



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

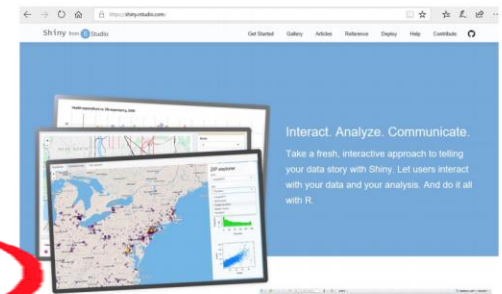
2. When “quick and dirty” moves to operational...

3. Tips & Tricks

- For shiny users

What is Shiny?



- R package that allows analysts to develop and deploy interactive web apps using R
- No web development expertise required
- Web apps are interactive and user-friendly
- Full flexibility and analytical horsepower of R
- **Interfaces to models, rather than reporting dashboards**

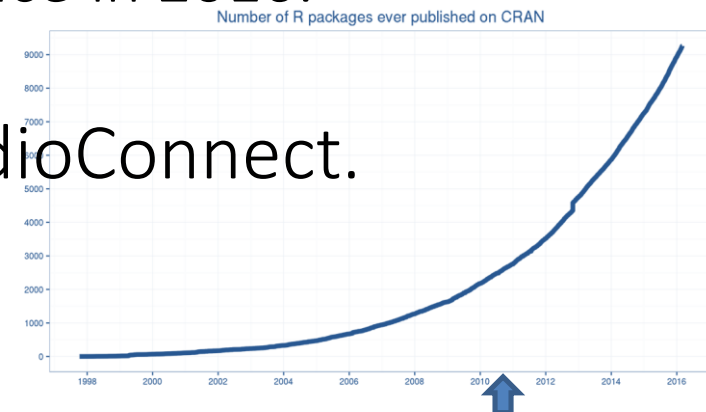


Summary

- Shiny is:
 - A great tool for 'quick and dirty' deployment of analytics applications
 - A great tool for developing analytics apps, ~~and all the flexibility of R~~
- Shiny can be:
 - A tool for developing and deploying enterprise-scale analytical tools
- Shiny is not:
 - The best tool for pure data visualization
- Overall, Shiny has been tremendously helpful for TVA in delivering advanced analytical models to non-technical users
- Email: mlkocoloski@tva.gov

TEA's R & R-Shiny Adaptation

- TEA analytics has used  as one of the main modeling and analysis tools for about a decade.
 - Tidy verse was named in 2016.
- Purchased  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



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



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

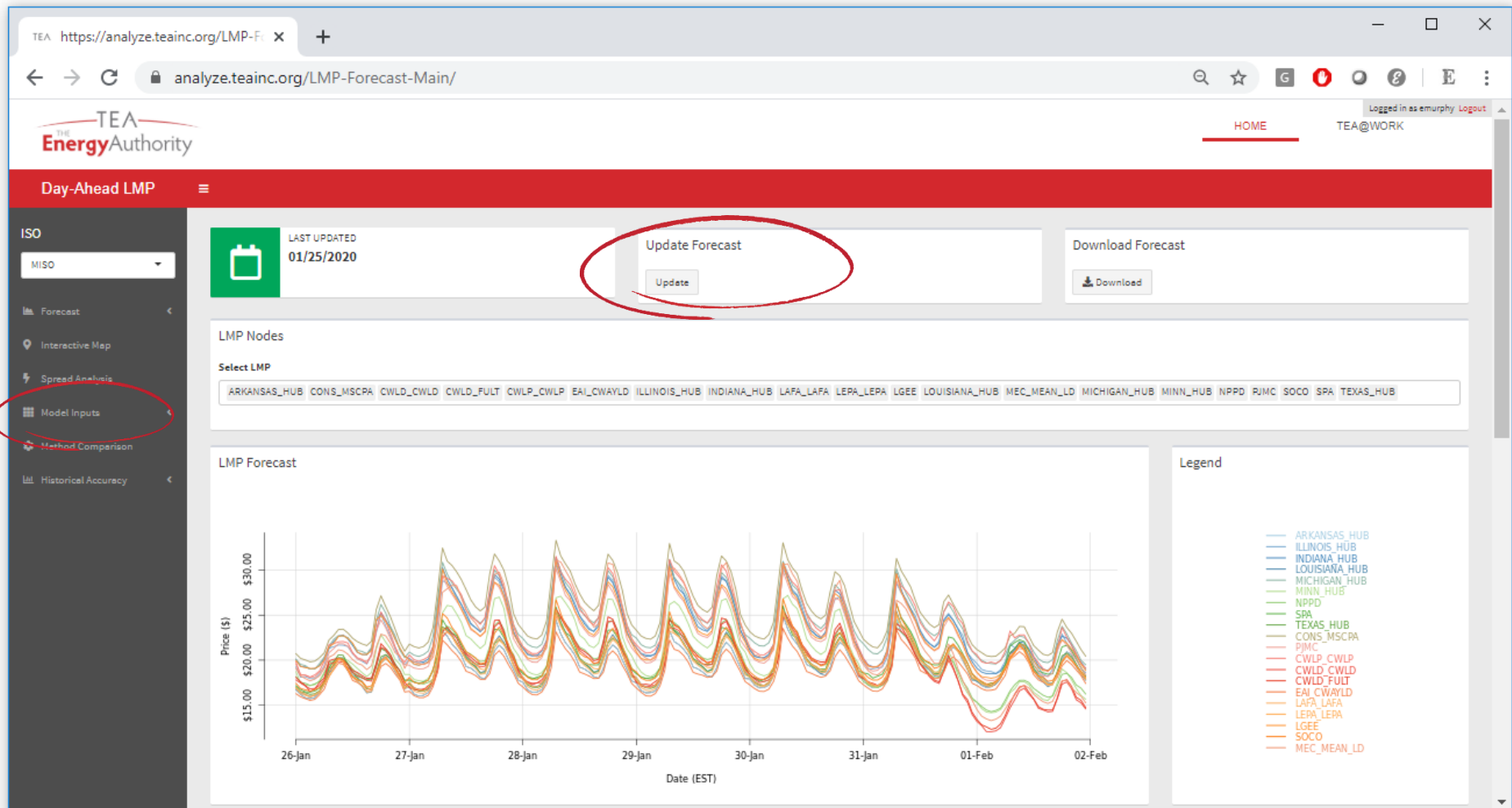


- Interfaces to Models
 - Scheduled Tasks + Shiny
 - Run models from UI

More than BI

DA Power Price Forecast

Load Trained Model + Rerun It with Modified Inputs



Delta Hedging App

Excel-like Interactive Input Tables

TEA <https://analyze.teainc.org/DeltaHedging/>

Not secure | analyze.teainc.org/DeltaHedging/

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Delta Hedging

Resource

Trade Triggers

Transactions

Performance

Reporting

About Delta Hedging

Logged in as emurphy

Logout

Data Plot

	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

TEA https://analyze.teainc.org/DeltaHedging/ x +

← → ↻ Not secure | analyze.teainc.org/DeltaHedging/ 🔍 ★ G O ? E :

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Delta Hedging ☰

Resource

Trade Triggers <

Transactions <

» Modify

» Verify

Performance

Reporting

? About Delta Hedging

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Monthly Quarterly QtoM

Month

2020-04-01 ▼

TradeID	HedgeID	TradeDate	TransactionType	Reference	ContractPeriod	IsQuarterly	BuySell	Commodity	TradeType	PeakType	Volume	Price	HedgeLevel	Delta	SpreadALL	SpreadHLH	SpreadLLH	Gamma	Notes
1038	424	03/11/2020	Hedge		2020-04	<input type="checkbox"/>	SELL	Electricity	Swap (P)	Peak	-25.00	20.20	60%	0.62	1.53	3.30	-0.90	0.06	
1037	424	03/11/2020	Hedge		2020-04	<input type="checkbox"/>	SELL	Electricity	Swap (P)	Off-Peak	-50.00	16.00	60%	0.62	1.53	3.30	-0.90	0.06	
1036	424	03/11/2020	Hedge		2020-04	<input type="checkbox"/>	BUY	Gas	Swap (G)	-	5000.00	1.63	60%	0.62	1.53	3.30	-0.90	0.06	

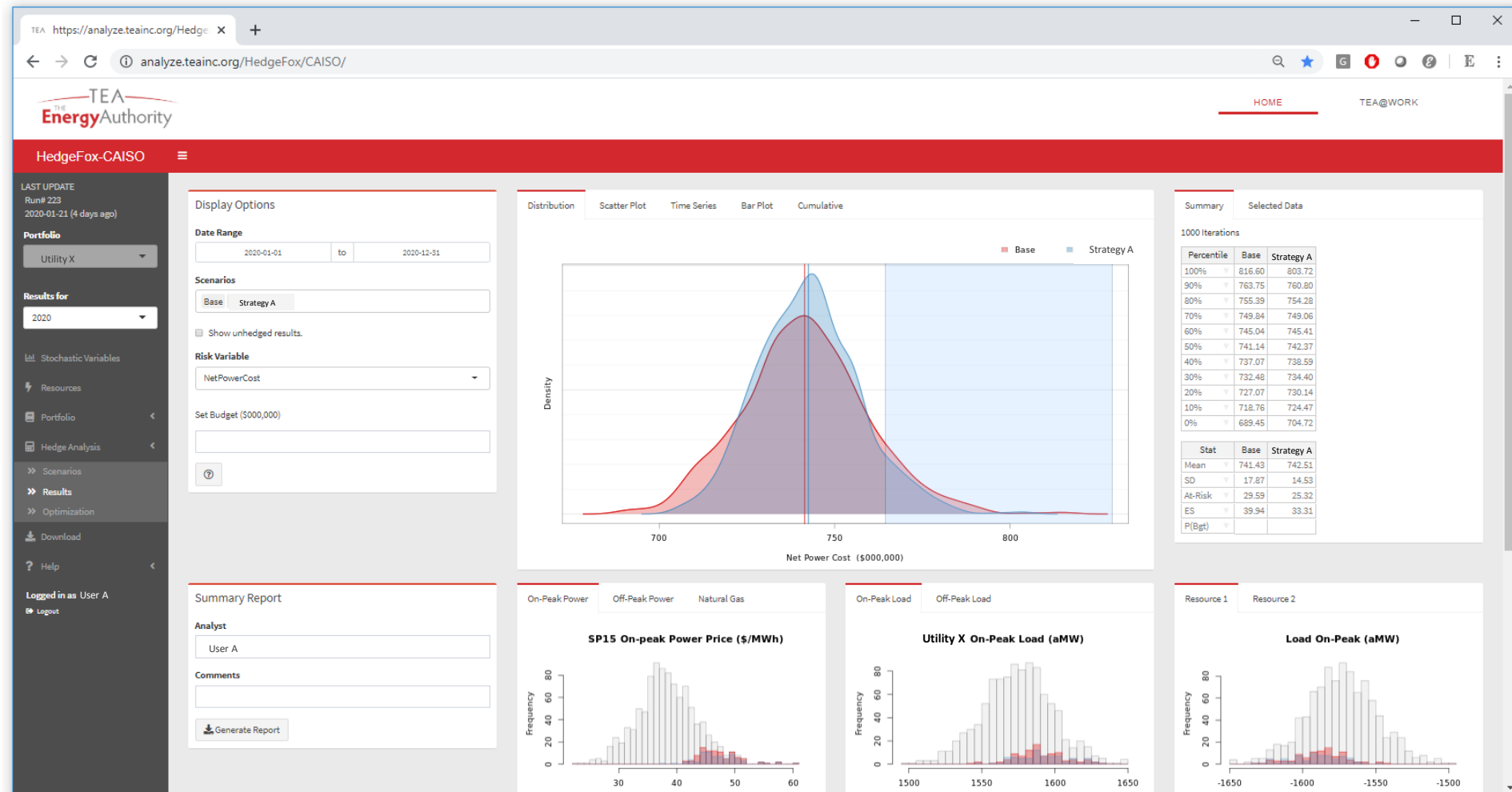
Modify Transactions

Save New Trades Modify Existing Trades Download Open Trades Download All

TradeID	HedgeID	TradeDate	TransactionType	Reference	ContractPeriod	IsQuarterly	BuySell	Commodity	TradeType	PeakType	Volume	Price	HedgeLevel	Delta	SpreadALL	SpreadHLH	SpreadLLH	Gamma	Notes
						<input type="checkbox"/>													
						<input type="checkbox"/>													
						<input type="checkbox"/>													
1035	423	03/11/2020	Hedge		2020-04	<input type="checkbox"/>	SELL	Electricity	Swap (P)	Peak	-50.00	20.40	30%	0.57	1.06	2.91	-1.49	0.06	
1033	423	03/11/2020	Hedge		2020-04	<input type="checkbox"/>	BUY	Gas	Swap (G)	-	5000.00	1.71	30%	0.57	1.06	2.91	-1.49	0.06	
1032	422	03/04/2020	Hedge		2020-04	<input type="checkbox"/>	SELL	Electricity	Swap (P)	Off-Peak	-25.00	12.00	10%	0.14	-0.82	1.04	-3.36	0.03	
1031	422	03/04/2020	Hedge		2020-04	<input type="checkbox"/>	BUY	Gas	Swap (G)	-	2500.00	1.42	10%	0.14	-0.82	1.04	-3.36	0.03	
1030	421	03/03/2020	Hedge		2022-Q1	<input checked="" type="checkbox"/>	SELL	Electricity	Swap (P)	Peak	-25.00	32.50	20%	0.71	3.45	6.14	-0.02	0.05	
1028	421	03/03/2020	Hedge		2022-Q1	<input checked="" type="checkbox"/>	BUY	Gas	Swap (G)	-	2500.00	2.86	20%	0.71	3.45	6.14	-0.02	0.05	
1027	420	03/02/2020	Hedge		2020-06	<input type="checkbox"/>	SELL	Electricity	Swap (P)	Peak	-25.00	16.25	30%	0.35	-1.83	2.08	-7.17	0.08	
1025	420	03/02/2020	Hedge		2020-06	<input type="checkbox"/>	BUY	Gas	Swap (G)	-	5000.00	1.26	30%	0.35	-1.83	2.08	-7.17	0.08	
1024	419	02/19/2020	Unwind		2020-05	<input type="checkbox"/>	BUY	Electricity	Swap (P)	Peak	25.00	12.25	0%	0.01	-5.17	-1.70	-9.20	0.00	

Portfolio Risk Analysis

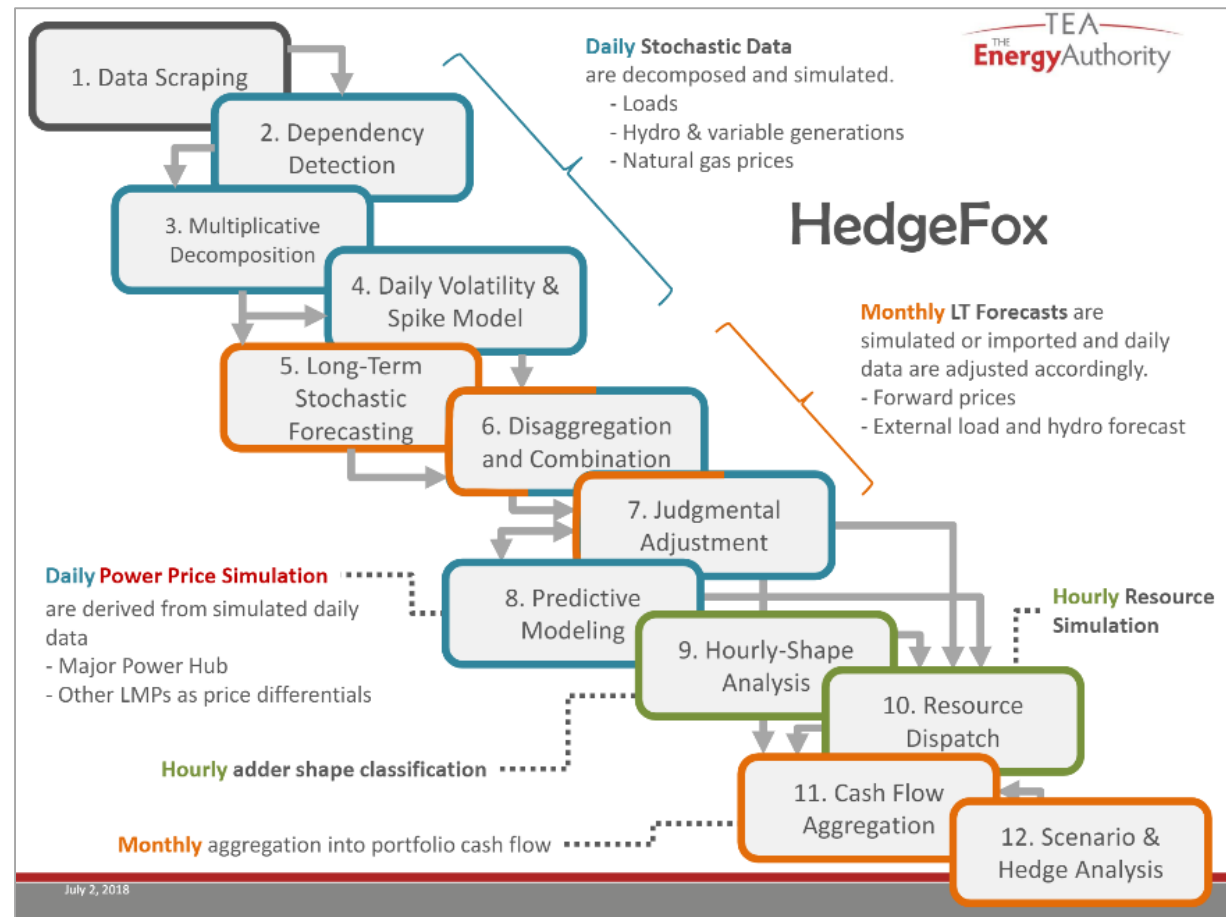
Human + Machine Collaboration



Background on this model

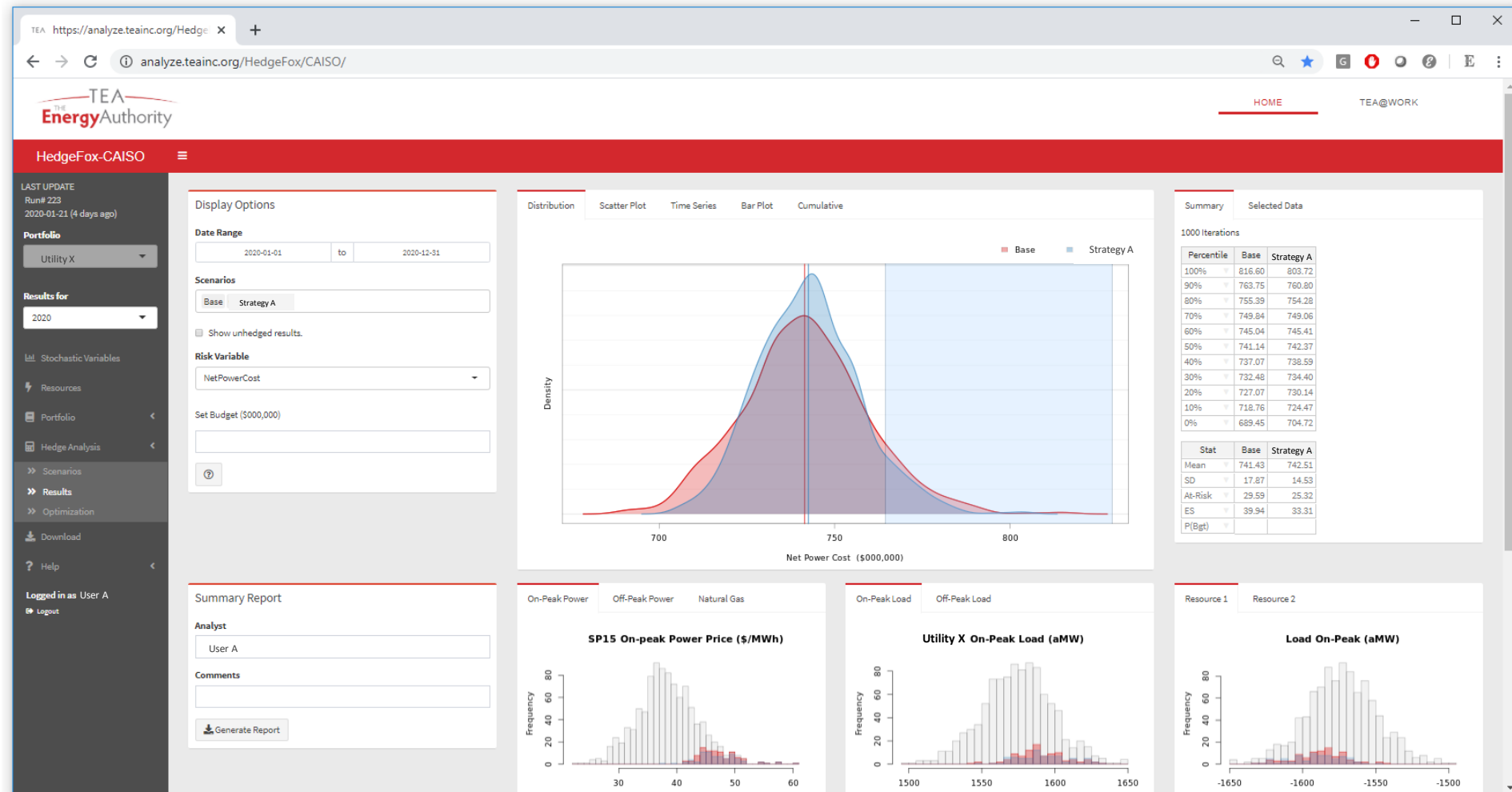
Stats + ML in R

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



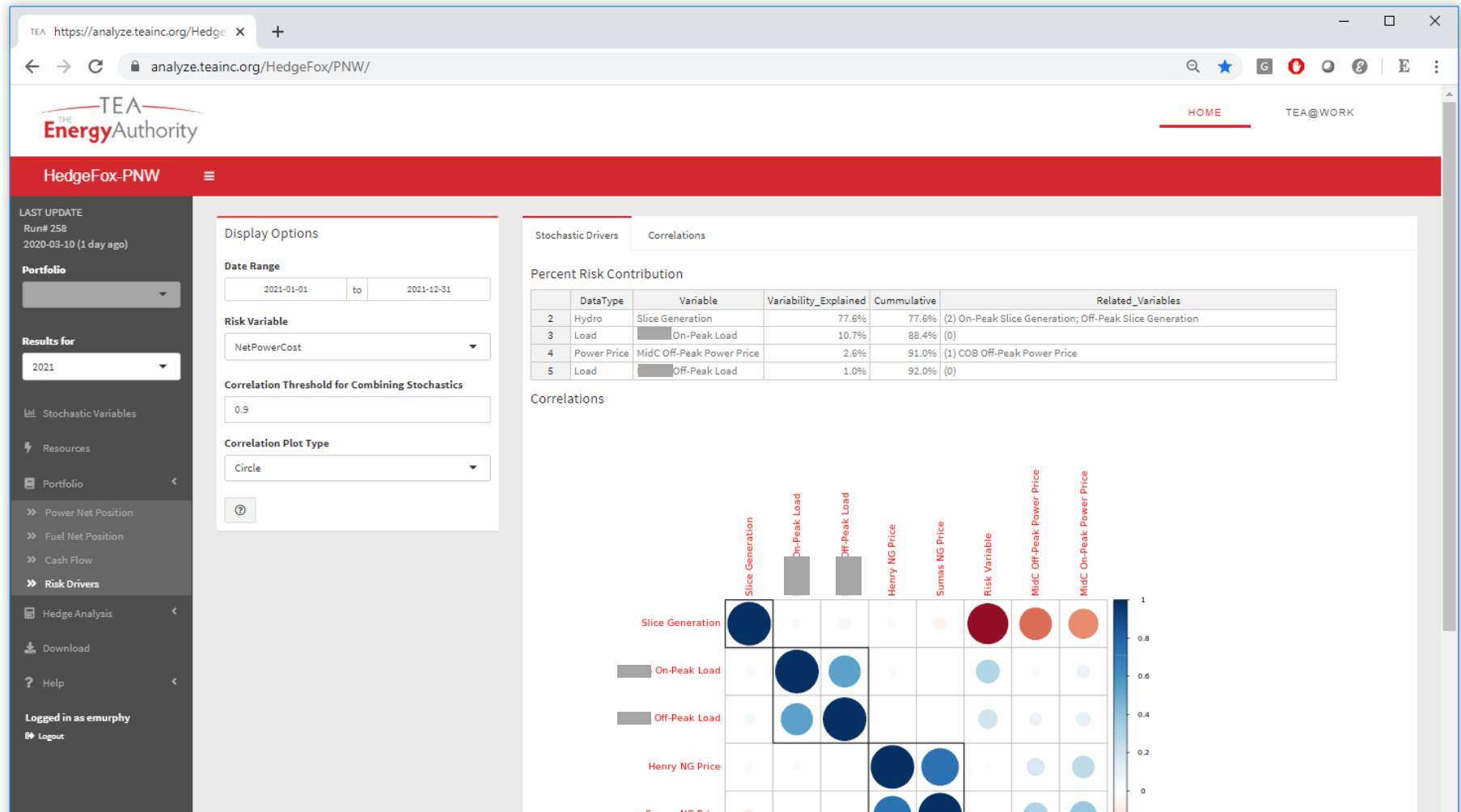
Portfolio Risk Analysis

Visualize Portfolio Risk



Whitening Black Boxes

Approximate a Black Box with an Interpretable Model



Hedge Analysis

Analyze Hypothetical Hedge Scenarios

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HedgeFox-CAISO

LAST UPDATE

Run# 81

2020-01-31 (41 days ago)

Portfolio

Results for

Multiple Years

[Stochastic Variables](#)
[Resources](#)
[Portfolio](#)
[Hedge Analysis](#)

[Scenarios](#)
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Hypothetical Scenario Definition

The scenario table was last modified on 2019-12-19.

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

[Save](#)

Data Reference

Transaction Cost

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	May-21
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	

Option Valuation

Custom Hedge Valuation

Location

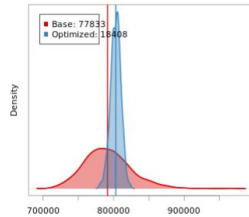
SP15 Power

Period

Hedge Optimization



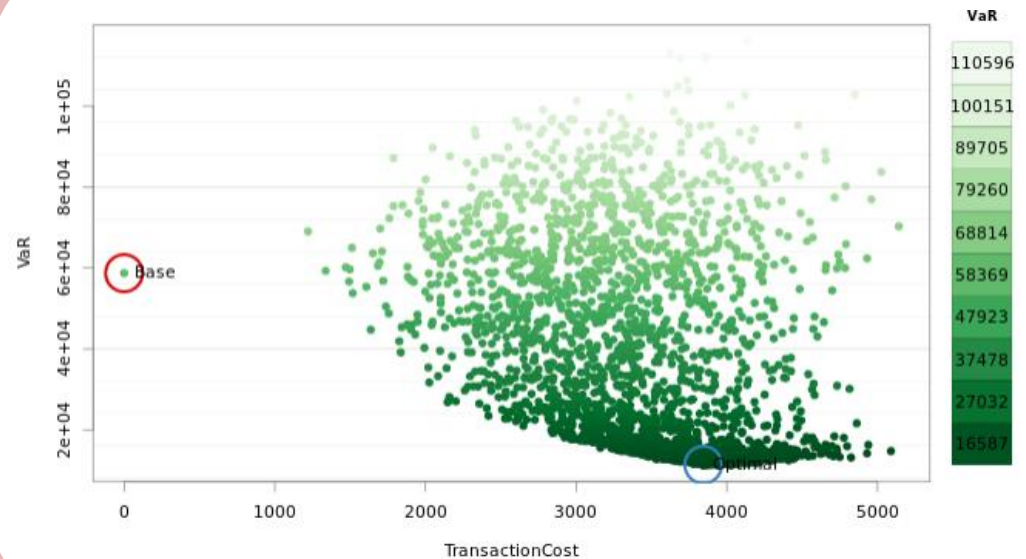
What's my optimal strategy?



	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?

...

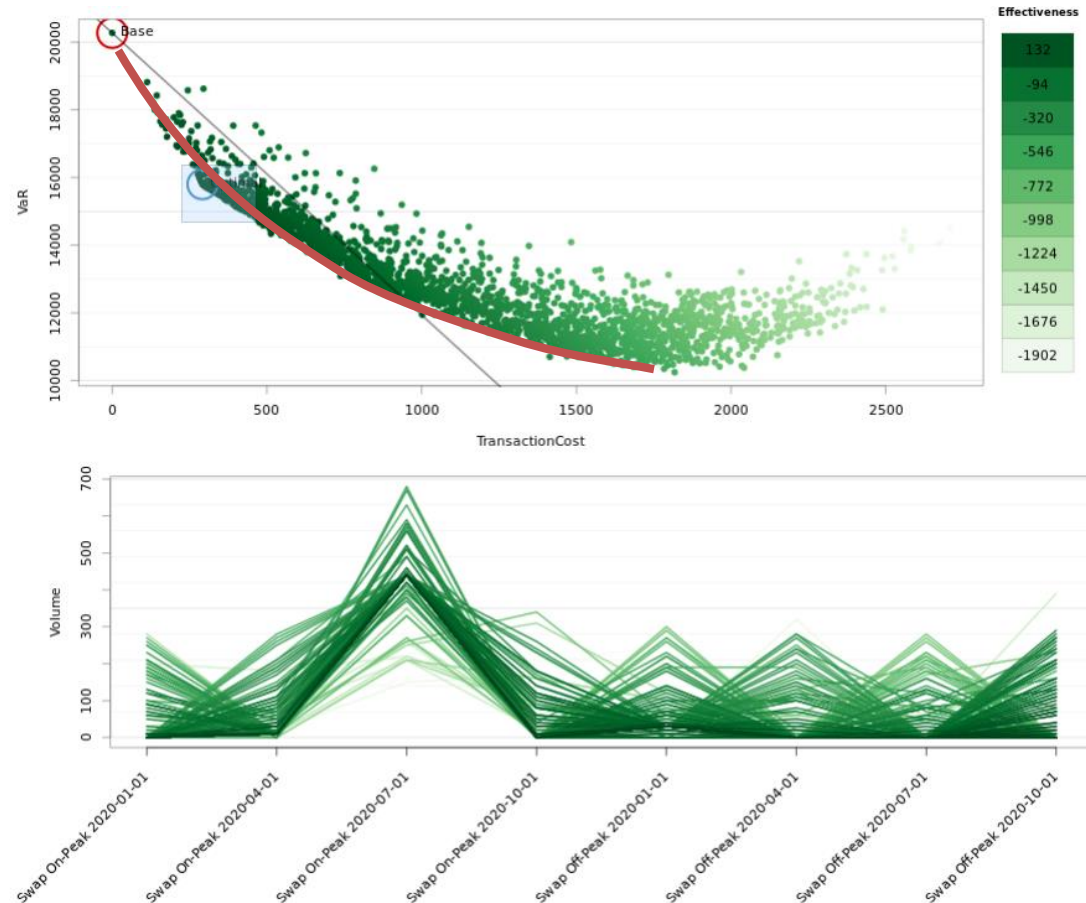


Can I pick another strategy?

Explore alternative solutions

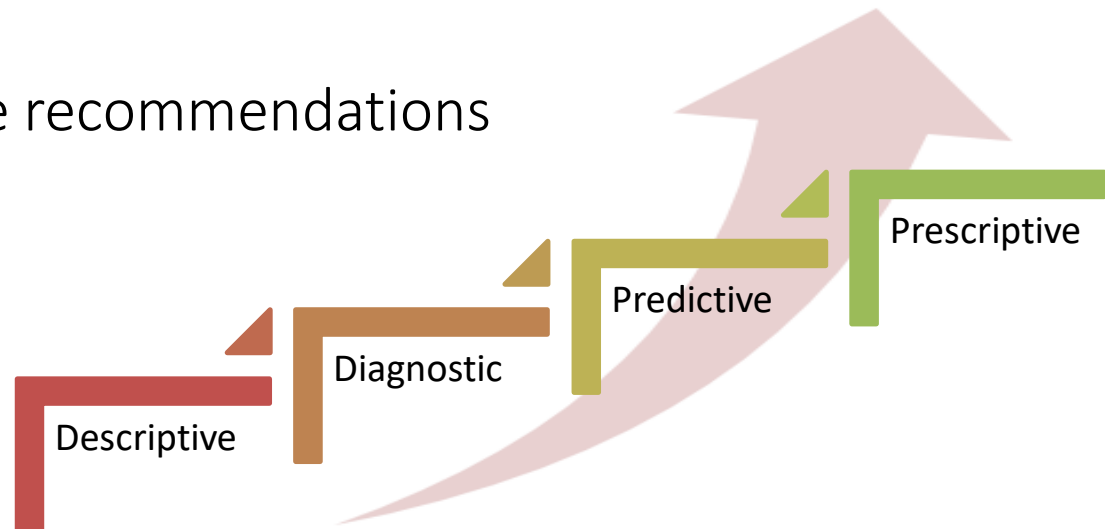
Lessons Learned

- 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...

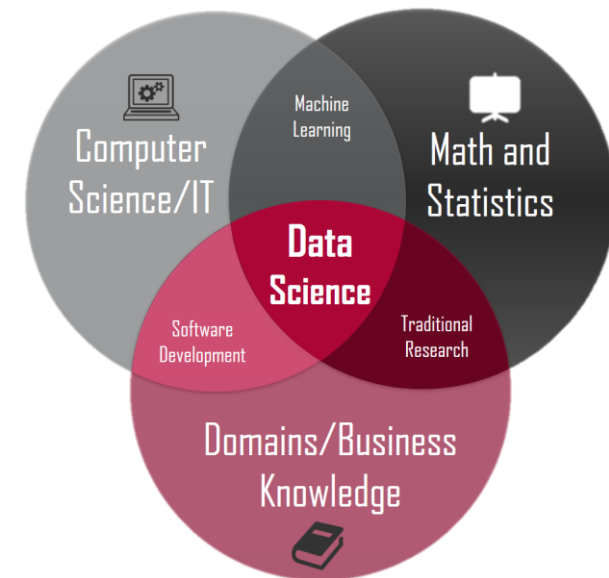
An App is “Operational” When

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

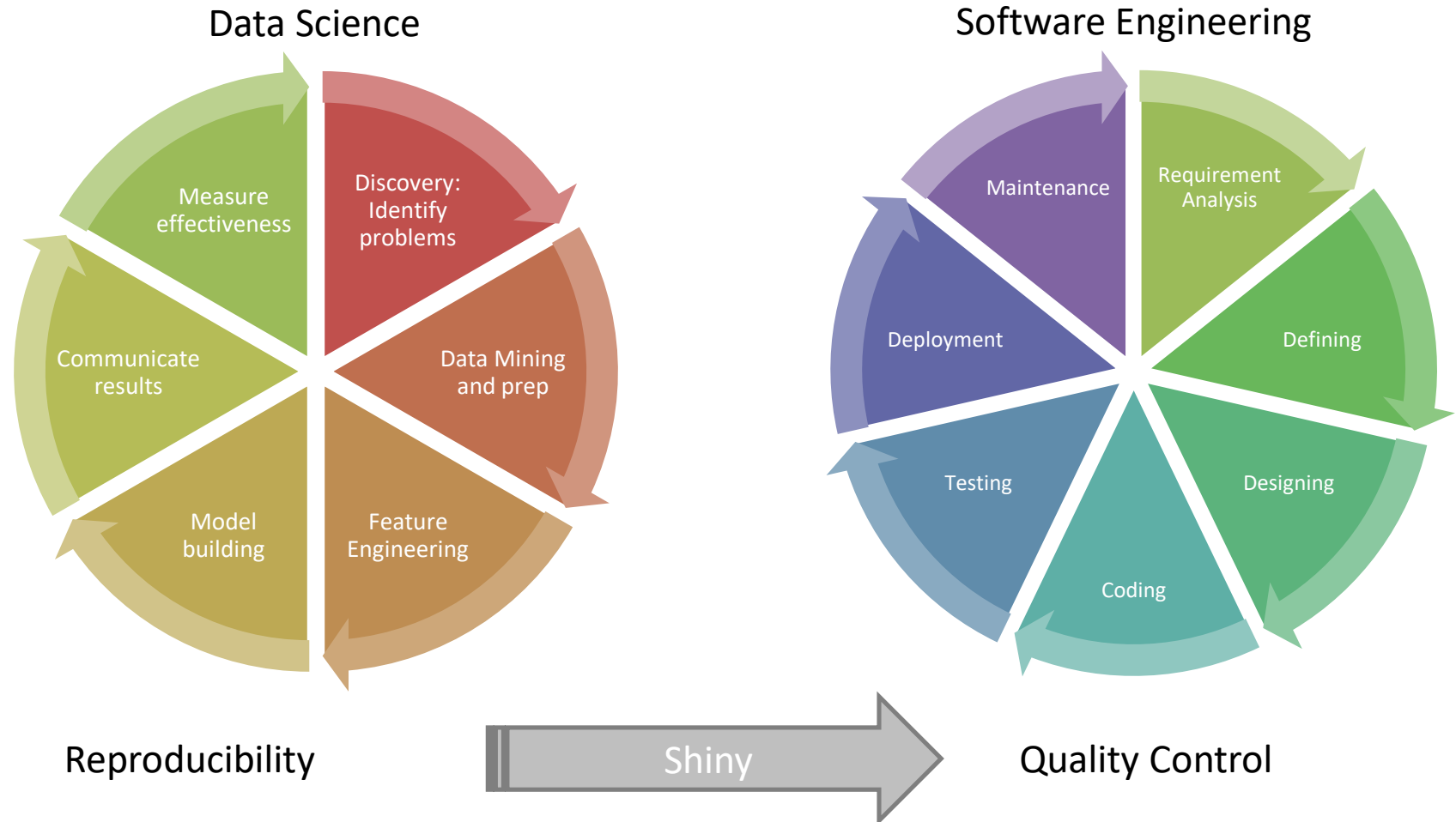


How many hats do you wear?

- 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

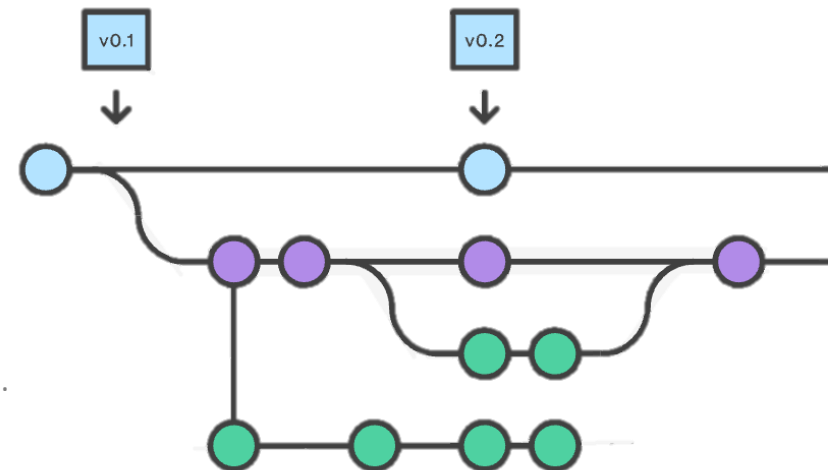


Life Cycles

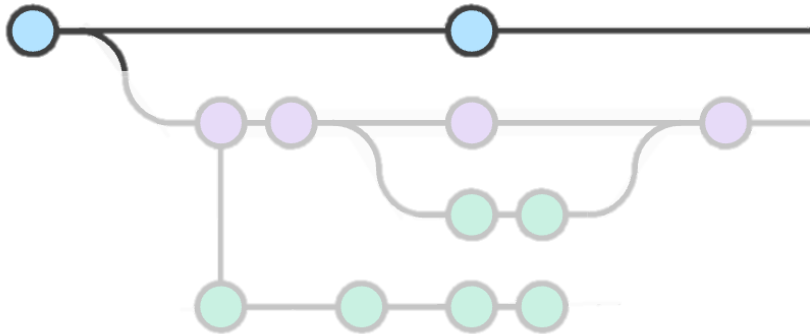


Quality Control

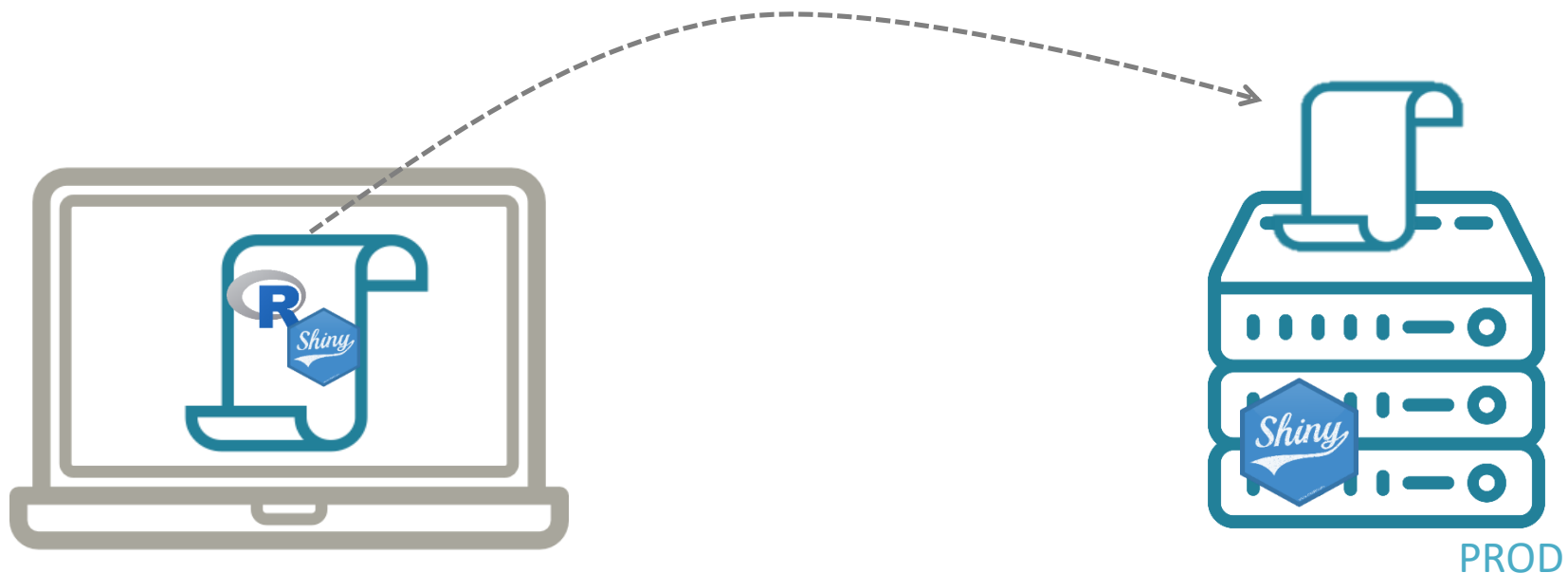
- Separation of Dev/Staging/PROD environments
 - Scripts, databases, shiny servers.
- Use of source control
 - Git + GitHub
- Support plans
 - Apps and models always fail at the most inconvenient times.
- Error handling
 - Users always come up with a way to produce errors.



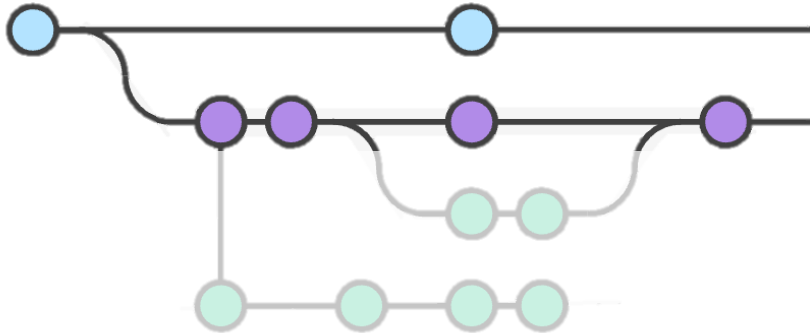
Environment Differentiation



- 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

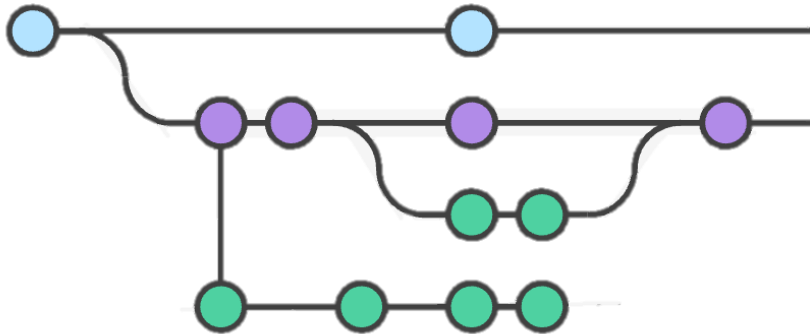


Staging



PROD

Environment Differentiation



- Couple shiny apps with scheduled tasks and live data.



Dev

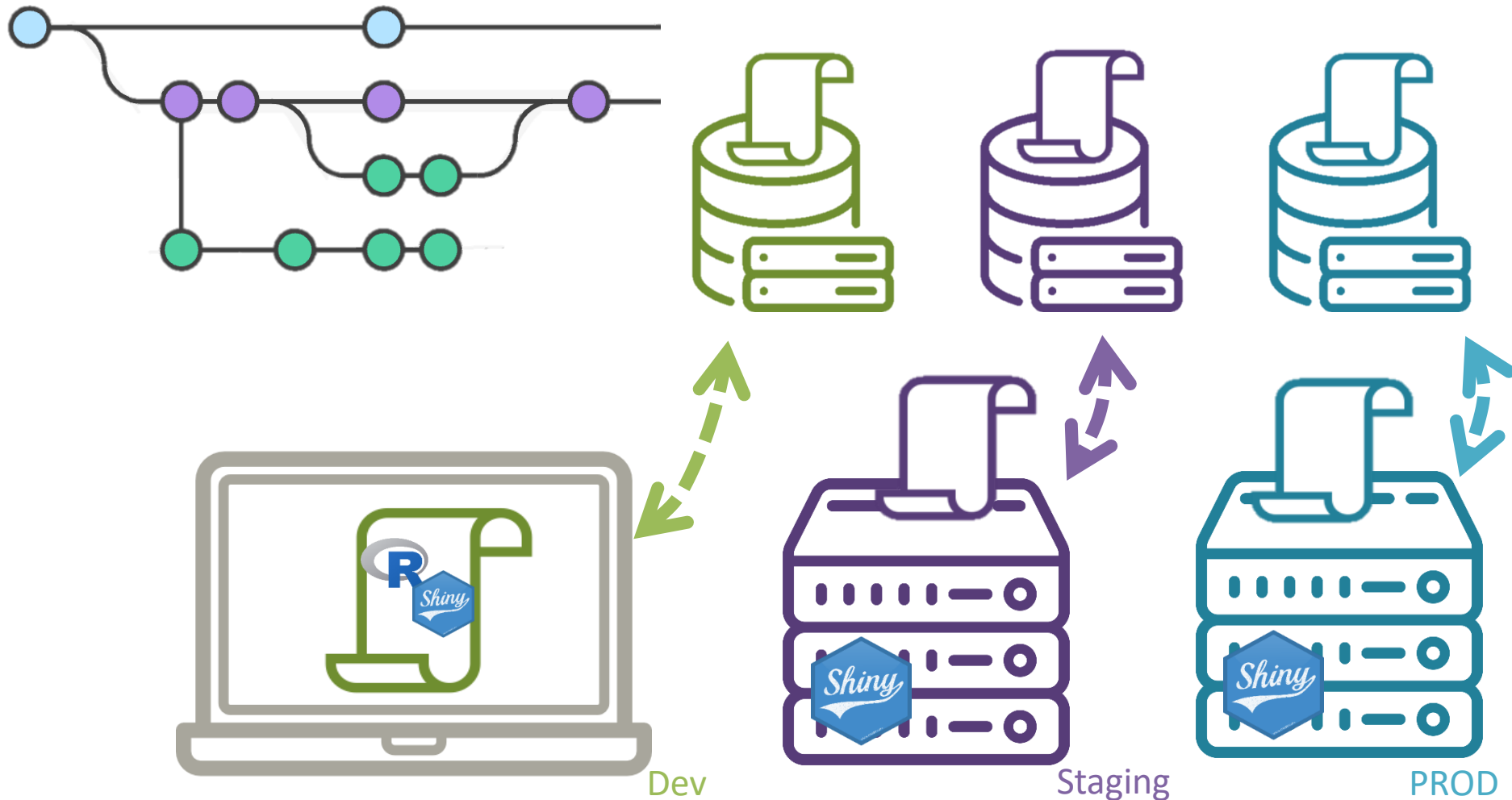


Staging



PROD

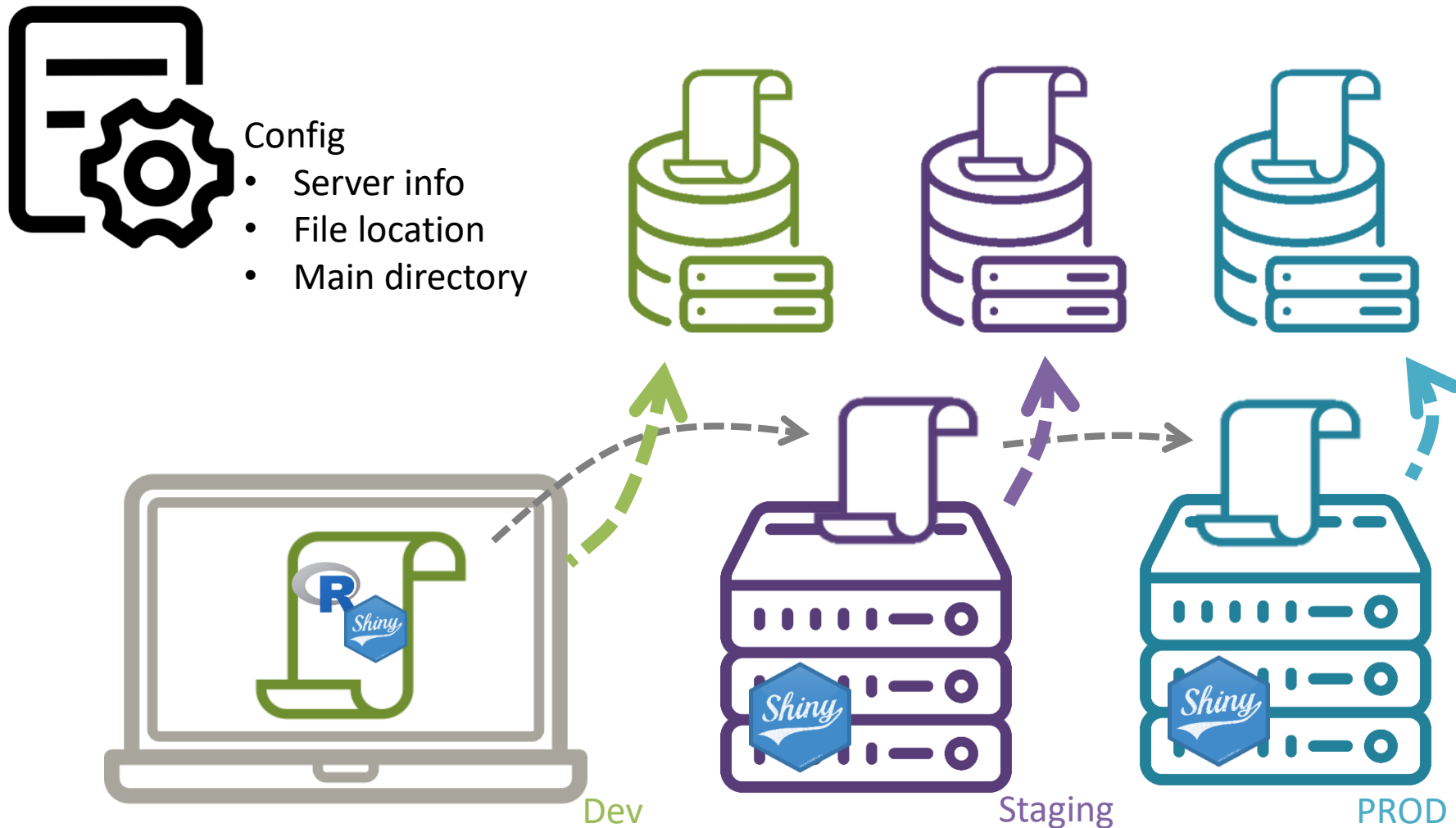
Environment Differentiation



(Random) Tips and Tricks

FOR SHINY USERS

Managing environments



'Config' 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.

```
## =====
## Master config file
## < Cascadia >
##
## author: Eina Ooka
## Note: Please do not change this file without asking the aut
## =====

default:
  dir.main: "c:/Users/{USERNAME}/Desktop/{proj}/"
  dir.main_shiny: "C:/Users/{USERNAME}/Desktop/{proj}/"
  # Analytics DB
  Ozette.dsn: "Driver={SQL Server}; Server=
  Ozette_shiny.dsn: "Driver={SQL Server}; S
  HedgeFox.dsn: "Driver={SQL Server}; Serve
  HedgeFox_shiny.dsn: "Driver={SQL Server};

# Zema
zema.username:
zema.password:
# shiny settings
shiny.sanitize.errors: FALSE
dir.restart: "C:/Users/{USERNAME}/Desktop/{proj}/RCode/shiny/"

PROD:

# shiny settings
shiny.sanitize.errors: TRUE

staging:
  dir.main:
  dir.main_s
```

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.

Error: cannot open the connection

Controlled safe message:

Messages are more meaningful.

Error: Data was not found for MISO.

Uncontrolled with error-sanitizer:

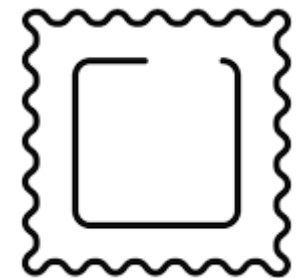
Error: An error has occurred. Check your logs or contact the app author for clarification.

Module

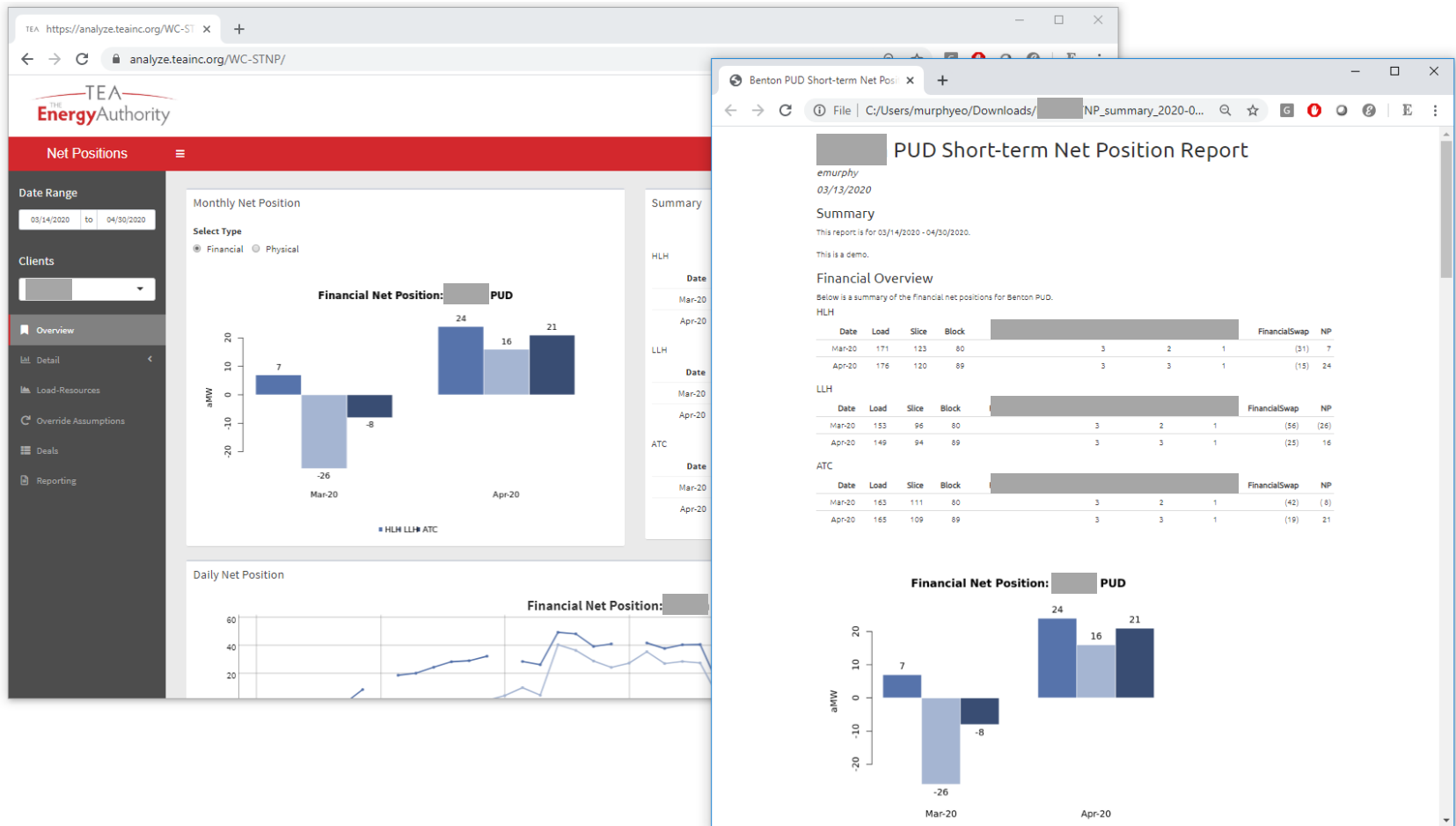
Reactive Spaghetti to Reactive Ravioli

“ 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.

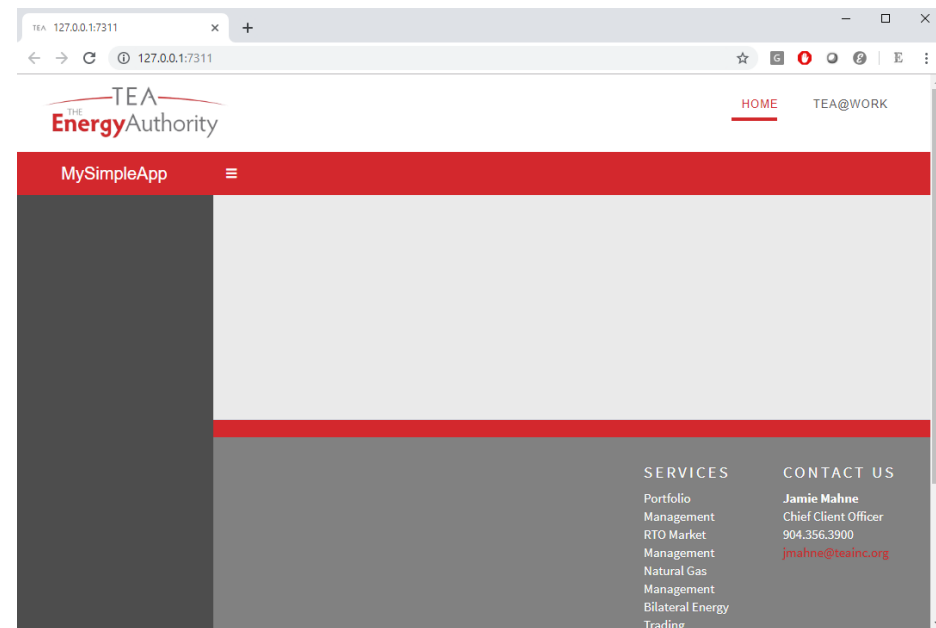


RMarkdown



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