R-Shiny at TEA

March 17, 2020

UAI Data Science meeting

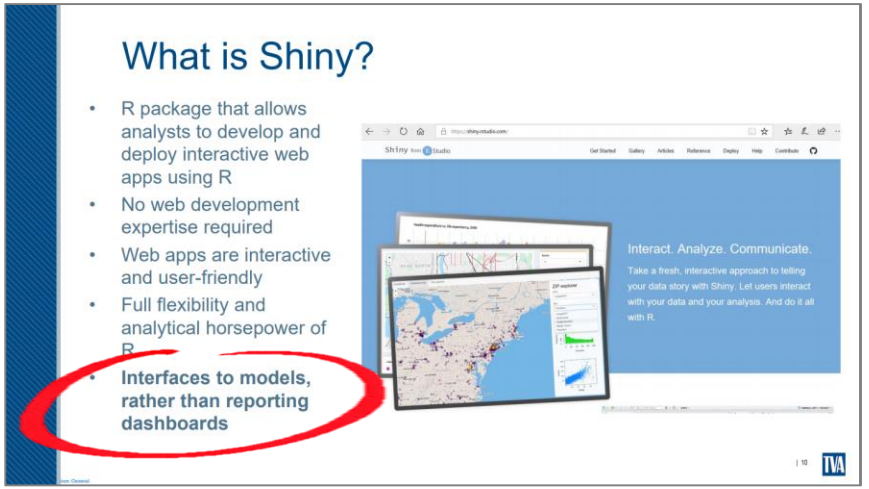
The Energy Authority (TEA)

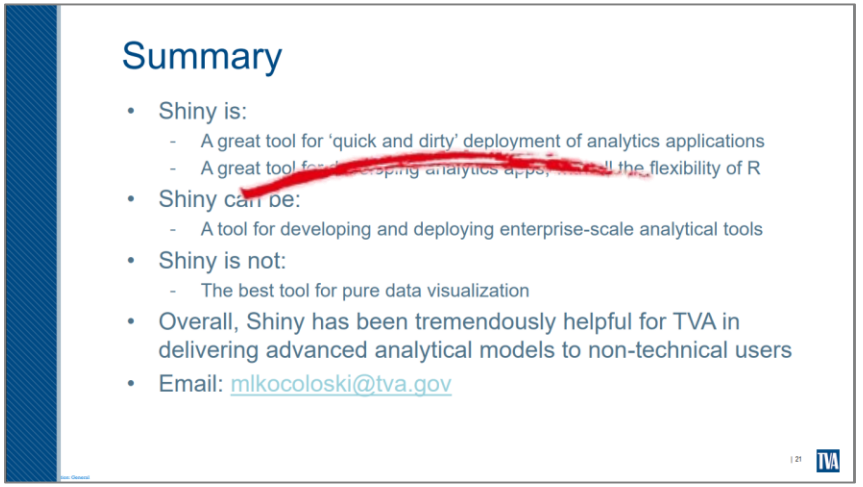
- The Energy Authority serves **public utilities** nationwide for trading and analytics.
- We are owned by several public utilities.

Agenda

Build on Matt Kocoloski(TVA)'s Presentation

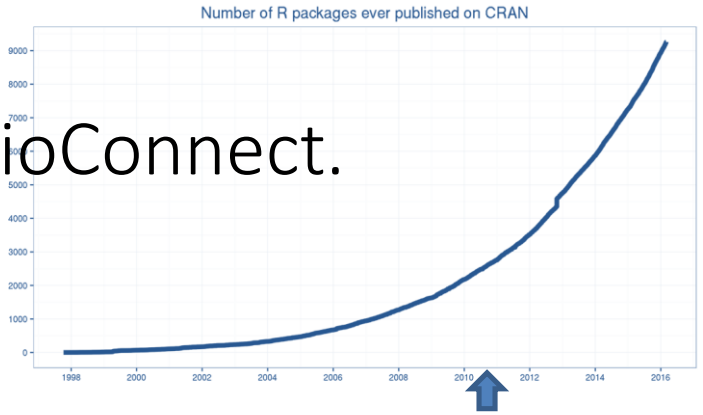
1. Interfaces to Models
   - Examples of human-machine collaboration
2. When "quick and dirty" moves to operational…
3. Tips & Tricks
   - For shiny users





TEA's R & R-Shiny Adaptation

- TEA analytics has used R as one of the main modeling and analysis tools for about a decade.
  - Tidy verse was named in 2016.
- Purchased Shiny Server Pro license in 2015.
  - The 1st Shiny Developer Conference in 2016.
- Just started evaluation of RStudioConnect.



1. Interfaces to Models

EXAMPLES OF TEA APPS

TEA's Dashboard Solutions

tableau

- TEA's company-wide BI solution
  - With enterprise data warehouse.

PowerBI

- BI solution for cloud-hosted data
  - With cloud-hosted data lake

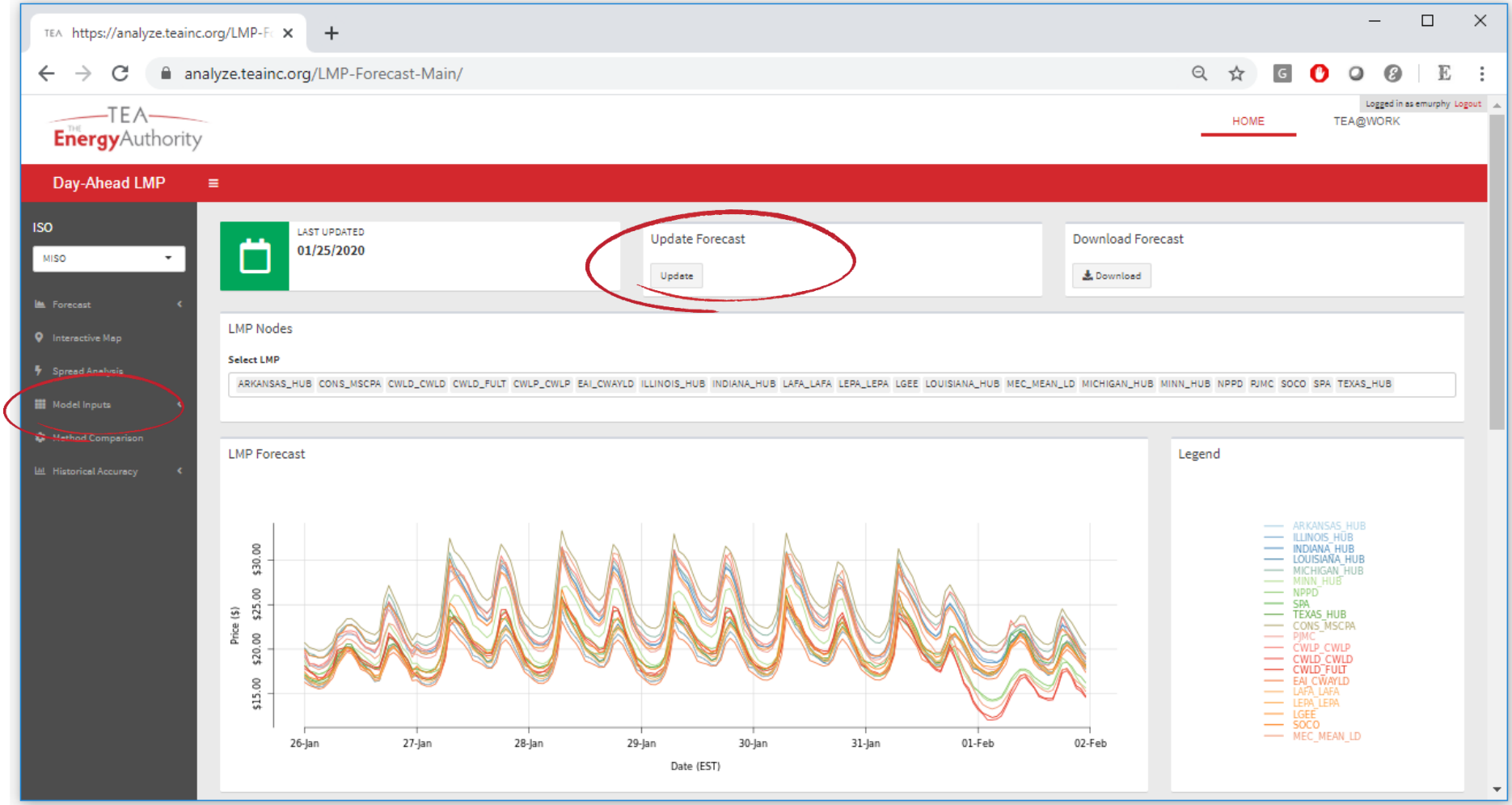
More than BI

R-Shiny

- Interfaces to Models
  - Scheduled Tasks + Shiny
  - Run models from UI

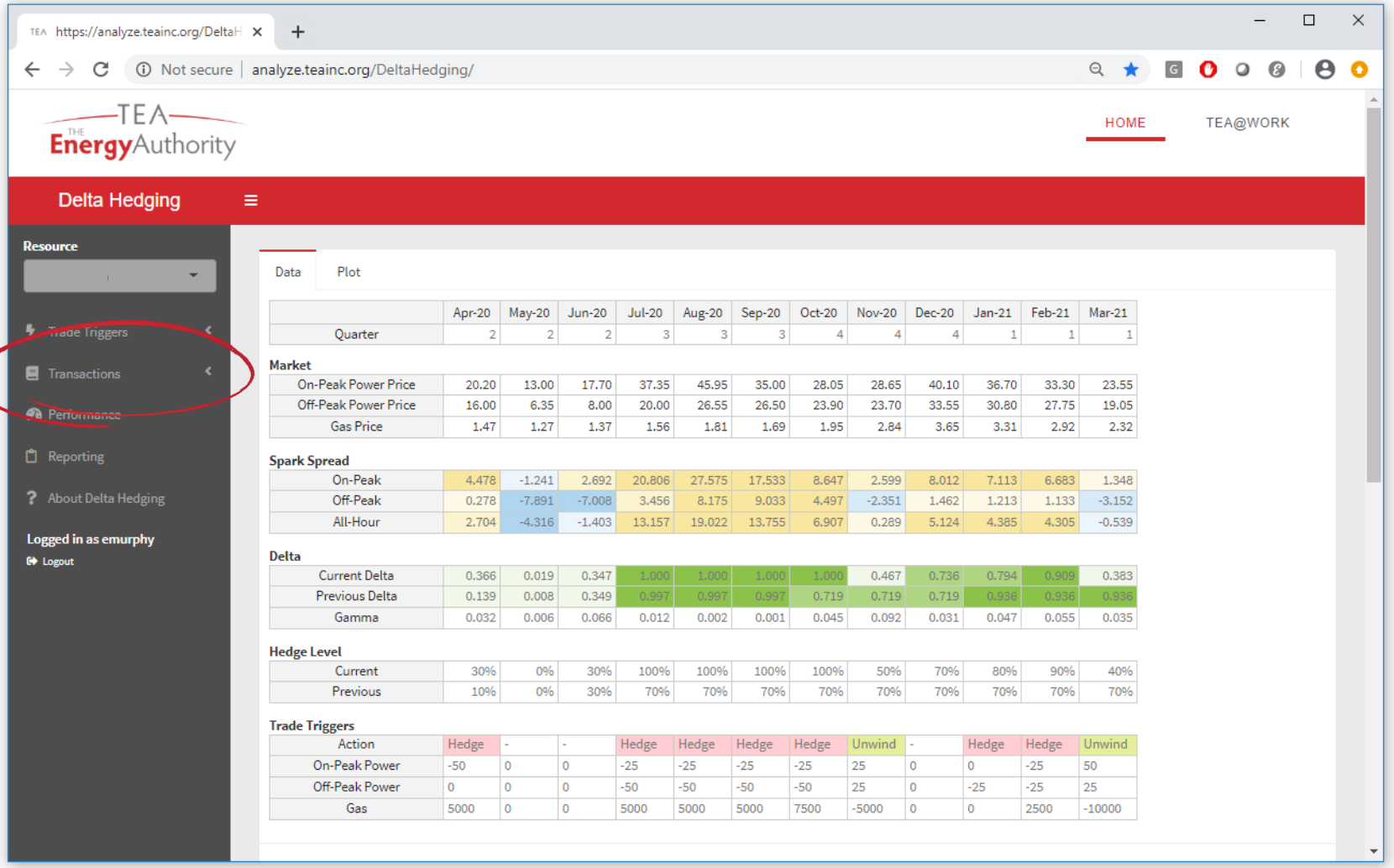
DA Power Price Forecast

Load Trained Model + Rerun It with Modified Inputs



Delta Hedging App

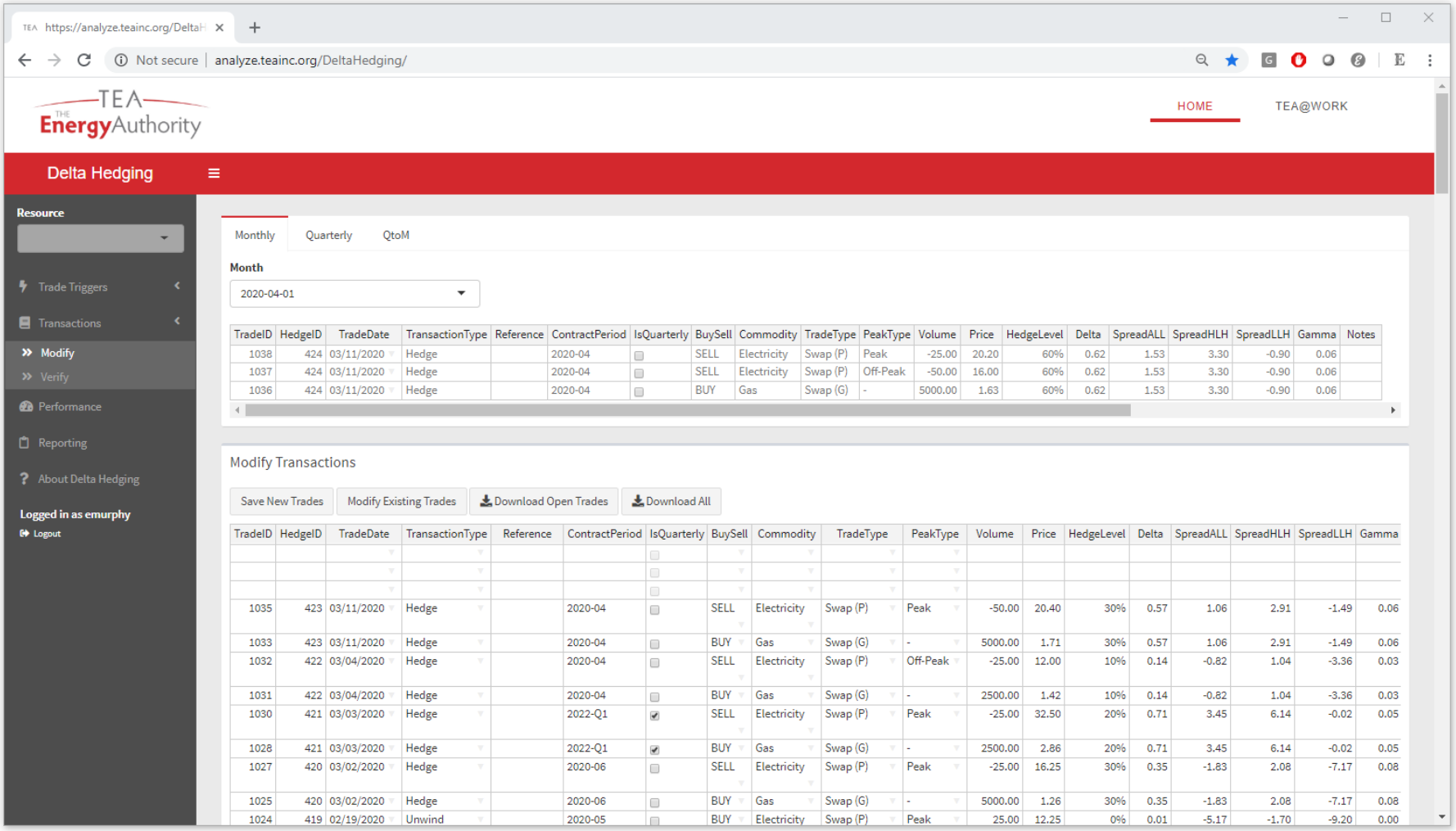
Excel-like Interactive Input Tables



	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21
Quarter	2	2	2	3	3	3	4	4	4	1	1	1
Market												
On-Peak Power Price	20.20	13.00	17.70	37.35	45.95	35.00	28.05	28.65	40.10	36.70	33.30	23.55
Off-Peak Power Price	16.00	6.35	8.00	20.00	26.55	26.50	23.90	23.70	33.55	30.80	27.75	19.05
Gas Price	1.47	1.27	1.37	1.56	1.81	1.69	1.95	2.84	3.65	3.31	2.92	2.32
Spark Spread												
On-Peak	4.478	-1.241	2.692	20.806	27.575	17.533	8.647	2.599	8.012	7.113	6.683	1.348
Off-Peak	0.278	-7.891	-7.008	3.456	8.175	9.033	4.497	-2.351	1.462	1.213	1.133	-3.152
All-Hour	2.704	-4.316	-1.403	13.157	19.022	13.755	6.907	0.289	5.124	4.385	4.305	-0.539
Delta												
Current Delta	0.366	0.019	0.347	1.000	1.000	1.000	1.000	0.467	0.736	0.794	0.909	0.383
Previous Delta	0.139	0.008	0.349	0.997	0.997	0.997	0.719	0.719	0.719	0.936	0.936	0.936
Gamma	0.032	0.006	0.066	0.012	0.002	0.001	0.045	0.092	0.031	0.047	0.055	0.035
Hedge Level												
Current	30%	0%	30%	100%	100%	100%	100%	50%	70%	80%	90%	40%
Previous	10%	0%	30%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Trade Triggers												
Action	Hedge	-	-	Hedge	Hedge	Hedge	Hedge	Unwind	-	Hedge	Hedge	Unwind
On-Peak Power	-50	0	0	-25	-25	-25	-25	25	0	0	-25	50
Off-Peak Power	0	0	0	-50	-50	-50	-50	25	0	-25	-25	25
Gas	5000	0	0	5000	5000	5000	7500	-5000	0	0	2500	-10000

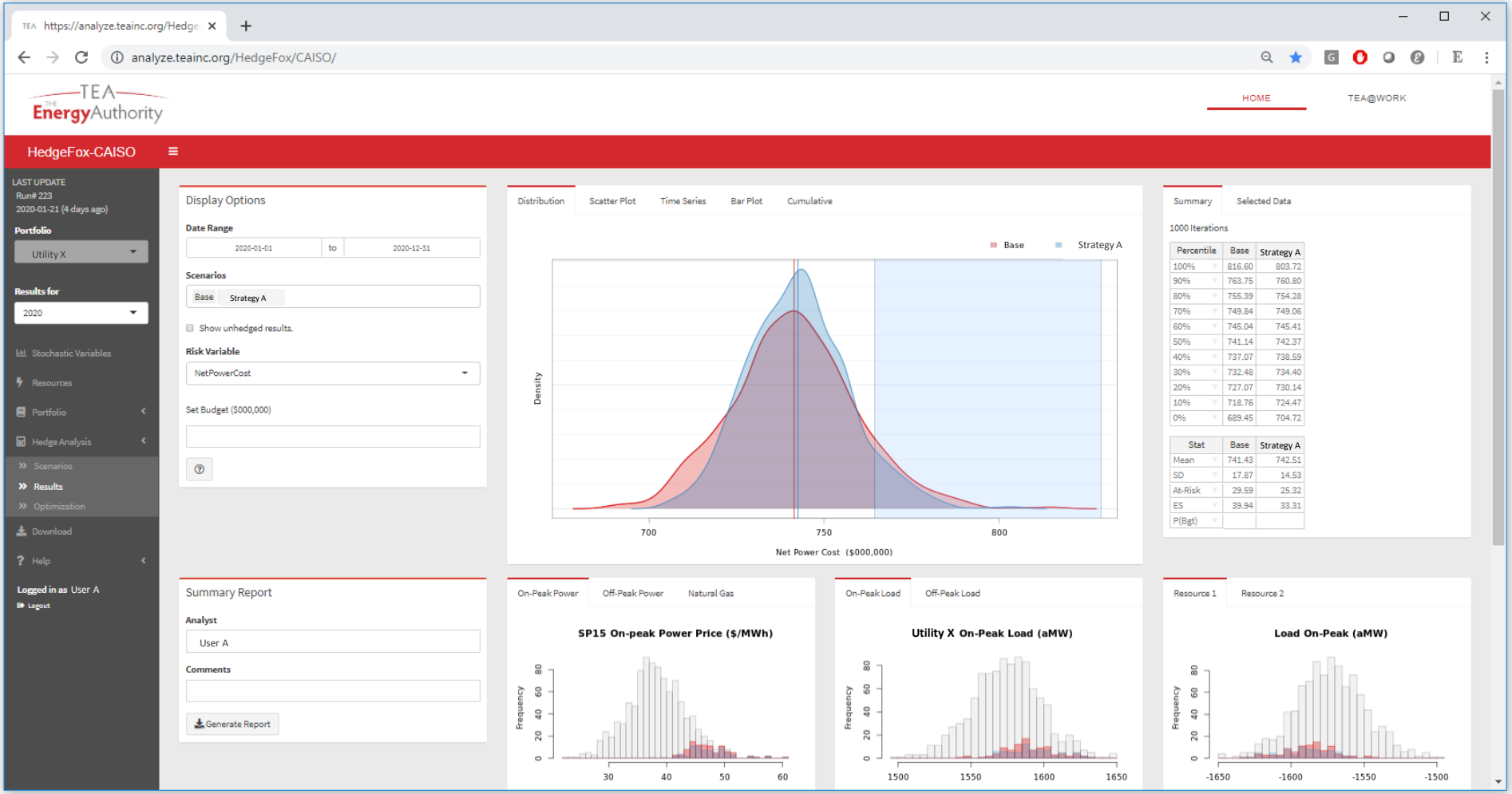
Delta Hedging App

Authenticate Users + Record Trade Data in a Database



Portfolio Risk Analysis

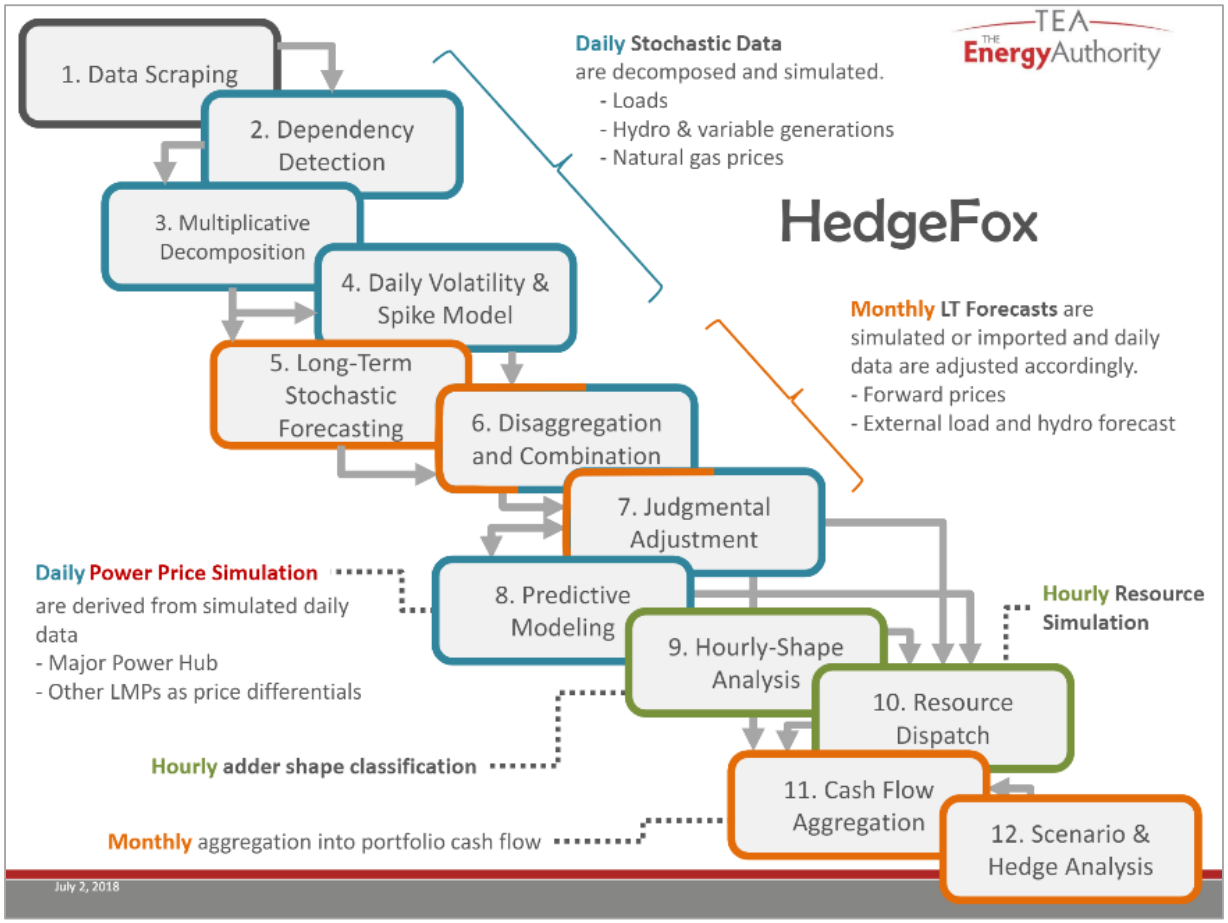
Human + Machine Collaboration



Background on this model

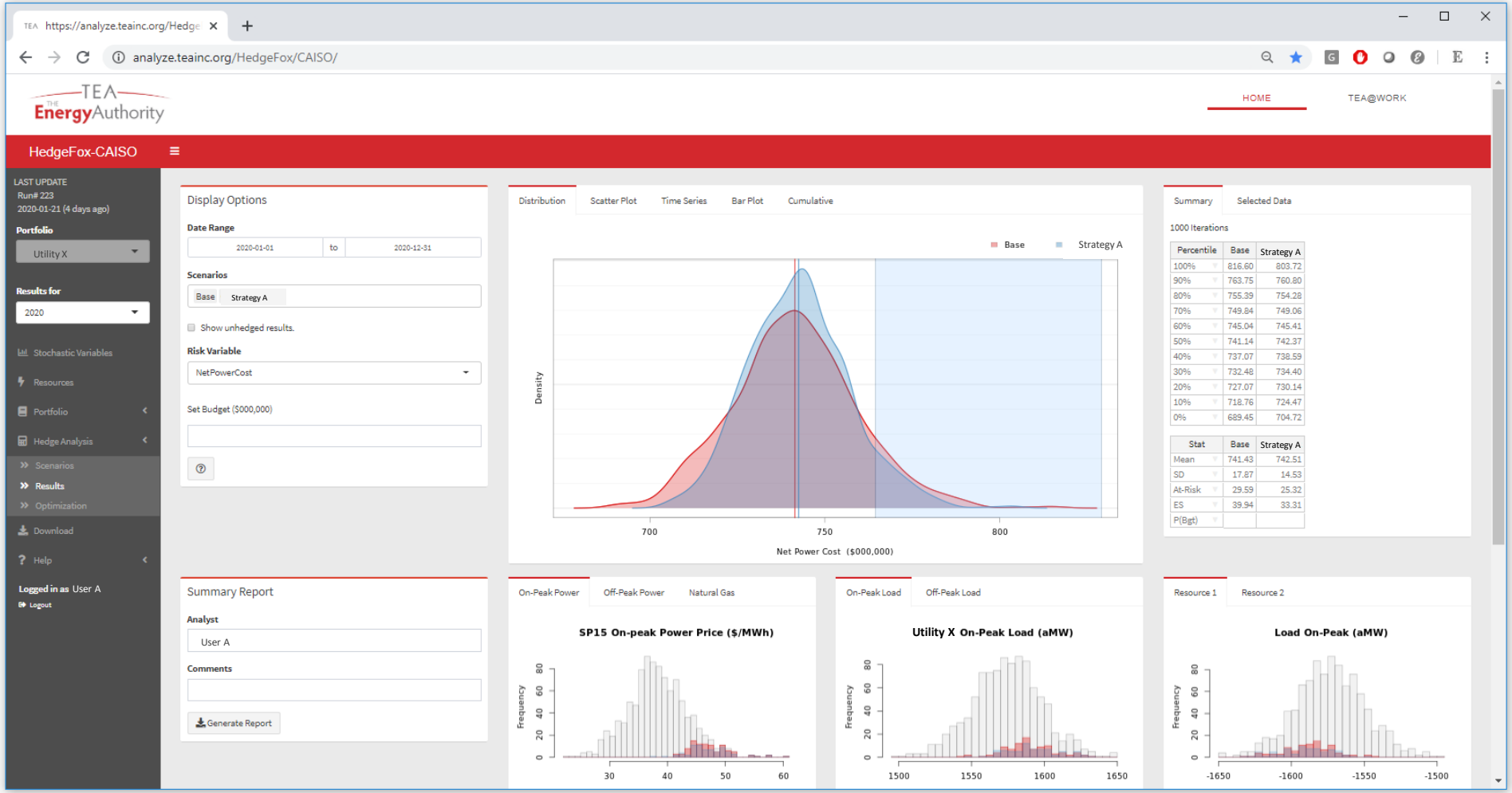
Stats + ML in R

- Quantify **portfolio risk**
- Combines statistical and, machine learning methods.
- All written in **R**
  - Scheduled model runs.
  - Interactive shiny UI.



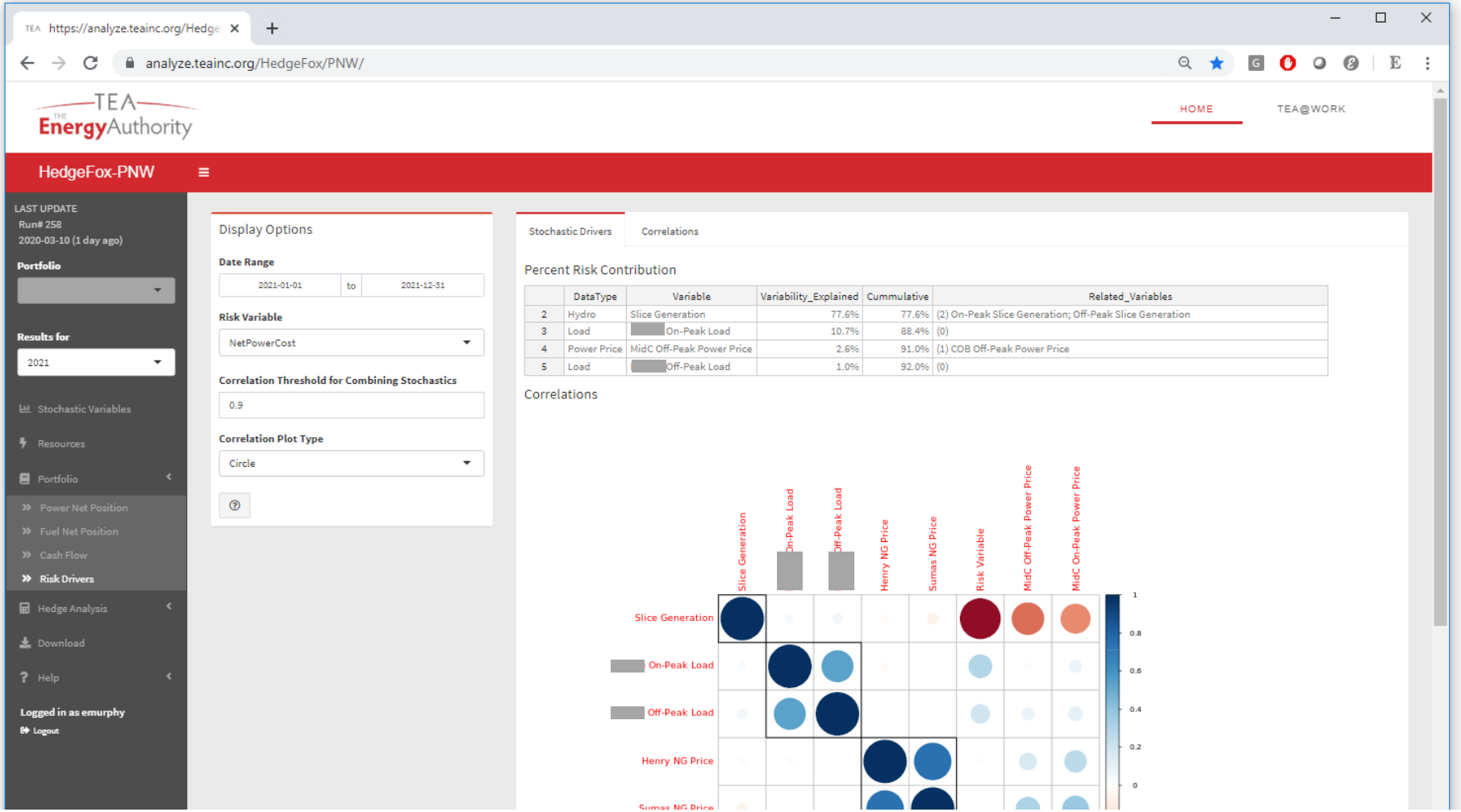
Portfolio Risk Analysis

Visualize Portfolio Risk



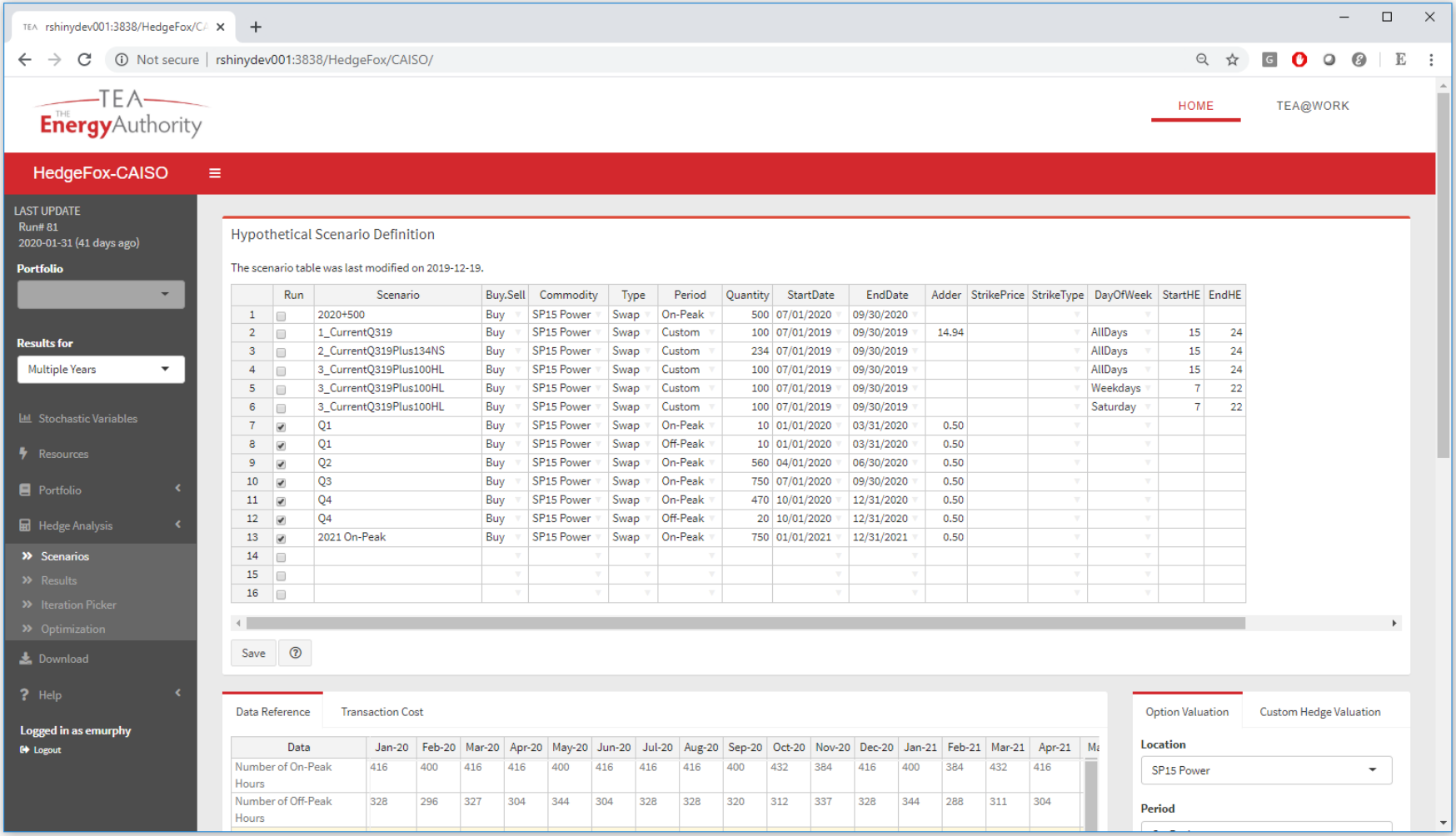
Whitening Black Boxes

Approximate a Black Box with an Interpretable Model



Hedge Analysis

Analyze Hypothetical Hedge Scenarios



	Run	Scenario	Buy.Sell	Commodity	Type	Period	Quantity	StartDate	EndDate	Adder	StrikePrice	StrikeType	DayOfWeek	StartHE	EndHE
1	☐	2020+500	Buy	SP15 Power	Swap	On-Peak	500	07/01/2020	09/30/2020						
2	☐	1_CurrentQ319	Buy	SP15 Power	Swap	Custom	100	07/01/2019	09/30/2019	14.94			AllDays	15	24
3	☐	2_CurrentQ319Plus134NS	Buy	SP15 Power	Swap	Custom	234	07/01/2019	09/30/2019				AllDays	15	24
4	☐	3_CurrentQ319Plus100HL	Buy	SP15 Power	Swap	Custom	100	07/01/2019	09/30/2019				AllDays	15	24
5	☐	3_CurrentQ319Plus100HL	Buy	SP15 Power	Swap	Custom	100	07/01/2019	09/30/2019				Weekdays	7	22
6	☐	3_CurrentQ319Plus100HL	Buy	SP15 Power	Swap	Custom	100	07/01/2019	09/30/2019				Saturday	7	22
7	☑	Q1	Buy	SP15 Power	Swap	On-Peak	10	01/01/2020	03/31/2020	0.50					
8	☑	Q1	Buy	SP15 Power	Swap	Off-Peak	10	01/01/2020	03/31/2020	0.50					
9	☑	Q2	Buy	SP15 Power	Swap	On-Peak	560	04/01/2020	06/30/2020	0.50					
10	☑	Q3	Buy	SP15 Power	Swap	On-Peak	750	07/01/2020	09/30/2020	0.50					
11	☑	Q4	Buy	SP15 Power	Swap	On-Peak	470	10/01/2020	12/31/2020	0.50					
12	☑	Q4	Buy	SP15 Power	Swap	Off-Peak	20	10/01/2020	12/31/2020	0.50					
13	☑	2021 On-Peak	Buy	SP15 Power	Swap	On-Peak	750	01/01/2021	12/31/2021	0.50					
14	☐														
15	☐														
16	☐														

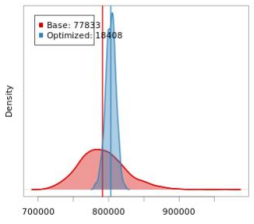
Data	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	Ma
Number of On-Peak Hours	416	400	416	416	400	416	416	416	400	432	384	416	400	384	432	416	
Number of Off-Peak Hours	328	296	327	304	344	304	328	328	320	312	337	328	344	288	311	304	

Hedge Optimization

What's my optimal strategy?

...

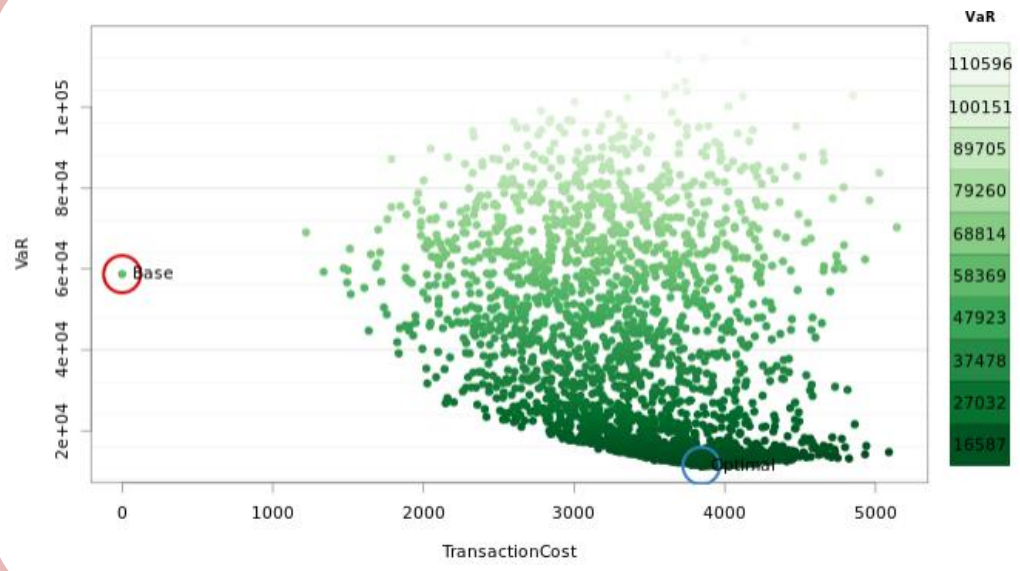
(a few minute later)
Tada!



	Scenario	Buy,Sell	Commodity	Type	Period	Quantity	StartDate	EndDate	Adder
1	Optimized	Buy	SP15 Power	Swap	On-Peak	680		03/31/2021	0.50
2	Optimized	Buy	SP15 Power	Swap	On-Peak	1400		06/30/2021	0.50
3	Optimized	Buy	SP15 Power	Swap	On-Peak	1210		09/30/2021	0.50
4	Optimized	Buy	SP15 Power	Swap	On-Peak	1460		12/31/2021	0.50
5	Optimized	Buy	SP15 Power	Swap	Off-Peak	690		03/31/2021	0.50
6	Optimized	Buy	SP15 Power	Swap	Off-Peak	60		06/30/2021	0.50
7	Optimized	Buy	SP15 Power	Swap	Off-Peak	1450		09/30/2021	0.50
8	Optimized	Sell	SP15 Power	Swap	Off-Peak	0		12/31/2021	0.00

How do I know this is optimal?

...

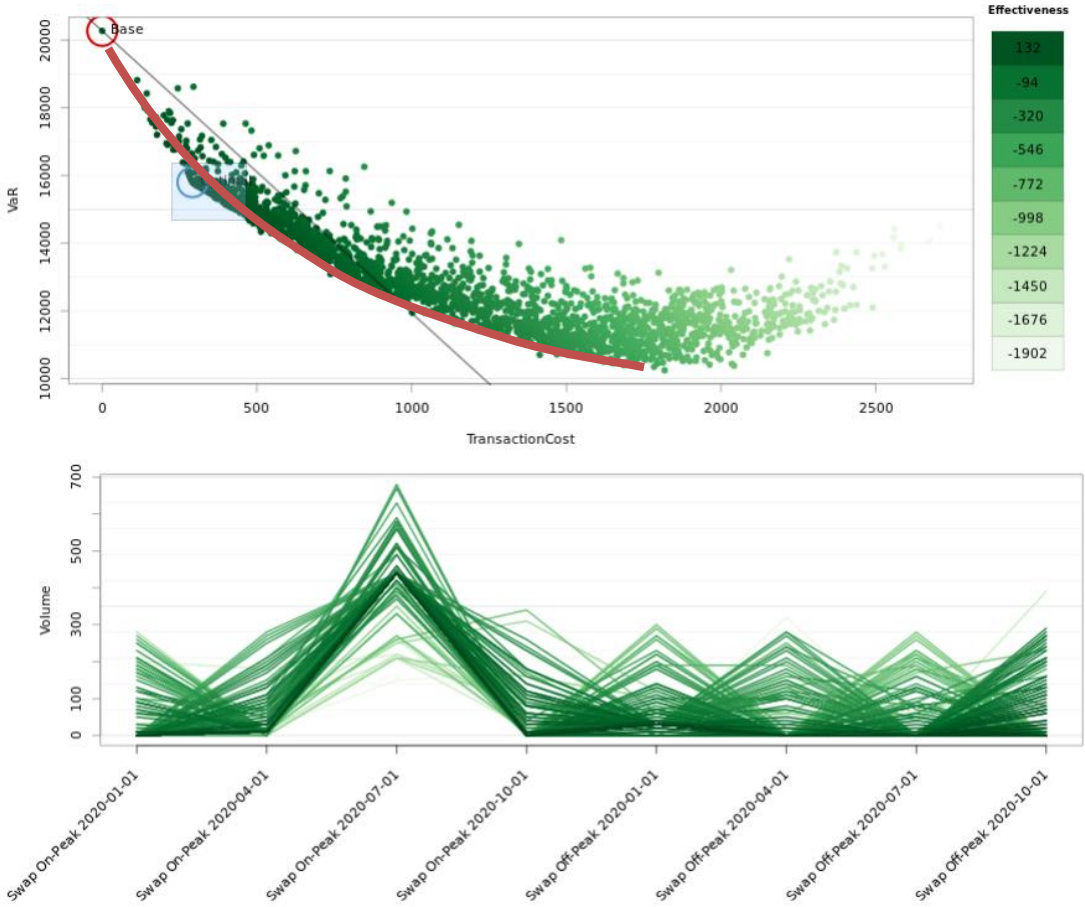


Can I pick another strategy?

Explore alternative solutions

Lessons Learned

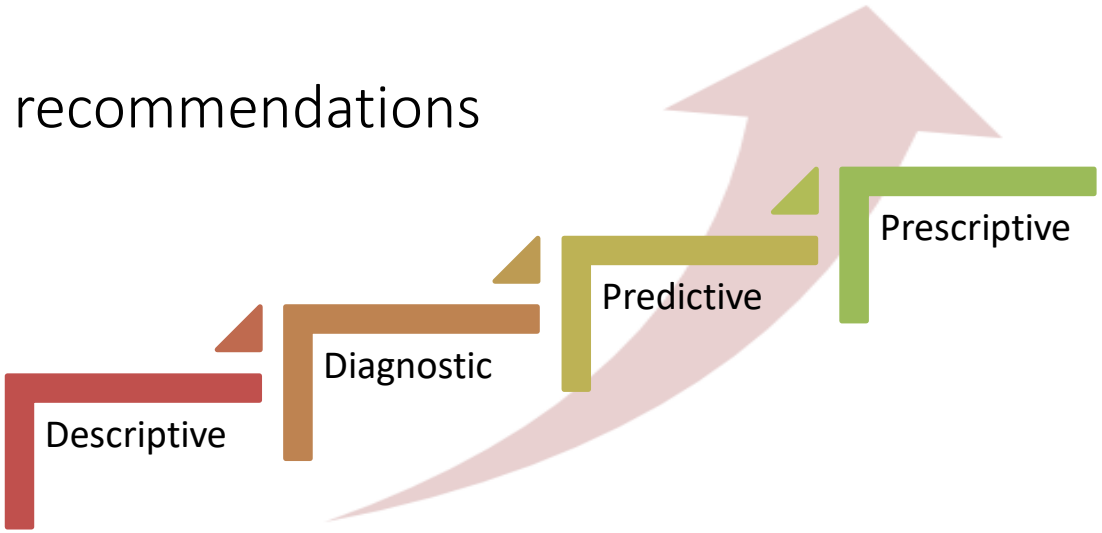
- Users didn't want the answer.
- Instead…
  - Get insights.
  - Change input to the model.
  - Explore alternatives.



Human + Machine Collaboration

- As the use of AI spread beyond point-forecasting, to decision making and prescriptive analytics, people will want to participate in finding a solution.

- Interactions with AI
  - Explore insights
  - Multiple/alternative recommendations
  - Inputs to AI



2 “Data Scientist” as IT

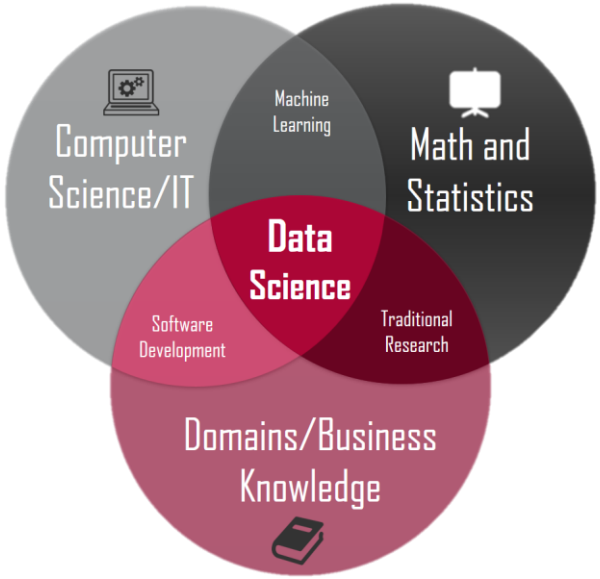
WHEN “QUICK AND DIRTY” MOVES TO OPERATIONAL…

An App is “Operational” When

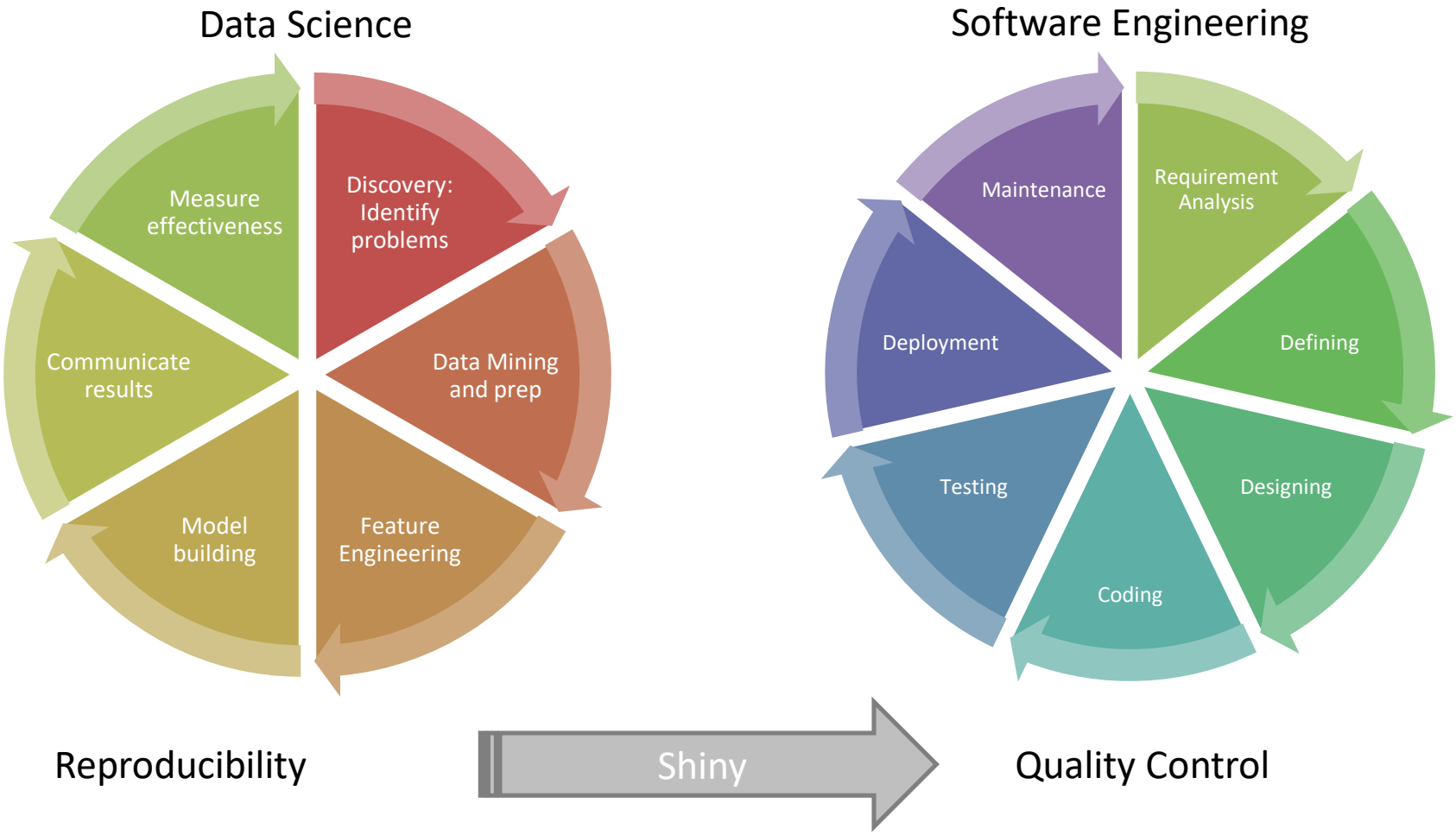
- It continually supports critical business operations
- It is connected to live data.

How many hats do you wear?

- Traditionally "Data Scientists" focused on analyzing data and prototyping models.
  - Operationalizing & maintenance by IT.
- Shiny is a way to operationalize models.
  - Data scientists directly provide access to models ↔ Users need support directly from data scientists

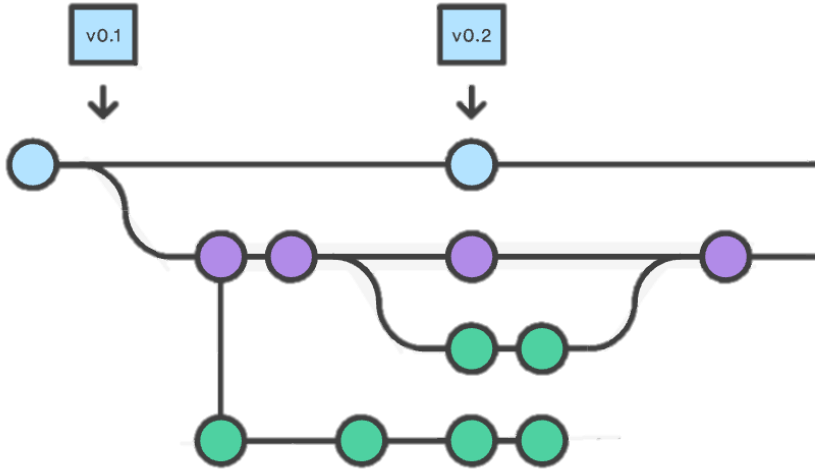


Life Cycles

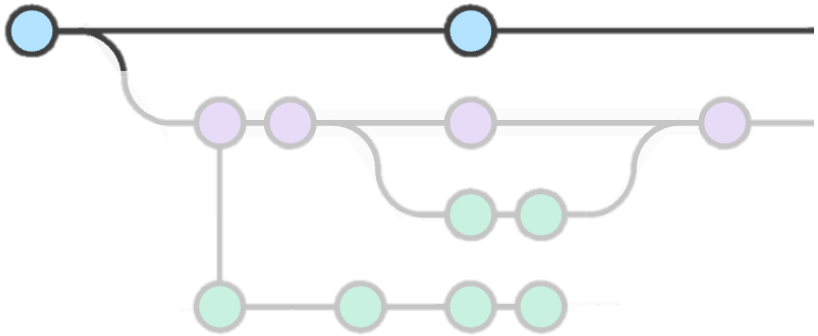

Data Science
Discovery: Identify problems
Data Mining and prep
Feature Engineering
Model building
Communicate results
Measure effectiveness
Software Engineering
Requirement Analysis
Defining
Designing
Coding
Testing
Deployment
Maintenance
Reproducibility
Shiny
Quality Control

Quality Control

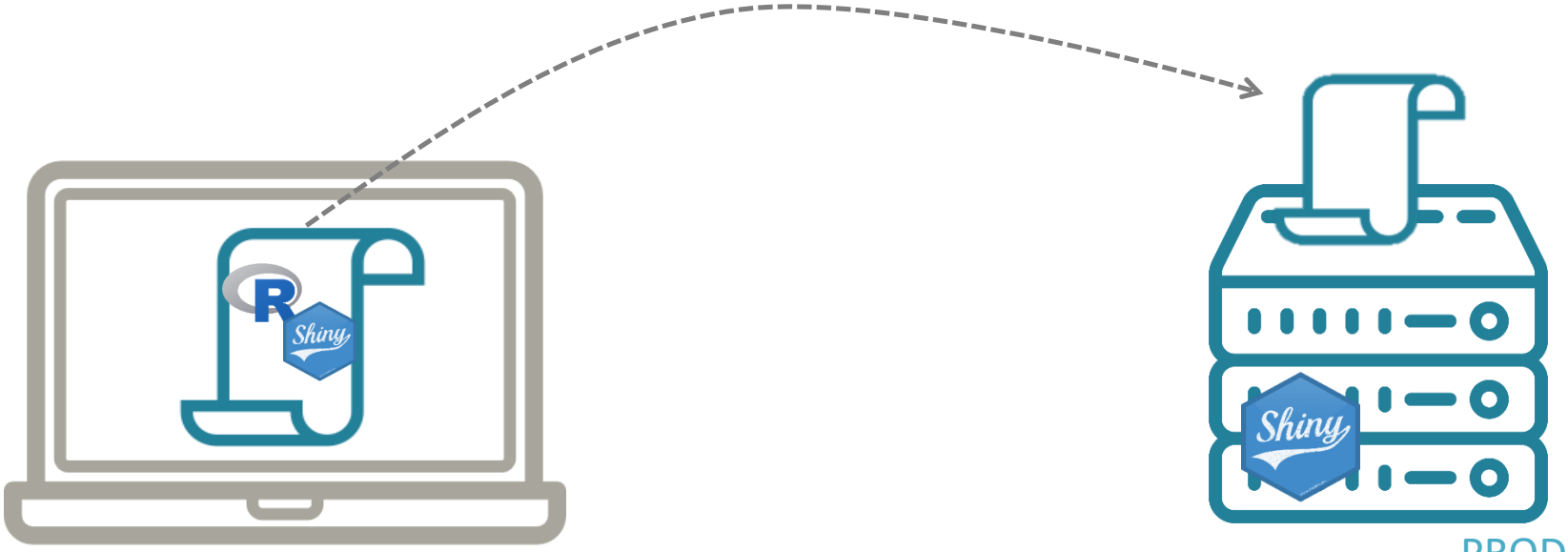
- Separation of Dev/Staging/PROD environments
  - Scripts, databases, shiny servers.
- Use of source control
  - Git + GitHub
- Support plans
  - Apps and models always fail at the most inconvenient times.
- Error handling
  - Users always come up with a way to produce errors.



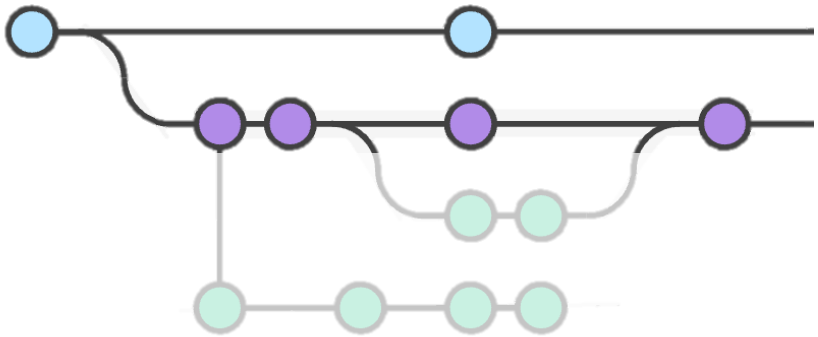
Environment Differentiation



- Quick and dirty
- Make sure to couple RShiny server with RStudio Server



Environment Differentiation

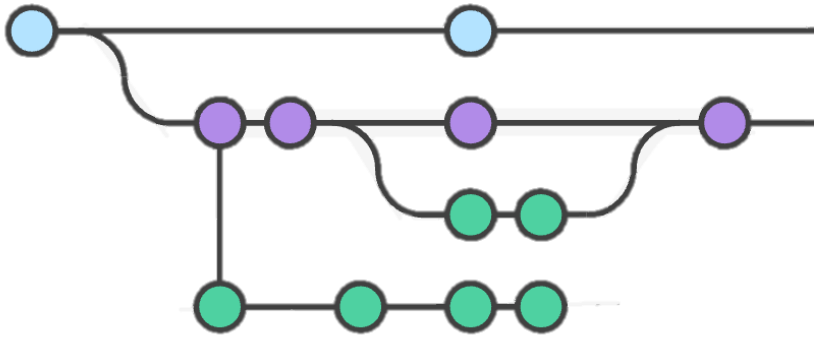


- Run something stably on PROD while working on improvements on the side

Staging

PROD

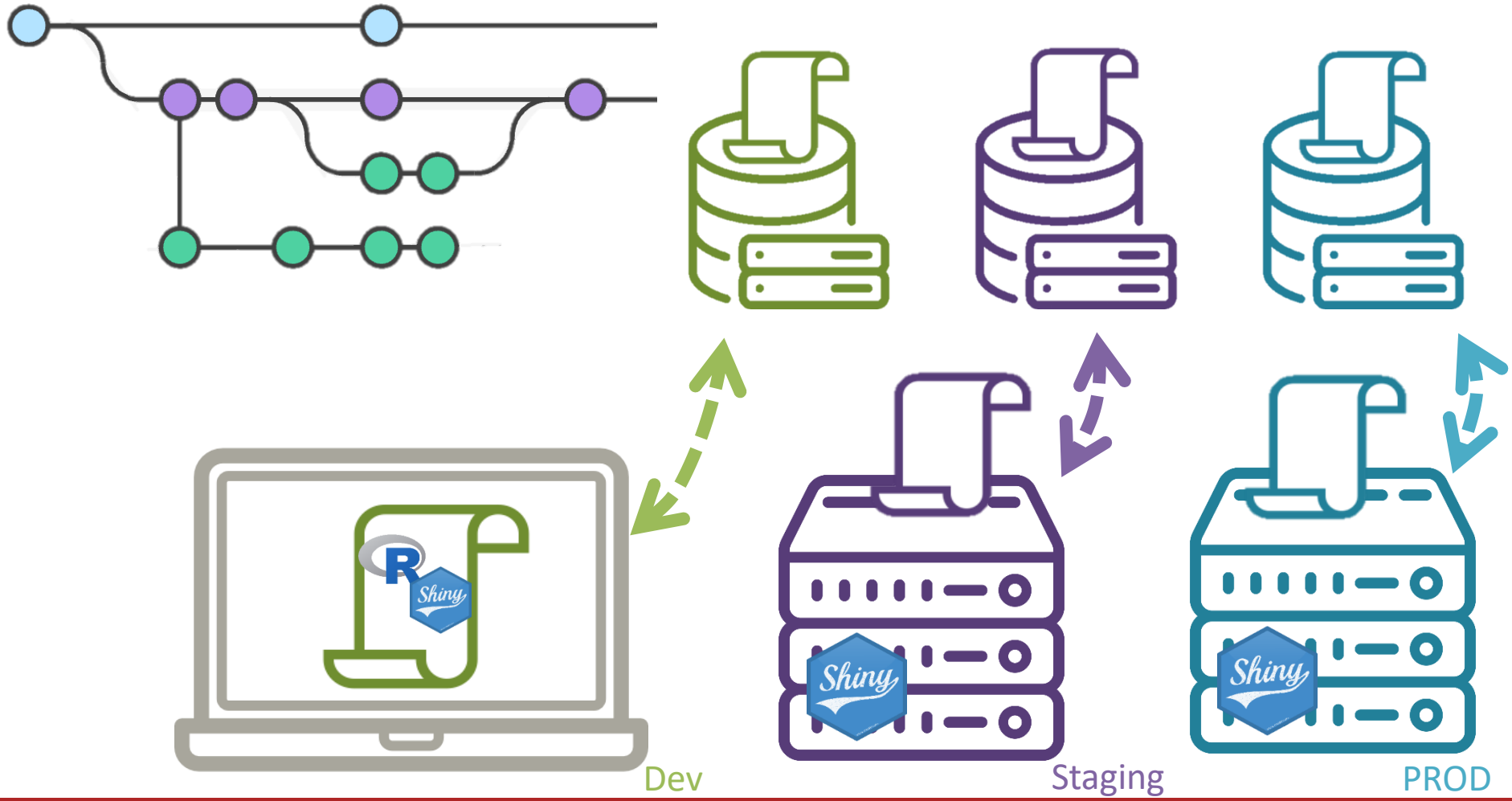
Environment Differentiation



- Couple shiny apps with scheduled tasks and live data.

Dev Staging PROD

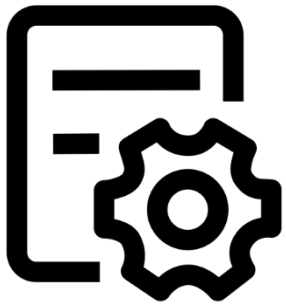
Environment Differentiation



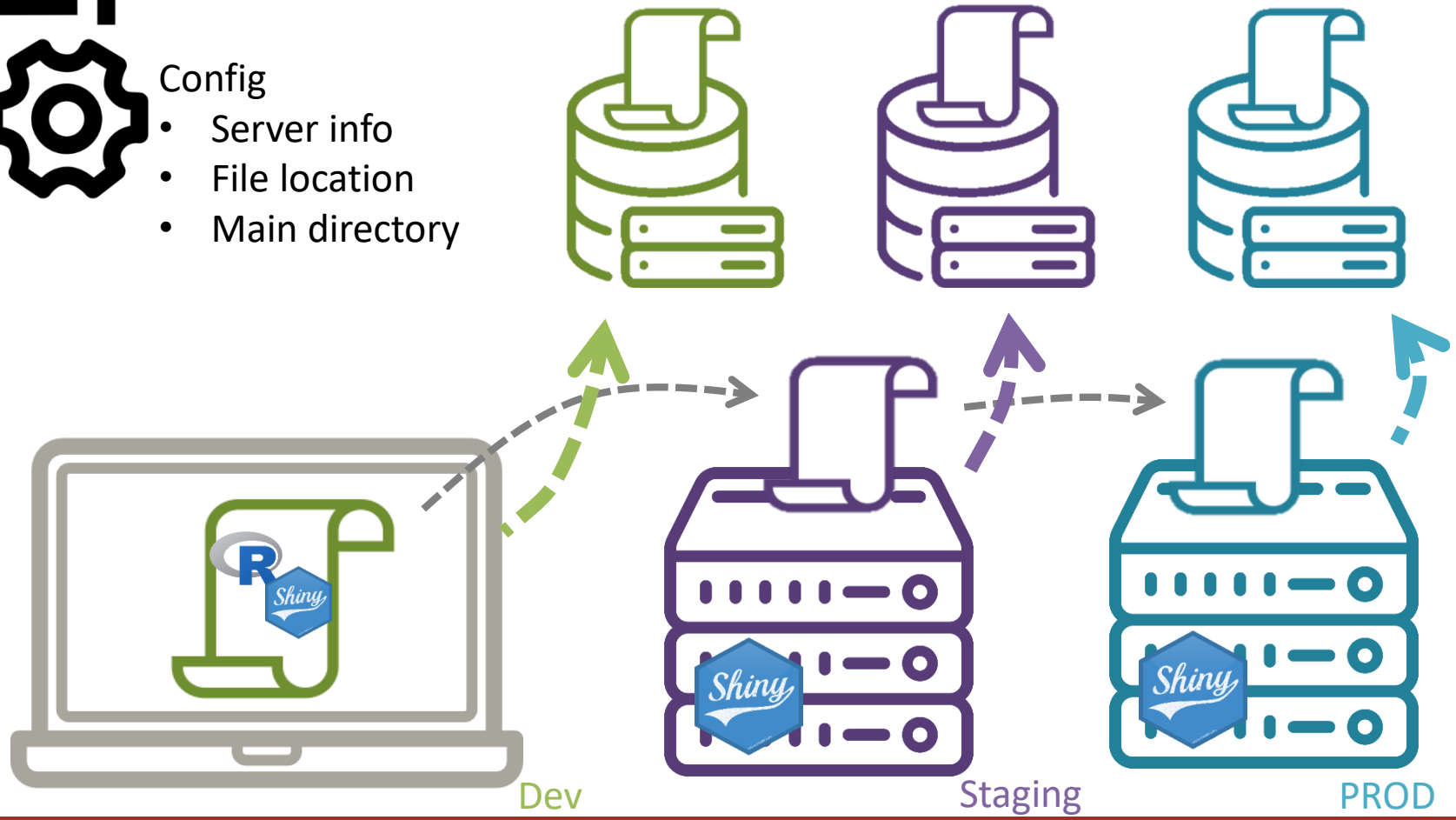
(Random) Tips and Tricks

FOR SHINY USERS

Managing environments



Config
- Server info
- File location
- Main directory



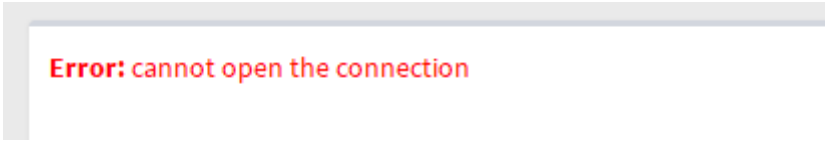
‘Config’ package

- Config.yaml
  - One file for all credentials and server info and directories.
    - Access to mounted Windows file system from linux.
    - Anything environment-specific. (e.g. the sanitize.errors option)
  - Deployment is easier.

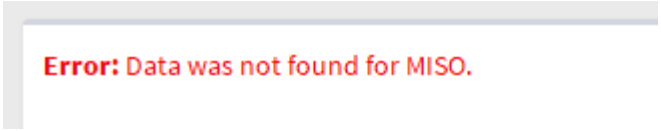
Error Handling

- Base R
  - tryCatch(…, error=function(e){…})
- Shiny
  - Req() and Validate(need(…, message = “”))
  - options(shiny.sanitize.errors = TRUE)
  - safeError() for controlled error messages.

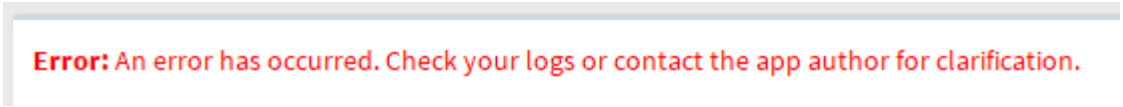
Uncontrolled R’s native error message:
It may not make sense to users. It might be revealing of sensitive information.



Controlled safe message:
Messages are more meaningful.



Uncontrolled with error-sanitizer:

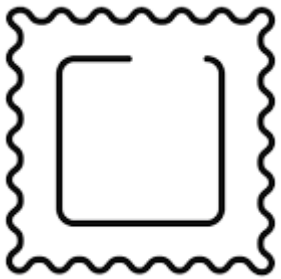


Module

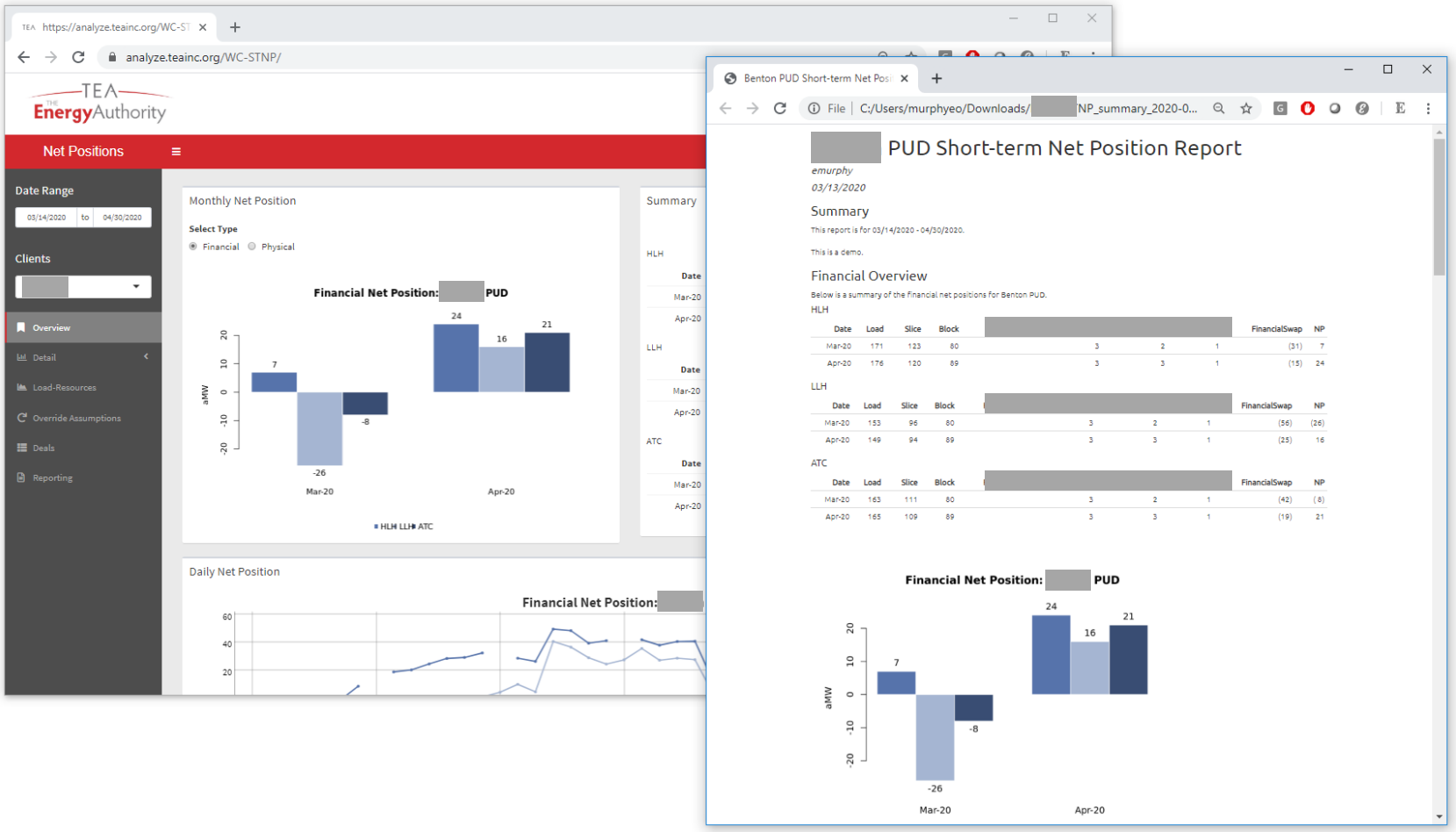
Reactive Spaghetti to Reactive Ravioli

> You should consider writing a function whenever you've copied and pasted a block of code more than twice (i.e. you now have three copies of the same code). Hadley Wickham, from "R for Data Science"

- Shiny structure makes it difficult to follow this advice, unless you use "module."
- Great way to section server & ui scripts even when there is no repetition.
  - Smaller, testable, self-contained, re-usable.
  - A couple thousand lines of reactive "spaghetti" became self contained "ravioli".
    - Local and global reactive variables become clear.



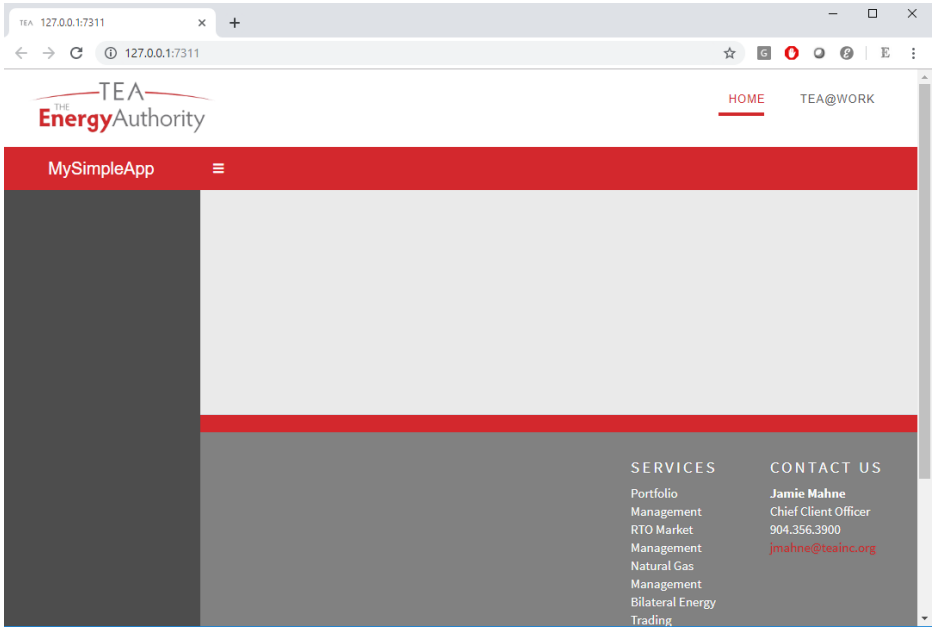
RMarkdown


Net Positions
Date Range
Clients
Overview
Detail
Load-Resources
Override Assumptions
Deals
Reporting
Monthly Net Position
Select Type
Financial
Physical
Financial Net Position: [redacted] PUD
aMW
Mar-20
Apr-20
HLH
LLH
ATC
Summary
Daily Net Position
Financial Net Position:
PUD Short-term Net Position Report
emurphy
03/13/2020
Summary
This report is for 03/14/2020 - 04/30/2020.
This is a demo.
Financial Overview
Below is a summary of the financial net positions for Benton PUD.
HLH
LLH
ATC
Date
Load
Slice
Block
FinancialSwap
NP
Mar-20
Apr-20

Branding & Template

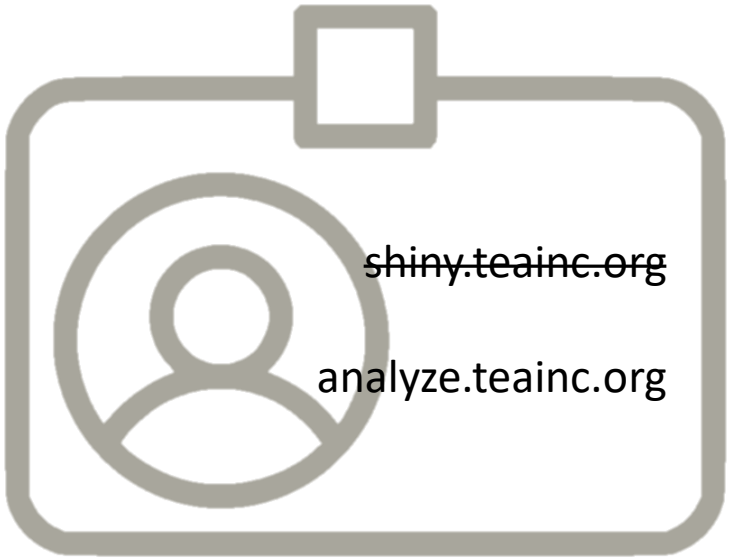
- Set templates and formatting helps create consistency.

- Shinydashboard
  - Open source AdminLTE
  - Create our own “teadashboard” package.
  - Self-publish it in github.



Naming

1. What is it?
2. What's the purpose?
3. A symbol that captures the concept?



~~PriceSpreadAnalysisTool~~
Caliper

Thank you!

Contact:
eooka@teainc.org