

R Optimization Infrastructure

ROI

Installation

Introduction

Use Cases

Mixed topics

FAQ

What's

ROI

Extensions

Installation

Package

Repository

1	ROI.plugin.alabama	https://r-forge.r-project.org/src/contrib , http://R-Forg...
2	ROI.plugin.cbc	https://github.com/dirkSchumacher



Optimization for Finance

With ROI Package (Part 2: Nonlinear Optimization)

Difficulty: **Intermediate**

10 ROI.plugin.ipsoive

https://r-forge.r-project.org/src/contrib/ROI.plugin.ipsoive_0.1.0.tar.gz

High-Performance

Matt Dancho & David Curry
Business Science Learning Lab



Learning Lab Structure

- **Presentation**
(20 min)

- **Demo's**
(20 min)

- **Pro-Tips**
(20 mins)



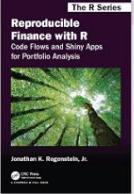
Learning Lab 15
Quantitative Business Decision-Making Using
R's Optimization Toolchain
TUESDAY, JULY 30 @ 2PM EST

SPECIAL GUEST

Jonathan Regenstein

Director of Financial Services, RStudio

Jonathan is the Director of Financial Services at RStudio and the author of **Reproducible Finance with R** (CRC Press). He writes the Reproducible Finance blog series for RStudio and his code/apps can be seen at www.reproduciblefinance.com. Prior to joining RStudio, he worked at JP Morgan, studied international relations at Harvard University and did graduate work in political economy at Emory University.



Your Hosts!



Matt Dancho
Founder of Business Science. Matt designs and executes educational courses and workshops that deliver immediate value to organizations. His passion is up-leveling future data scientists coming from untraditional backgrounds.



David Curry
Founder of Sure Optimize. David works with businesses to help improve website performance and SEO using data science. His passion is ethical Machine Learning initiatives.



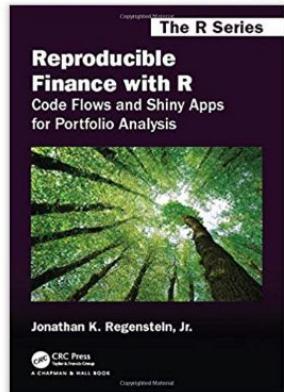
Reproducible Finance with R

Reproducible Finance with R: Code Flows and Shiny Apps for Portfolio Analysis (Chapman & Hall/CRC The R Series) 1st Edition

by Jonathan K. Regenstein Jr. (Author)

★★★★★ 20 customer reviews

Look inside ↓



ISBN-13: 978-1138484221

ISBN-10: 1138484229

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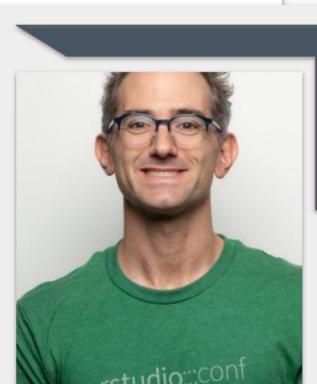
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Success Story

Luis Francisco Gomez Lopez

- Economist & Student
- Started courses 2 months ago
- Was using Excel
- Completely switched to R
- Latest report & homework assignment
- **TOTAL TRANSFORMATION!**



“Without the BSU courses, I couldn’t do what I’m doing.”



Gross Domestic Product (GDP)

Real and Nominal GDP

- Enter into the World Bank's Human Development Indicators database using the link:

<https://databank.worldbank.org/source/world-development-indicators>

- In Country select Venezuela, RB
- In Series select GDP (current LCU)
- In Time select VIEW RECENT YEARS: 50
- Apply changes and download the data using Download options > Excel at the upper right corner of the platform

1. Make a plot of the Nominal GDP of Venezuela, RB where the x-axis corresponds to the years and y-axis corresponds to the value of the Nominal GDP. (4 points)



Nominal GDP Venezuela, RB
Variable code WDI: NY.GDP.MKTP.CN - Variable units: current LCU

Source: World Bank - World Development Indicators (WDI)
Last update date: 2019/07/10

#BusinessScienceSuccess

Agenda

2 Parts



Part 1 (Lab 15)

Product Mix Problem

Linear Programming

If you missed this, join
Learning Labs PRO

A	B	C	D	E	F	G	H	I	J	
Assembling and Testing Macbooks										
Cost per labor hour assembling	\$14									
Cost per labor hour testing, line 1	\$22									
Cost per labor hour testing, line 2	\$19									
Inputs for assembling and testing a Macbook										
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8		
Labor hours for assembly	4	5	5	5	5.5	5.5	5.5	6		
Labor hours for testing, line 1	1.5	2	2	2	2.5	2.5	2.5	3		
Labor hours for testing, line 2	2	2.5	2.5	2.5	3	3	3.5	3.5		
Cost of component parts	\$900	\$1,350	\$1,350	\$1,350	\$1,500	\$1,500	\$1,500	\$1,800		
Selling price	\$2,100	\$2,700	\$2,760	\$2,820	\$3,000	\$3,150	\$3,180	\$3,600		
Unit margin, tested on line 1	\$1,111	\$1,236	\$1,296	\$1,356	\$1,368	\$1,518	\$1,548	\$1,650		
Unit margin, tested on line 2	\$1,106	\$1,233	\$1,293	\$1,353	\$1,366	\$1,516	\$1,537	\$1,650		
Assembling, testing plan (# of Macbooks)										
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8		
Number tested on line 1	1500	0	0	0	0	100	1000	0		
Number tested on line 2	0	0	0	0	0	900	0	500		
Total computers produced	1500	0	0	0	0	1000	1000	500		
<=	<=	<=	<=	<=	<=	<=	<=	<=		
Maximum sales	1500	1250	1250	1250	1000	1000	1000	800		
Constraints (hours per month)										
	Hours used		Hours available							
Labor availability for assembling	20000		<= 20000							
Labor availability for testing, line 1	5000		<= 5000							
Labor availability for testing, line 2	4450		<= 6000							
Net profit (\$ per month)										
Tested on line 1	\$1,666,500	\$0	\$0	\$0	\$0	\$151,800	\$1,548,000	\$0	\$3,366,300	
Tested on line 2	\$0	\$0	\$0	\$0	\$0	\$1,364,400	\$0	\$824,750	\$2,189,150	
									\$5,555,450	

```
89 model_2 <- MIPModel() %>%
90
91   add_variable(macbooks_tested_line_1[i], i = 1:n_models, type = "integer", lb = 0) %>%
92   add_variable(macbooks_tested_line_2[i], i = 1:n_models, type = "integer", lb = 0) %>%
93
94   add_constraint(macbooks_tested_line_1[i] + macbooks_tested_line_2[i] <= max_sales[i], i = 1:n_models) %>%
95
96   add_constraint(sum_expr((macbooks_tested_line_1[i] + macbooks_tested_line_2[i]) * labor_hours_for_assembly[i], i = 1:n_models) <= max_labor[1]) %>%
97   add_constraint(sum_expr((macbooks_tested_line_1[i]) * labor_hours_for_testing_line_1[i], i = 1:n_models) <= max_labor[2]) %%%
98   add_constraint(sum_expr((macbooks_tested_line_2[i]) * labor_hours_for_testing_line_2[i], i = 1:n_models) <= max_labor[3]) %>%
99
100  set_objective(
101    sum_expr(macbooks_tested_line_1[i] * unit_margin_line_1[i] + macbooks_tested_line_2[i] * unit_margin_line_2[i], i = 1:n_models),
102    sense = "max") %>%
103
104  solve_model(with_ROI(solver = "glpk"))
```



Part 2 (Today)

Stock Portfolio Optimization

Nonlinear Programming

R has 19 Solvers
that are written in
High-Performance
C++ / Fortran

Package	Repository
1 ROI.plugin.alabama	https://github.com/ropensci/alabama
2 ROI.plugin.cbc	https://github.com/cbc-solver/cbc-solver
3 ROI.plugin.clp	https://github.com/concorde-open-source-project/clp
4 ROI.plugin.cplex	http://ilrcforge.r-project.org/
5 ROI.plugin.dynamite	https://github.com/ropensci/dynamite
6 ROI.plugin.ecos	https://github.com/ropensci/ecos
7 ROI.plugin.gurobi	http://ilrcforge.r-project.org/gurobi
8 ROI.plugin.gurobi	http://ilrcforge.r-project.org/gurobi
9 ROI.plugin.ipopt	http://ilrcforge.r-project.org/ipopt
10 ROI.plugin.jools	https://github.com/ropensci/jools
11 ROI.plugin.mosek	http://ilrcforge.r-project.org/mosek
12 ROI.plugin.mosekdp	http://ilrcforge.r-project.org/mosekdp
13 ROI.plugin.nlopt	https://github.com/ropensci/nlopt
14 ROI.plugin.nlopt	https://github.com/ropensci/nlopt
15 ROI.plugin.optimizer	https://github.com/ropensci/optimizer , http://ilrcforge.r-project.org/optimizer
16 ROI.plugin.oozannes	http://ilrcforge.r-project.org/oozannes
17 ROI.plugin.quadprog	http://ilrcforge.r-project.org/quadprog
18 ROI.plugin.scs	http://ilrcforge.r-project.org/scs
19 ROI.plugin.symphony	http://ilrcforge.r-project.org/symphony



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Lab 15 **R's Optimization Toolchain, Part 1**

Lab 14 **Customer Churn Survival Analysis**

Lab 13 **Wrangling 4.6M Rows of Financial Data w/ `data.table`**

Lab 12 **How I built `anomalize`**

Lab 11 **Market Basket Analysis w/ `recommenderLab`**

Lab 10 **Building API's with `plumber` & `postman`**

Lab 9 **Finance in R with `tidyquant`**



Learning Labs Pro

Community-Driven Data Science Courses

 Matt Dancho

\$19/m

R in Industry

The power of R for trading

The power of R for Trading

R is the best language in the world for doing **rapid financial analysis**



Ralph Sueppel

Head of Research and Quant Strategies at Macrosynergy Partners

The screenshot shows a LinkedIn Pulse article page. At the top right is a circular icon with a stylized blue and green line graph. The main header of the article is "The power of R for trading (part 1)". Below the header is a large, stylized blue "R" set against a background of abstract data visualizations and mathematical symbols. The author's profile picture, name "Ralph Sueppel", title "Head of Research and Quant Strategies at Macrosynergy Partners", and a "Follow" button are visible. The article summary discusses R as an object-oriented programming language for statistical analysis, highlighting its efficiency and functional programming features.

<https://www.linkedin.com/pulse/power-r-trading-part-1-ralph-sueppel/>

Financial Case Study

Optimize Stock Portfolio



Building a Financial Portfolio

Historical Stock Prices

We analyze the historical stock prices for
5 Stocks:

AAPL, AMZN, FB, GOOG, & NFLX

How do we determine an **optimal portfolio mix?**

The screenshot shows the GitHub project page for tidyquant. At the top, there's a navigation bar with tabs for Home, Function Reference, Vignettes, and News. Below the navigation is the project title "tidyquant" with a version of 0.5.6. To the right of the title is a green hexagonal logo featuring a line graph. The main content area has a heading "tidyquant" and a brief description: "Bringing financial analysis to the tidyverse". It mentions that tidyquant integrates resources for collecting and analyzing financial data like zoo, xts, quantmod, TTR, and PerformanceAnalytics, and provides a tidy data infrastructure for the tidyverse. A "2-Minutes To Tidyquant" section includes a link to a YouTube video. On the right side, there are sections for "Links", "License" (MIT), "Developers" (Matt Dancho, Author, maintainer; Davis Vaughan, Author), and "Report a bug" (GitHub link). At the bottom, it says "Check out our entire Software Intro Series on YouTube!".



Modern Portfolio Theory

Minimize Variance

Harry Markowitz - Nobel Prize

What is the **lowest portfolio variance** that I can achieve a given **return objective**?

$$\min_{x \in \mathbb{R}^N} x^\top Q x$$
$$Q = \text{Cov}(r)$$

X						
Stock input data		AAPL	AMZN	FB	GOOG	NFLX
Mean return		0.18	0.39	0.37	0.19	0.81

Q		AAPL	AMZN	FB	GOOG	NFLX
Covariances		0.0451	-0.0407	0.0270	-0.0106	-0.0968
AAPL		0.0451	-0.0407	0.0270	-0.0106	-0.0968
AMZN		-0.0407	0.1926	0.0320	0.0880	0.2619
FB		0.0270	0.0320	0.1411	0.0620	0.2632
GOOG		-0.0106	0.0880	0.0620	0.0626	0.2291
NFLX		-0.0968	0.2619	0.2632	0.2291	1.1377

Efficient Frontier - What happens when we minimize risk

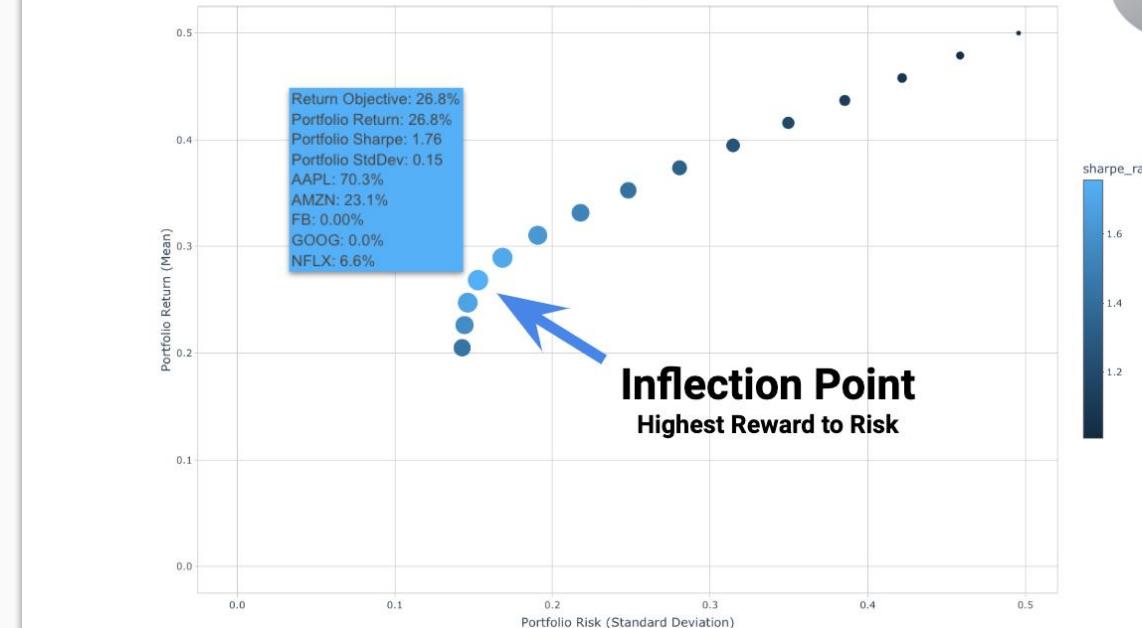


Efficient Frontier

What happens when we
adjust the
Portfolio Return Objective?

**Quantitative Decision
Making + Optimization**

Stock Portfolio Optimization in



Optimization (Recap)

80/20 Concepts



Terminology

1

Objectives

The **goal** of the model

Always Maximize or
Minimize.

2

Constraints

Decision Rules for the
model

Restricts the decision
variables to boundaries

3

Decision Variables

Your problem's **Frame of
Reference**

The parameters that your
**optimization model
adjusts**



**Decision Variables
(adjusted values)**

Constraints

Goal

Google Sheets Optimization - 3.0 Portfolio Optimization Model

Data

Calculation

Portfolio Optimization

Non-Linear Excel: Use GRG Nonlinear Solver Google Sheets: Use Satalia Solve Engine - Available with API Key

Stock input data

	AAPL	AMZN	FB	GOOG	NFLX
Mean return	0.18	0.39	0.37	0.19	0.81
StDev of return	0.21	0.44	0.38	0.25	1.07

Correlations

	AAPL	AMZN	FB	GOOG	NFLX
AAPL	1.00	-0.44	0.34	-0.20	-0.43
AMZN	-0.44	1.00	0.19	0.80	0.56
FB	0.34	0.19	1.00	0.66	0.66
GOOG	-0.20	0.80	0.66	1.00	0.86
NFLX	-0.43	0.56	0.66	0.86	1.00

Covariances

	AAPL	AMZN	FB	GOOG	NFLX
AAPL	0.0451	-0.0407	0.0270	-0.0106	-0.0968
AMZN	-0.0407	0.1926	0.0320	0.0880	0.2619
FB	0.0270	0.0320	0.1411	0.0620	0.2632
GOOG	-0.0106	0.0880	0.0620	0.0626	0.2291
NFLX	-0.0968	0.2619	0.2632	0.2291	1.1377

Investment decisions

	AAPL	AMZN	FB	GOOG	NFLX
Weights (Frac to Invest)	0.000	0.973	0.000	0.000	0.027

Constraint on investing everything

Total invested	Required value
1.000	1.00

Constraint on expected portfolio return

Actual return	Required return
0.4	0.4

Portfolio variance

MIN
0.1970
0.4438

$\min_{x \in \mathbb{R}^N} x^\top Q x$

$Q = \text{Cov}(r)$



Types of Optimization Models

Linear

- Fastest solutions
- Easy to conceptualize
- Analysis limited to aggregations, constant multiplications, etc
- Many problems don't fit this mold (e.g. take correlation of something)

Quadratic

- Fast solutions
- Difficult to Conceptualize
- Requires formulation as a quadratic function

Nonlinear

- Easy to conceptualize
- Super Flexible
- Cannot use linear solvers
- Slower solutions
- Can get suboptimal results (local vs global maxima)



Types of Optimization Models

Linear

- Fastest solutions
- Easy to conceptualize
- Analysis limited to aggregations, constant multiplications, etc
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Part 1

Quadratic

- Fast solutions
- Difficult to Conceptualize
- Requires formulation as a quadratic function

Nonlinear

- Easy to conceptualize
- Super Flexible
- Cannot use linear solvers
- Slower solutions
- Can get suboptimal results (local vs global maxima)

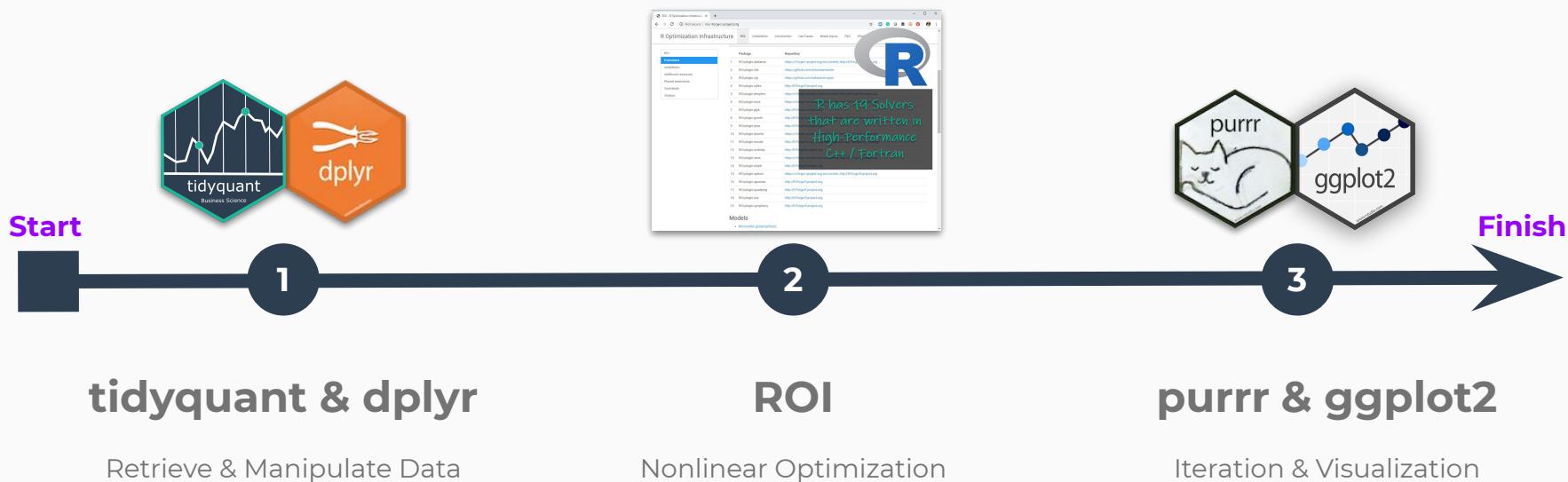
Part 2

Process & Tools

What we need to know

Financial Optimization Modeling

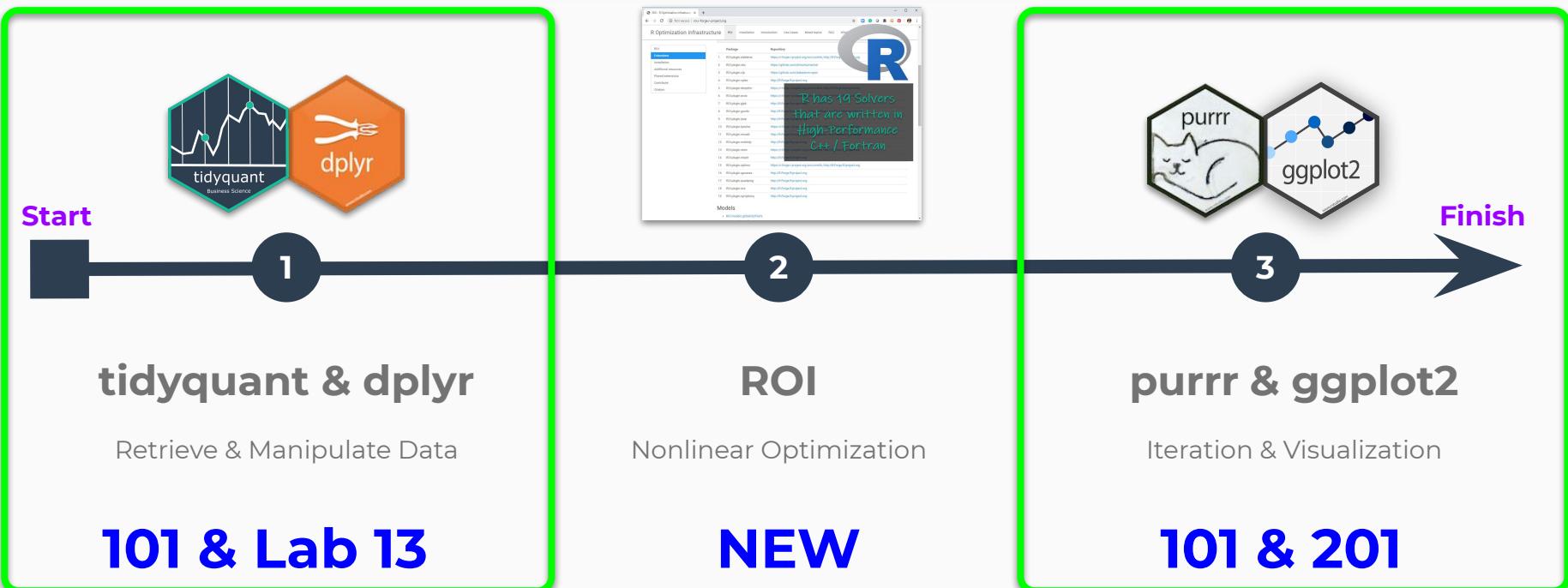
Step-By-Step





Financial Optimization Modeling

Step-By-Step



ROI Package

80/20 Concepts & Important
Operations

ROI

Conversion process is a bit trickier than what we learned in **Part 1**

Need to think in terms of **Matrix Calculations**

Nonlinear programming has 4 Super Powers

Using ROI



Decision Variables (adjusted variables)

Asset Weights for each stock

[w_aapl, w_amzn, w_fb, w_goog, w_nflx]

```
70 model_nlp <- OP(
71   objective  = F_objective(F = calc_portfolio_variance, n = n_assets, names = assets),
72   constraints = rbind(
73     F_constraint(F = calc_portfolio_return, dir = ">=", rhs = 0.40),
74     L_constraint(diag(n_assets), rep(">=", n_assets), rep(0, n_assets)),
75     L_constraint(diag(n_assets), rep("<=", n_assets), rep(1, n_assets)),
76     L_constraint(rep(1, n_assets), "==", 1)
77   ),
78   maximum = FALSE
79 )
80
81 tic()
82 sol <- ROI_solve(model_nlp, solver = "alabama", start = rep(1/n_assets, n_assets))
83 toc()
84
```

- **F_objective**
 - Minimize portfolio variance calculation
- **F_constraint** - Functional Constraint
 - Inputs asset weights, outputs port
 - Return objective set to 40% per year
- **L_constraint** - Linear Constraint
 - Bounding the weights



Nonlinear Super Power #1

Functional Objective

```
str(F_objective)

## function (F, n, G = NULL, H = NULL, names = NULL)

fo <- F_objective(F = function(x) sum(x^2), n = 2,
                  G = function(x) 2*x, names = c("x_1", "x_2"))
```



$$x_1^2 + x_2^2$$



Nonlinear Super Power #2

Functional Constraints

```
str(F_constraint)
```

```
## function (F, dir, rhs, J = NULL, names = NULL)
```

$$\begin{aligned}x^2 &\leq 2 \\y^2 &\leq 4\end{aligned}$$

```
fcl <- F_constraint(F = function(x) x^2, dir = c("<=", "<="), rhs = c(2, 4),
                      J = function(x) diag(x = 2, nrow = 2) * x,
                      names = c("x", "y"))
```





Nonlinear Super Power #3

Linear Constraints

```
str(L_constraint)
```

```
## function (L, dir, rhs, names = NULL)
```

$$\begin{aligned} 3x + 4y + 1z &\leq 90 \\ 1x + 0y + 2z &\geq 5 \\ 1x + 1y + 0z &= 2 \end{aligned}$$



```
lc <- L_constraint(L = rbind(c(3, 4, 1), c(1, 0, 2), c(1, 1, 0)),
                     dir = c("<=", ">=", "="), rhs = c(90, 5, 2),
                     names = c("x", "y", "z"))
```



Nonlinear Super Power #4

Put it all together

Can combine linear (matrix) & nonlinear programming (functions)

```
70 model_nlp <- OP(
71   objective  = F_objective(F = calc_portfolio_variance, n = n_assets, names = assets),
72   constraints = rbind(
73     F_constraint(F = calc_portfolio_return, dir = ">=", rhs = 0.40),
74     L_constraint(diag(n_assets), rep(">=", n_assets), rep(0, n_assets)),
75     L_constraint(diag(n_assets), rep("<=", n_assets), rep(1, n_assets)),
76     L_constraint(rep(1, n_assets), "==", 1)
77   ),
78   maximum = FALSE
79 )
80
81 tic()
82 sol <- ROI_solve(model_nlp, solver = "alabama", start = rep(1/n_assets, n_assets))
83 toc()
84
```

Demo

Optimizing a Stock Portfolio

AAPL, AMZN, FB, GOOG, NFLX

Optimization

Secret Tactics & Pro Tips

People get **frustrated** with

Optimization

Because they **fail to start simple**

Pro Tip

Design in Excel, then Convert to R



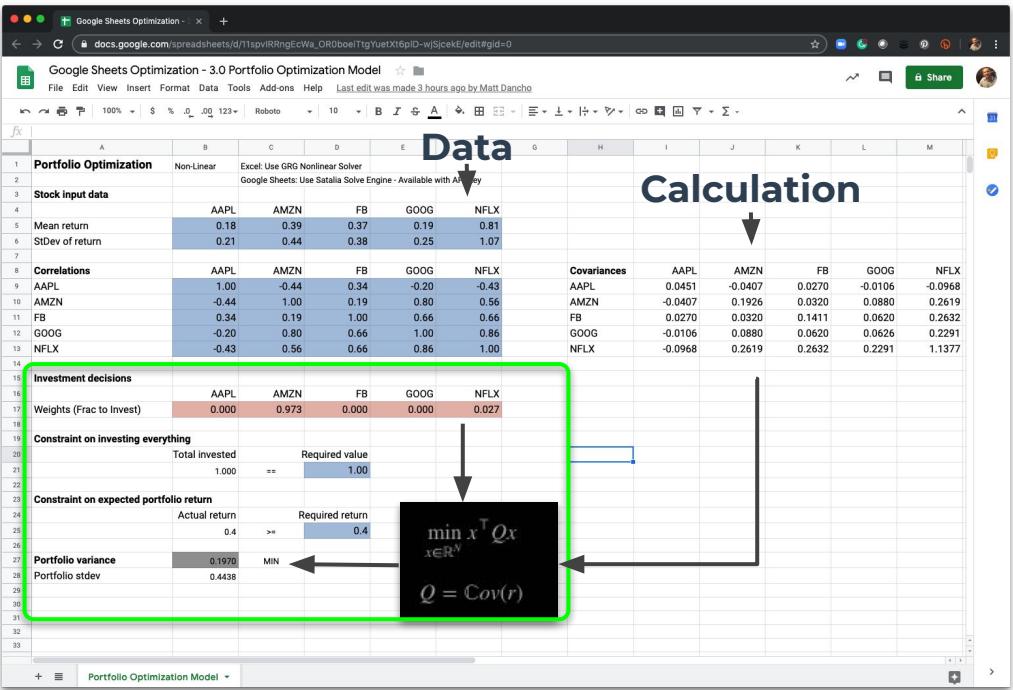
When starting out...

Pros:

Sometimes Excel is **easier** to conceptualize

Cons:

- Excel cannot scale (try to do **iterative analysis**)
- Excel cannot scale (try to add **1 more stock**)
- Excel has difficulties with **nonlinear** problems





Pro Tip

Design in Excel, then Convert to R

When starting out...

Cons:

Sometimes R is **more difficult** to conceptualize

Pros:

- R can scale (try to do **iterative analysis**)
- R can scale (try to add **1 more stock**)
- R is really good with **nonlinear** problems

```
70 model_nlp <- OP(  
71   objective  = F_objective(F = calc_portfolio_variance, n = n_assets, names = assets),  
72   constraints = rbind(  
73     F_constraint(F = calc_portfolio_return, dir = ">=", rhs = 0.40),  
74     L_constraint(diag(n_assets), rep(">=", n_assets), rep(0, n_assets)),  
75     L_constraint(diag(n_assets), rep("<=", n_assets), rep(1, n_assets)),  
76     L_constraint(rep(1, n_assets), "==", 1)  
77   ),  
78   maximum = FALSE  
79 )  
80 tic()  
81 sol <- ROI_solve(model_nlp, solver = "alabama", start = rep(1/n_assets, n_assets))  
82 toc()  
83
```

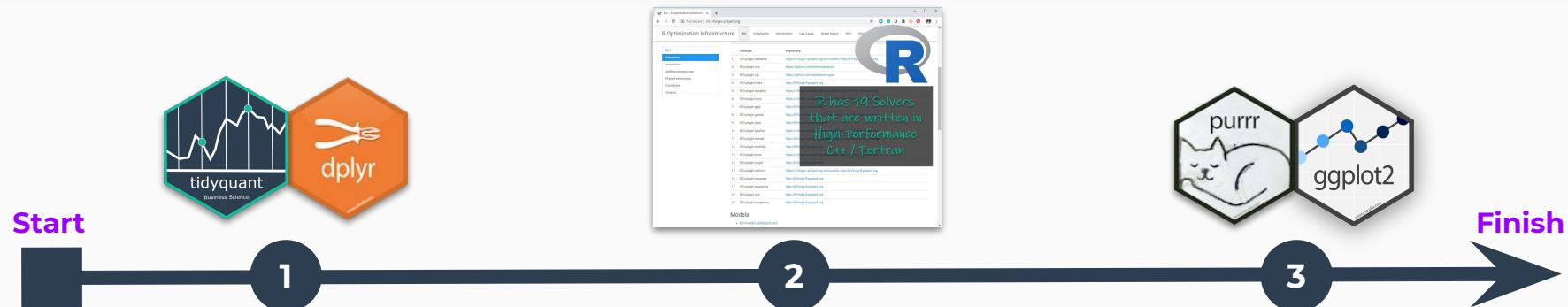
Data Science + Decision Science

Learning Plan



Financial Optimization Modeling

Step-By-Step



tidyquant & dplyr

Retrieve & Manipulate Data

101 & Lab 13

Lab 16

purrr & ggplot2

Iteration & Visualization

101 & 201

dplyr + tidyquant



```
22 # 2.0 DATA ----
23 assets <- c("FB", "AMZN", "AAPL", "GOOG", "NFLX") %>% sort()
24
25 stock_prices_tbl <- tq_get(assets, from = "2013-01-01", to = "2019-07-01")
26
27 stock_returns_tbl <- stock_prices_tbl %>%
28   select(symbol, date, adjusted) %>%
29   group_by(symbol) %>%
30   tq_transmute(adjusted, mutate_fun = periodReturn, period = "yearly", col_rename = "returns")
31
32 returns_matrix_tbl <- stock_returns_tbl %>%
33   spread(symbol, returns) %>%
34   select(assets)
35
36 returns_matrix_tbl
37
```

Lab 13



```
130 # 4.3.1 Heat Map ----
131 plot_heatmap <- function(data) {
132
133   data_transformed_tbl <- data %>%
134     mutate(sharpe_ratio = portfolio_return / portfolio_stdev) %>%
135     mutate(portfolio_id = row_number()) %>%
136     gather(key = stock, value = weight,
137            -sharpe_ratio, -portfolio_return, -portfolio_stdev,
138            -portfolio_id, -return_constraint,
139            factor_key = TRUE) %>%
140     mutate(return_objective = scales::percent(return_constraint)) %>%
141     mutate(label_text = str_glue("Return Objective: {scales::percent(return_constraint)}\n"
142                                 "Portfolio Return: {scales::percent(portfolio_return)}\n"
143                                 "Portfolio Sharpe: {round(sharpe_ratio, 2)}\n"
144                                 "Portfolio StdDev: {round(portfolio_stdev, 2)}"))
```

101



R Optimization Infrastructure

Extensions

Installation

Add-on resources

Planned extensions

Contributors

Changelog

Package Repository

- 1 ROI plugin alabama <http://r-forge.r-project.org/scm/viewvc.cgi/ROI/R/trunk/src/alabama.c?view=markup&root=ROI>
- 2 ROI plugin cbc <http://github.com/dirkchmehel>
- 3 ROI plugin cjp <http://github.com/tstatom/cjp>
- 4 ROI plugin optee <http://RForge.R-project.org>
- 5 ROI plugin deoptim <http://RForge.R-project.org>
- 6 ROI plugin ecos <http://RForge.R-project.org>
- 7 ROI plugin glpk <http://RForge.R-project.org>
- 8 ROI plugin gurobi <http://RForge.R-project.org>
- 9 ROI plugin ipso <http://RForge.R-project.org>
- 10 ROI plugin lpsolve <http://RForge.R-project.org>
- 11 ROI plugin mosek <http://RForge.R-project.org>
- 12 ROI plugin moseqlp <http://RForge.R-project.org>
- 13 ROI plugin nest <http://RForge.R-project.org>
- 14 ROI plugin nlopt <http://RForge.R-project.org>
- 15 ROI plugin nlpqr <http://RForge.R-project.org>
- 16 ROI plugin osqpases <http://RForge.R-project.org>
- 17 ROI plugin quadprog <http://RForge.R-project.org>
- 18 ROI plugin scs <http://RForge.R-project.org>
- 19 ROI plugin symphony <http://RForge.R-project.org>

Models

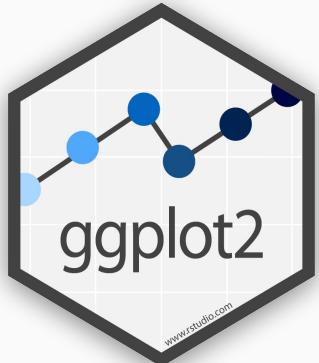
• ROI/models/globalTests

R has 19 Solvers
that are written in
High-Performance
C++ / Fortran

```
70 model_nlp <- OP(
71   objective  = F_objective(F = calc_portfolio_variance, n = n_assets, names = assets),
72   constraints = rbind(
73     F_constraint(F = calc_portfolio_return, dir = ">=", rhs = 0.40),
74     L_constraint(diag(n_assets), rep(">=", n_assets), rep(0, n_assets)),
75     L_constraint(diag(n_assets), rep("<=", n_assets), rep(1, n_assets)),
76     L_constraint(rep(1, n_assets), "==", 1)
77   ),
78   maximum = FALSE
79 )
80
81 tic()
82 sol <- ROI_solve(model_nlp, solver = "alabama", start = rep(1/n_assets, n_assets))
83 toc()
```

Lab 16

ggplot2 & purrr



```
145  
146 g <- data_transformed_tbl %>%  
147   ggplot(aes(stock, y = return_objective, fill = weight)) +  
148     geom_tile() +  
149     geom_point(aes(text = label_text), size = 0.1, alpha = 0) +  
150     scale_fill_gradient(low = "#FFFFFF", high = "#2c3e50") +  
151     geom_text(aes(label = scales::percent(weight)), size = 3) +  
152     theme_tq() +  
153     labs(title = "Optimized Portfolio Weights", x = "Stock", y = "Return Objective")  
154  
155   ggplotly(g, tooltip = "text")  
156 }  
157  
158 portfolio_sim_results_tbl %>% plot_heatmap()  
159  
160
```

101 + 201



```
119  
120 # 4.2 Map (Simulation) ----  
121 tic()  
122 portfolio_sim_results_tbl <- seq(0.10, 0.50, length.out = 20) %>%  
123   map_dfr(optimize_portfolio)  
124 toc()  
125  
126 portfolio_sim_results_tbl  
127
```

101 + 201

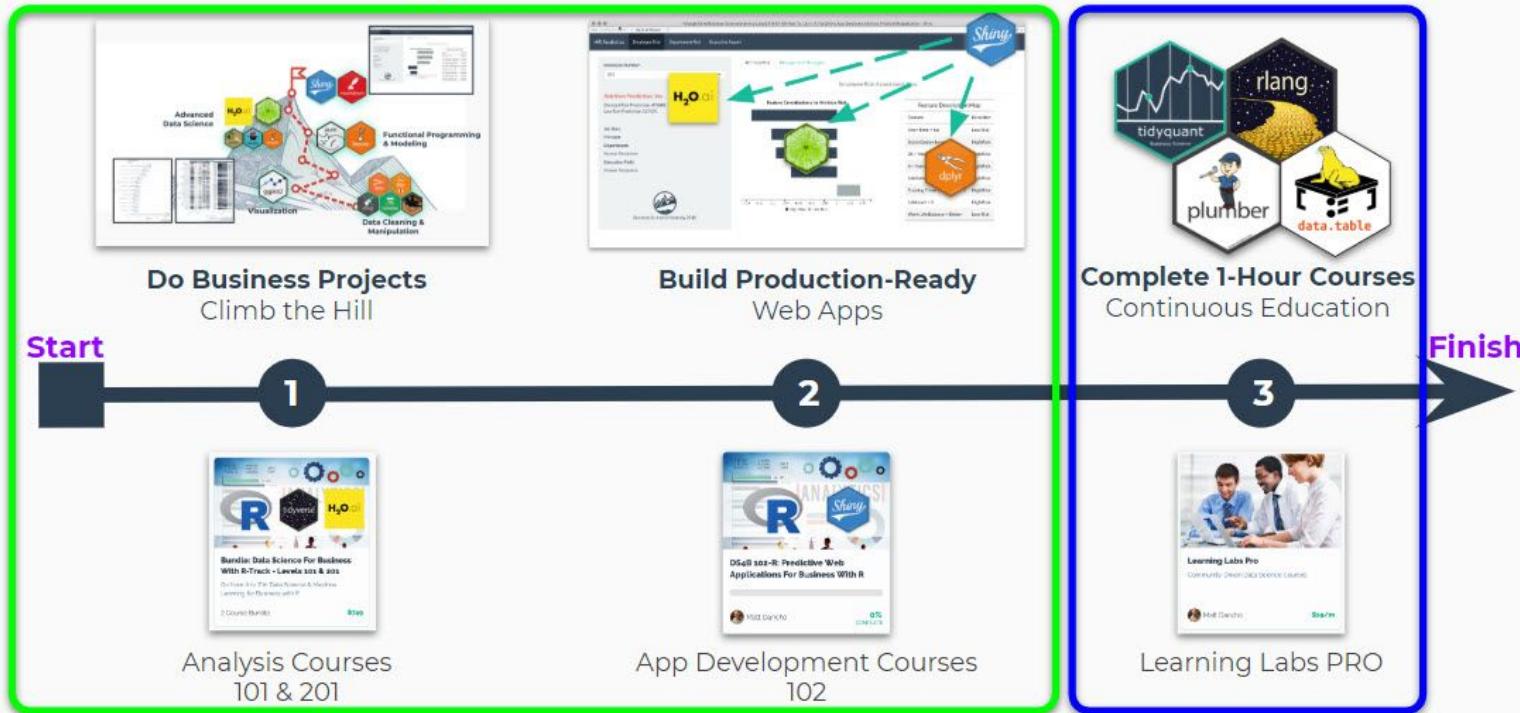
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Web Application Development
4 Weeks



DS4B 102-R: Shiny Web Applications For Business (Level 1)

Build a predictive web application using Shiny, Flexdashboard, and XGBoost

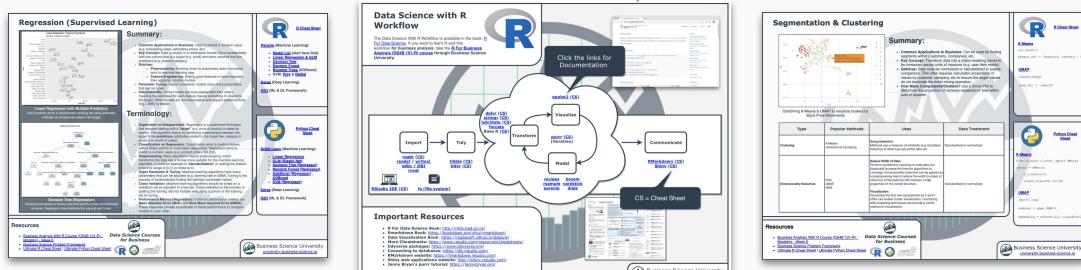


Key Benefits

- Fundamentals - Weeks 1-5 (25 hours of Video Lessons)
 - Data Manipulation (dplyr)
 - Time series (lubridate)
 - Text (stringr)
 - Categorical (forcats)
 - Visualization (ggplot2)
 - Programming & Iteration (purrr)
 - 3 Challenges
- **Machine Learning - Week 6 (8 hours of Video Lessons)**
 - Clustering (3 hours)
 - Regression (5 hours)
 - 2 Challenges
- Learn Business Reporting - Week 7
 - RMarkdown & plotly
 - 2 Project Reports:
 1. Product Pricing Algo
 2. Customer Segmentation

Business Analysis with R (DS4B 101-R)

Data Science Foundations
7 Weeks



Key Benefits

End-to-End Churn Project

Understanding the Problem & Preparing Data - Weeks 1-4

- Project Setup & Framework
- Business Understanding / Sizing Problem
- Tidy Evaluation - rlang
- EDA - Exploring Data -GGally, skimr
- Data Preparation - recipes
- Correlation Analysis
- 3 Challenges

Machine Learning - Weeks 5, 6, 7

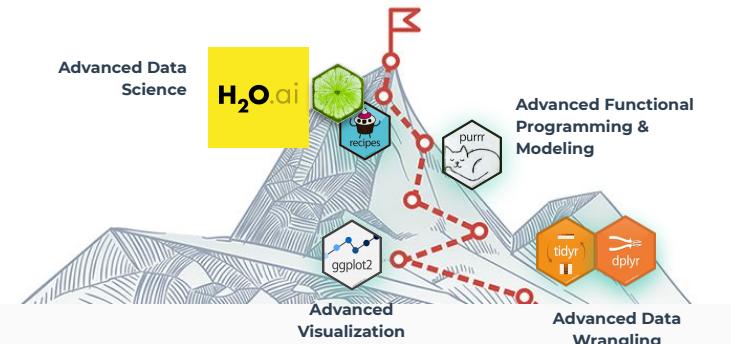
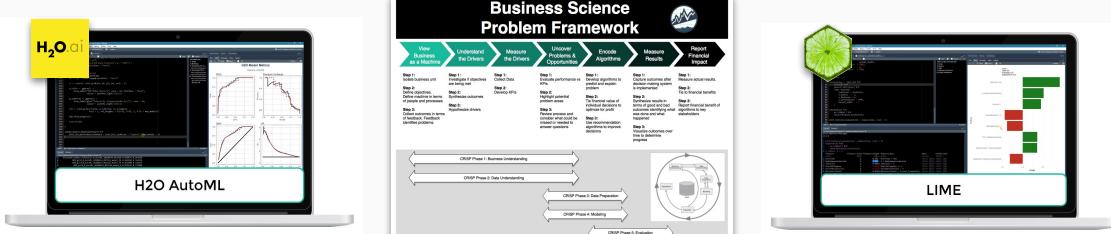
- H2O AutoML - Modeling Churn
- ML Performance
- LIME Feature Explanation

Return-On-Investment - Weeks 7, 8, 9

- Expected Value Framework
- Threshold Optimization
- Sensitivity Analysis
- Recommendation Algorithm

Data Science For Business (DS4B 201-R)

Machine Learning & Business Consulting
10 Weeks



Key Benefits

Learn Shiny & Flexdashboard

- Build Applications
- Learn Reactive Programming
- Integrate Machine Learning

App #1: Predictive Pricing App

- Model Product Portfolio
- XGBoost Pricing Prediction
- Generate new products instantly

App #2: Sales Dashboard with Demand Forecasting

- Model Demand History
- Segment Forecasts by Product & Customer
- XGBoost Time Series Forecast
- Generate new forecasts instantly

Shiny Apps for Business (DS4B 102-R)



Web Application Development
4 Weeks

The collage includes:

- A "Data Science with R" course page featuring a "Predictive Pricing App" dashboard.
- A "Flexdashboard Apps" section showing a dashboard with a map of the US and time series plots.
- A "Shiny Apps" section showing a dashboard with a scatter plot and a histogram.
- A "Themes, Dashboards, & Examples" section showing a dashboard with multiple panels and a sidebar.
- A "Business Analytics" section showing a dashboard with a map and a bar chart.
- A "Machine Learning" section showing a dashboard with a scatter plot and a sidebar.
- A "Data Science with R" course page featuring a "Sales Dashboard with Demand Forecasting" dashboard.



The collage includes:

- A "Shiny" logo and a bar chart showing sales data.
- A "Machine Learning" section showing a scatter plot of data points.
- A "Analytics" section showing a bar chart and a pie chart.
- A "Shiny" logo and a bar chart showing sales data.

DS4B 102-R: Shiny Web Applications for Business (Level 1)

Build a predictive web application using Shiny, Flexdashboard, and XGBoost.

Matt Dancho

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-Rodrigo Prado, Managing Partner Big Data Analytics & Strategy at Genesis Partners



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-Mohana Chittor, Data Scientist with Kabbage, Inc

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