secondary market price [smoothing]
  - **liquidity metric**: slippage in secondary market [grace]
  - **responsiveness metric**: arbitrageur and controller response times to different environmental parameter impulses [smoothing; stability]

Simulation Workflow

- **Specify** simulation scenarios to test against system goals
- **Specify** generating process(es) for environmental parameters: can be ranges, distribution assumptions, historical fit, etc.
- **Specify** sweep ranges for control parameters
- **Perform** simulations across sweep ranges, Monte Carlo (for stochastic draws)
- **Build** corpus of KPIs/Metrics for simulations

Simulation Workflow

- **Assess** KPIs/Metrics using e.g. ranking, ML, system goal landscape mapping, qualitative analysis
- **Select** optimal parameter values based upon KPI/Metric assessment
- **Perform** robustness assessment around optimal parameter values, fine-tuning parameters where needed
- **Deliver** final optimal parameter recommendations along with basin(s) of attraction / confidence intervals (if applicable)