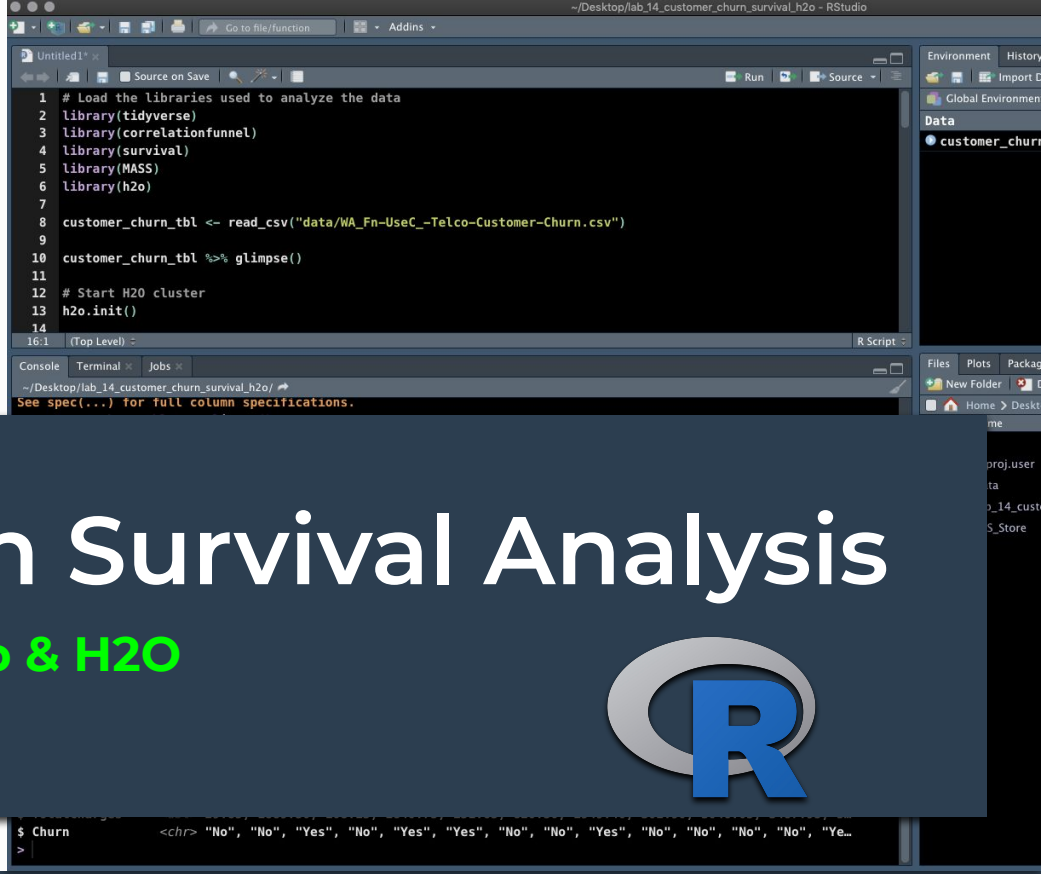


Customer Churn Survival Analysis

With correlationfunnel, parsnip & H2O

Difficulty: **Intermediate**

Matt Dancho & David Curry
Business Science Learning Lab #14

Learning Lab Structure

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

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

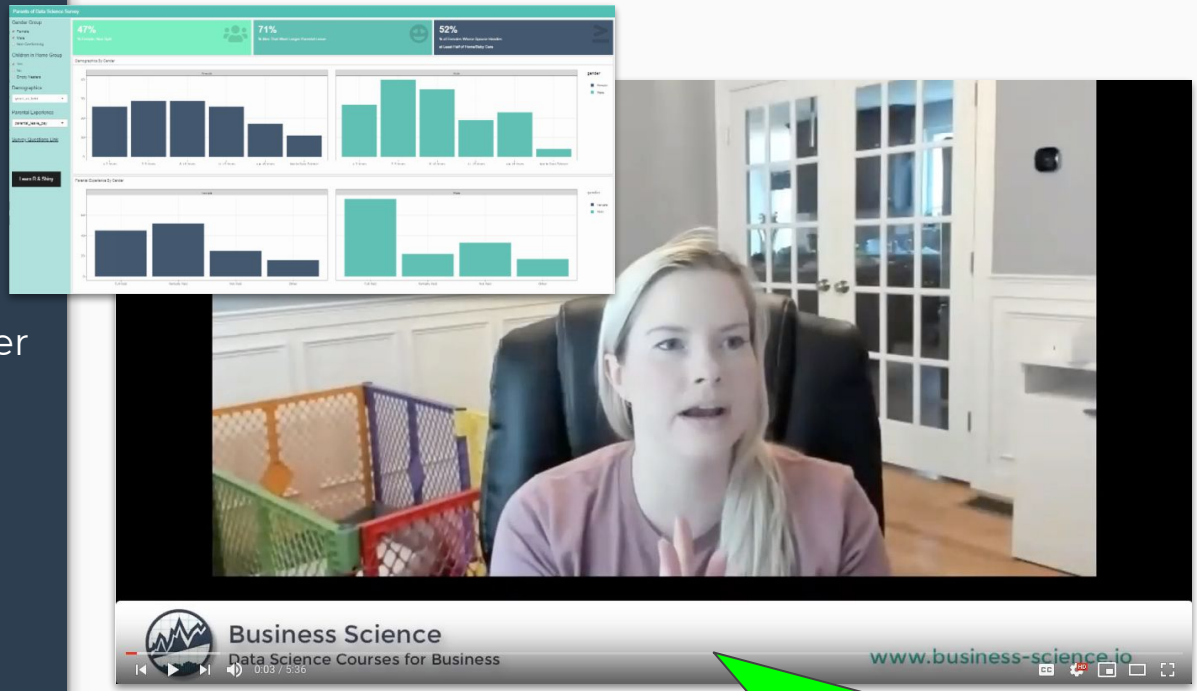
Founder of Sure Optimize, David works with businesses to help improve website performance and SEO using data science. His passion is **ethical Machine Learning initiatives**.

Success Story

Kristen Kehrer

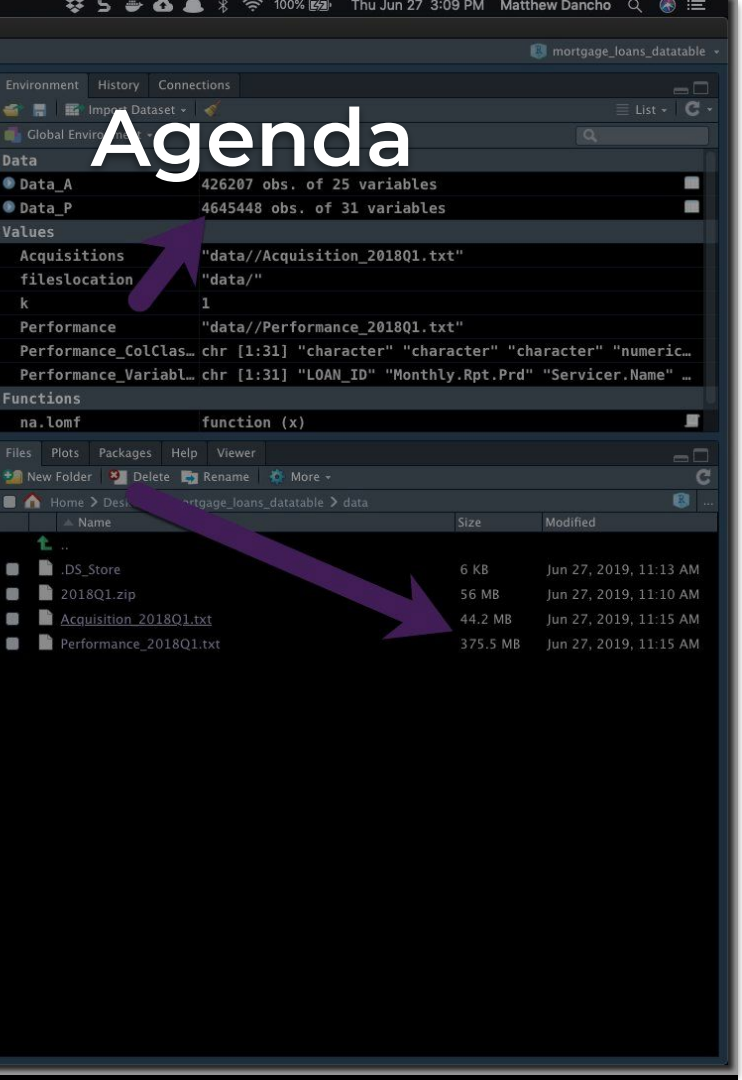
- Founder, DataMovesMe
- Consultant & Keynote Speaker
- Built Shiny App **3-Days** after **STARTING** our 102 Course

"Now, all my clients are getting SHINY APPS!"



#BusinessScienceSuccess

Agenda



- **Business Case Study**
  - Customers Leaving Telecommunications Company
- **Process & Tools**
- **Survival Analysis**
  - 80/20 Concepts
  - Methods & Pros/Cons
  - Game Plan
- **30-Min Demo**
  - correlationfunnel
  - Survival Analysis
  - H2O + LIME
- **Tactics for Customer Retention**
  - What to look for
  - What to learn to be able to implement at scale

Learning Labs PRO

Every 2 Weeks

Get Code

Recordings

Slack Community

$19/month

university.business-science.io

Lab 13
Wrangling 4.6M Rows 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

Business Case Study

Telecom Company that is losing customers

Customers Leaving Telecommunications Company

Business Objectives

Customers are the lifeblood of subscription business.

Losing customers (churn) requires gaining new customers to replace a **10X more expensive** alternative than retaining existing.

Solution: Understand why & implement retention strategies.

Prediction + Explanation

Telecom Customer Data

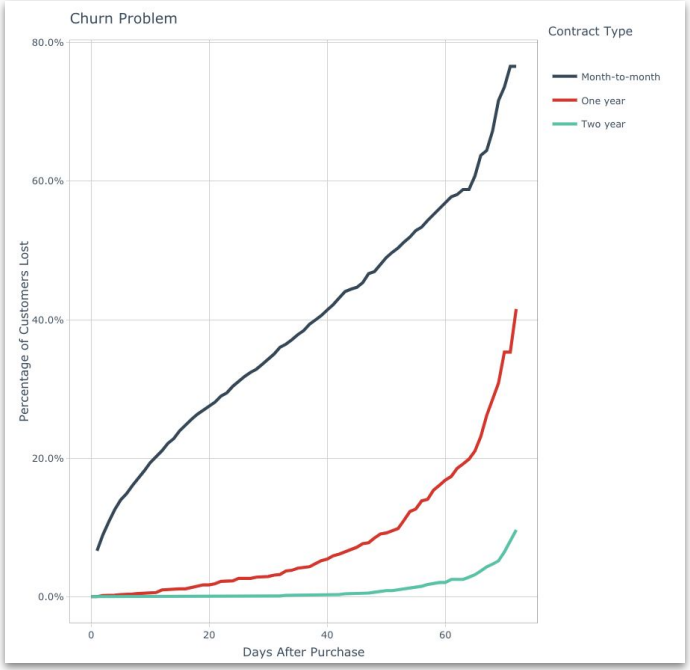
Customer Product History

Tenure (numeric)

- Number of months that the customer has been with the company
- Time series converted to duration

Churn (yes/no)

- Whether or not customer has cancelled their service



https://www.kaggle.com/blastchar/telco-customer-churn

Feature List

7043 Customers

21 Features

- Time varying - Tenure
- Whether Canceled - Churn

- What services they had
- Customer Information
- Services Purchased
- Contract Information
  - Payment Method
  - Contract Type

Details

Telecom Customer Data:

- customerID (chr): CUSTOMER ID
- gender (chr): Customer's gender ("Female", "Male")
- SeniorCitizen (dbl): 1 = Senior Citzen, 0 = Not Senior Citizen
- Partner (chr): Whether the customer has a partner or not (Yes, No)
- Dependents (chr): Whether the customer has dependents or not (Yes, No)
- tenure (dbl): Number of months the customer has stayed with the company
- PhoneService (chr): Whether the customer has a phone service or not (Yes, No)
- MultipleLines (chr): Whether the customer has multiple lines or not (Yes, No, No phone service)
- InternetService (chr): Customer's internet service provider (DSL, Fiber optic, No)
- OnlineSecurity (chr): Whether the customer has online security or not (Yes, No, No internet service)
- OnlineBackup (chr): Whether the customer has online backup or not (Yes, No, No internet service)
- DeviceProtection (chr): Whether the customer has device protection or not (Yes, No, No internet service)
- TechSupport (chr): Whether the customer has tech support or not (Yes, No, No internet service)
- StreamingTV (chr): Whether the customer has streaming TV or not (Yes, No, No internet service)
- StreamingMovies (chr): Whether the customer has streaming movies or not (Yes, No, No internet service)
- Contract (chr): The contract term of the customer (Month-to-month, One year, Two year)
- PaperlessBilling (chr): Whether the customer has paperless billing or not (Yes, No)
- PaymentMethod (chr): The customer's payment method (Electronic check, Mailed check, Bank transfer (automatic), Credit card (automatic))
- MonthlyCharges (dbl): The amount charged to the customer monthly
- TotalCharges (dbl): The total amount charged to the customer
- Churn (chr): Outcome. Whether the customer churned or not (Yes or No)

Process & Tools

Churn Modeling & Machine Learning Tools

Churn Modeling Process

Step-By-Step

dplyr

Format Data

For EDA with ***correlationfunnel***

parsnip

Modeling

Also need ***survival*** (Survival Curves)

h2o & lime

Automated Machine Learning

Local Feature Explanation

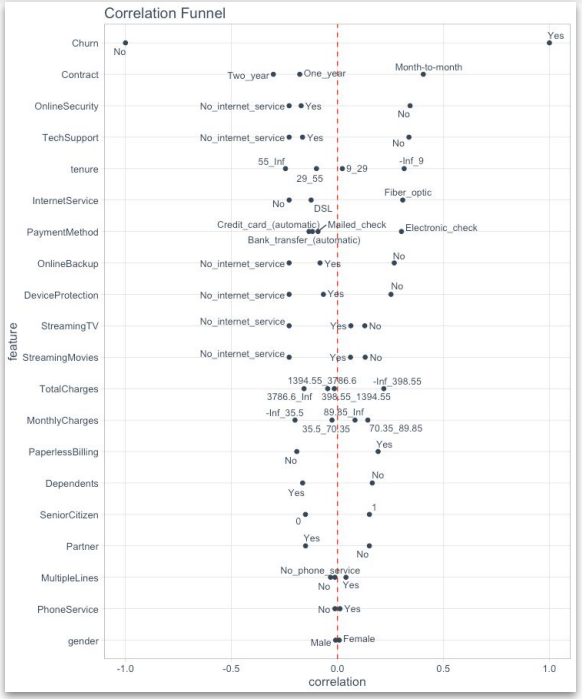
(50+ Models in seconds)

Tools Needed

dplyr & ggplot2

Data preparation is critical for correlation funnel

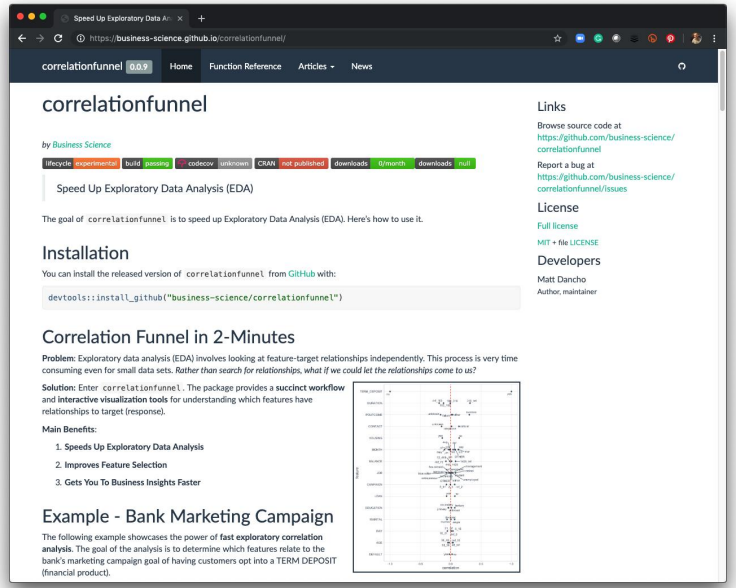
- Missing values
- Data imbalance



Tools Needed

correlationfunnel

- **Speeds Up Exploratory Data Analysis**
- **Improves Feature Selection**
- **Gets You To Business Insights Faster**



https://business-science.github.io/correlationfunnel/

Tools Needed

parsnip

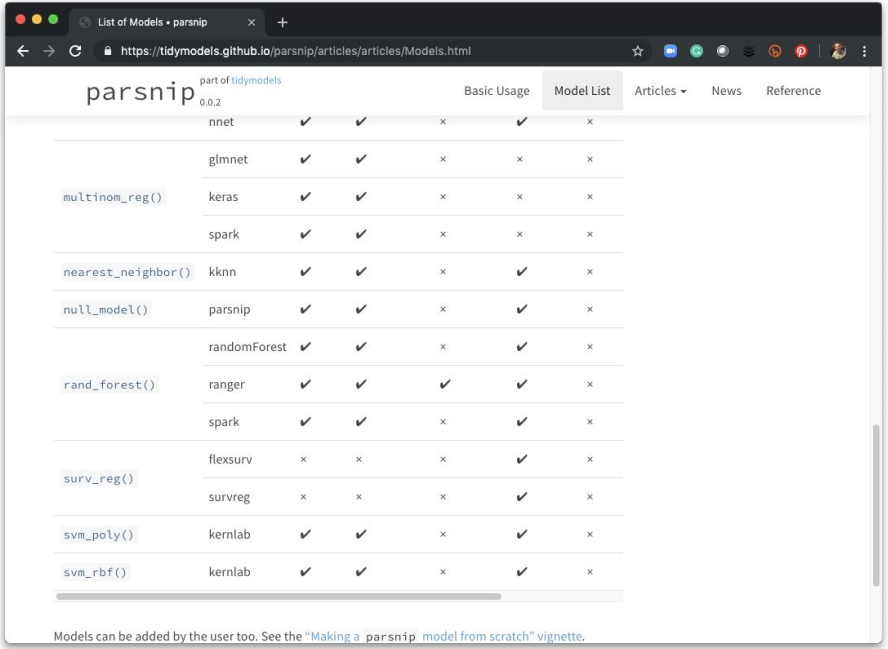
Like scikit-learn for R

Included:

- **survival regression (surv_reg)**

Not Included:

- **Survival Curves**
- **CoxPH**



https://tidymodels.github.io/parsnip/reference/surv_reg.html

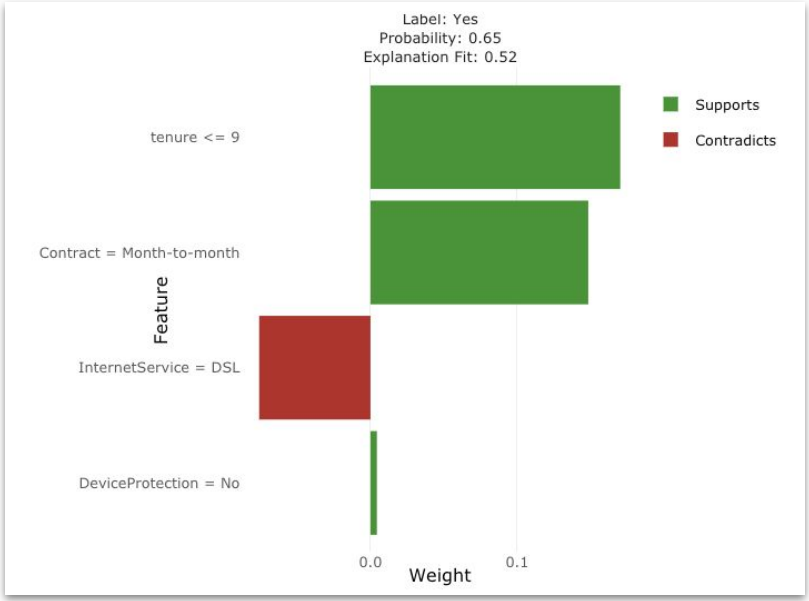
Tools Needed

H2O & LIME

Automatic Machine Learning

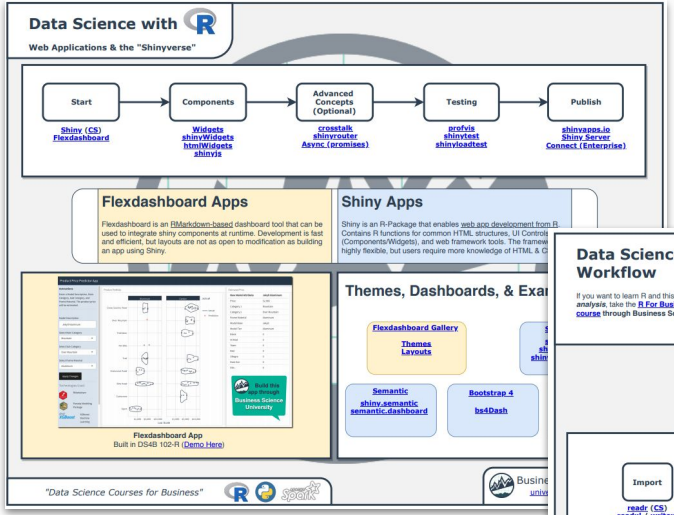
Predicts Churn Risk (%)

Tells what features contribute to **the person of interest** leaving



Links To The Resources

Page 2



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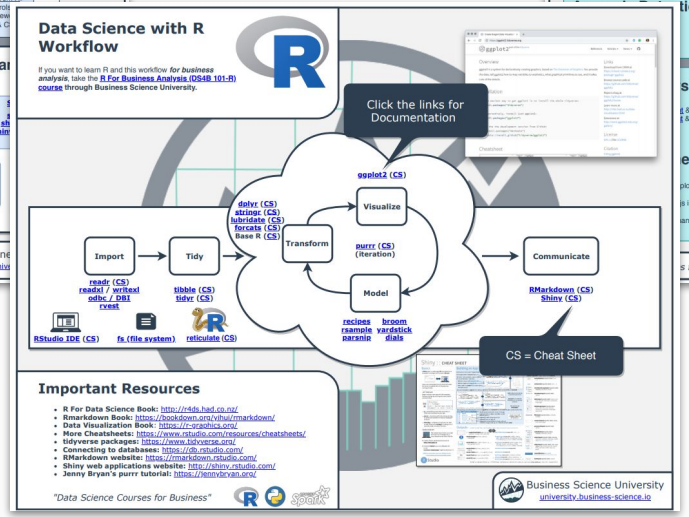

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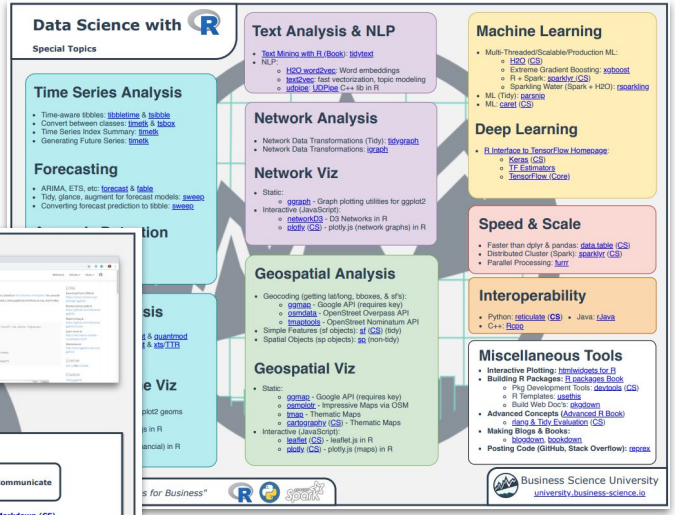


https://www.business-science.io/r-cheatsheet.html

Survival Analysis

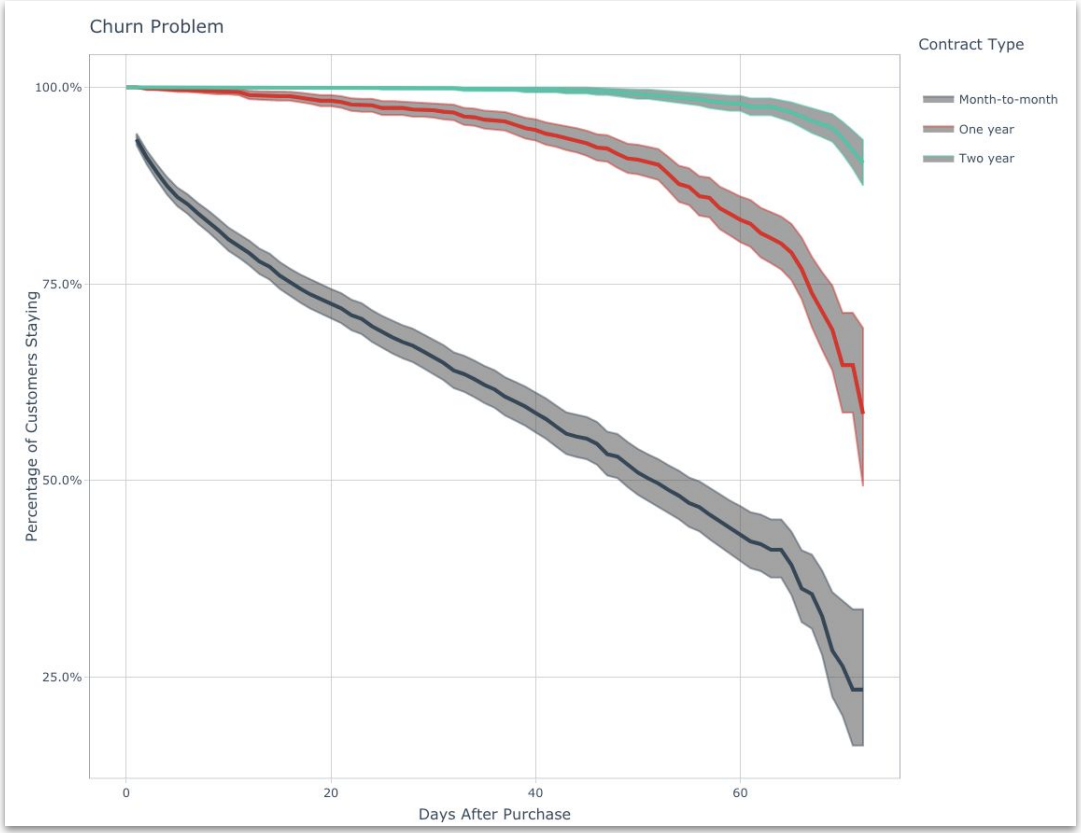
80/20 Concepts

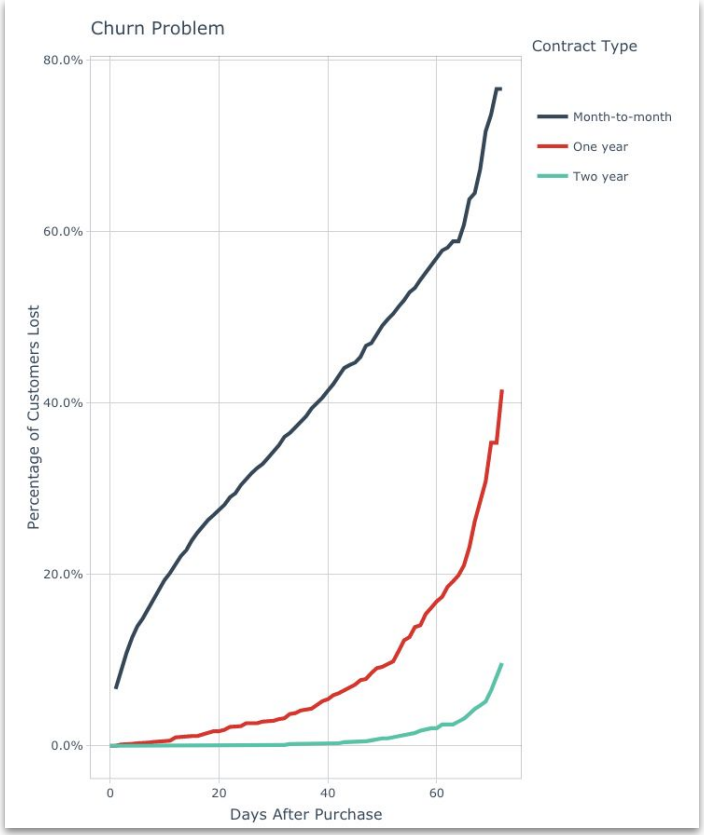
Mortality Table

- Based on Time
- How long until churn

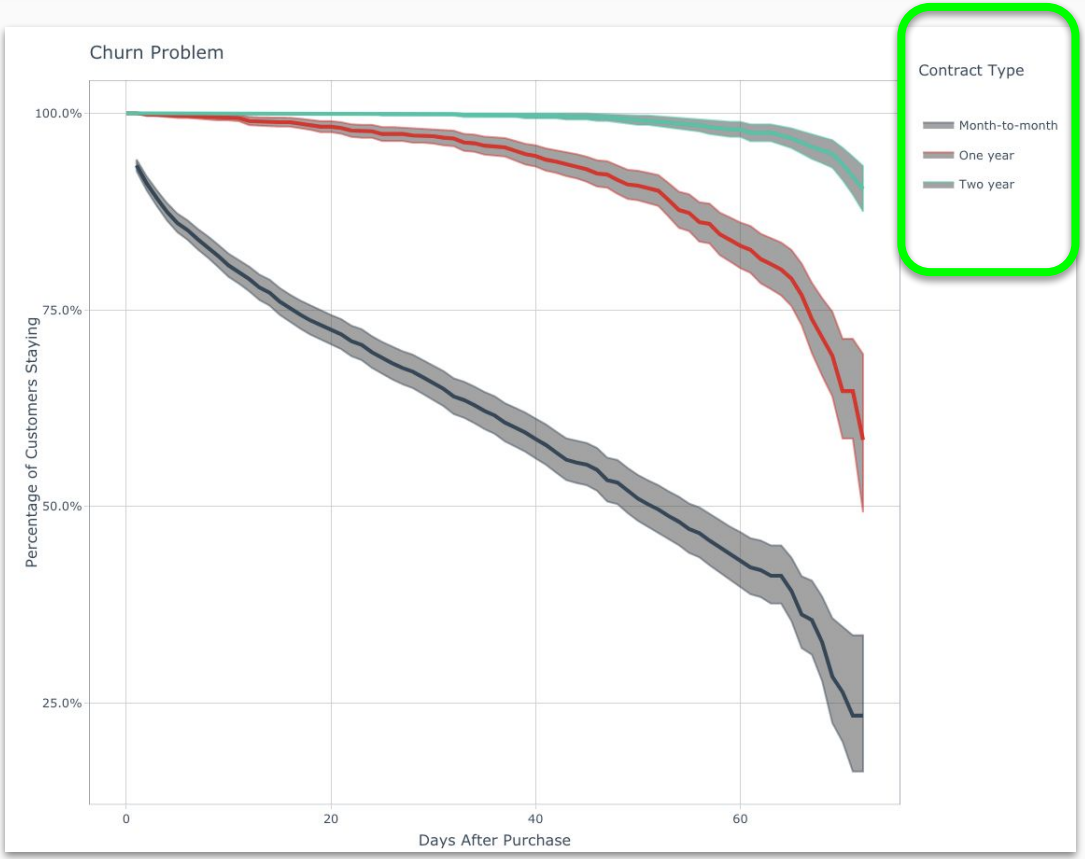
```
# A tibble: 218 x 9
    time n.risk n.event n.censor estimate std.error conf.high conf.low strata
   <dbl>  <dbl>   <dbl>    <dbl>    <dbl>     <dbl>     <dbl>    <dbl> <chr>
 1     1   3875     380      224    0.934   0.00405     0.941    0.926 Month-to-month
 2     2   3271     121      109    0.911   0.00500     0.920    0.902 Month-to-month
 3     3   3041      94       97    0.892   0.00578     0.902    0.882 Month-to-month
 4     4   2850      82       83    0.874   0.00649     0.886    0.863 Month-to-month
 5     5   2685      63       65    0.860   0.00706     0.872    0.849 Month-to-month
 6     6   2557      40       55    0.851   0.00744     0.864    0.839 Month-to-month
 7     7   2462      50       63    0.840   0.00793     0.853    0.827 Month-to-month
 8     8   2349      41       60    0.830   0.00836     0.843    0.816 Month-to-month
 9     9   2248      45       60    0.818   0.00885     0.833    0.804 Month-to-month
10    10   2143      45       51    0.807   0.00936     0.821    0.792 Month-to-month
# … with 208 more rows
```

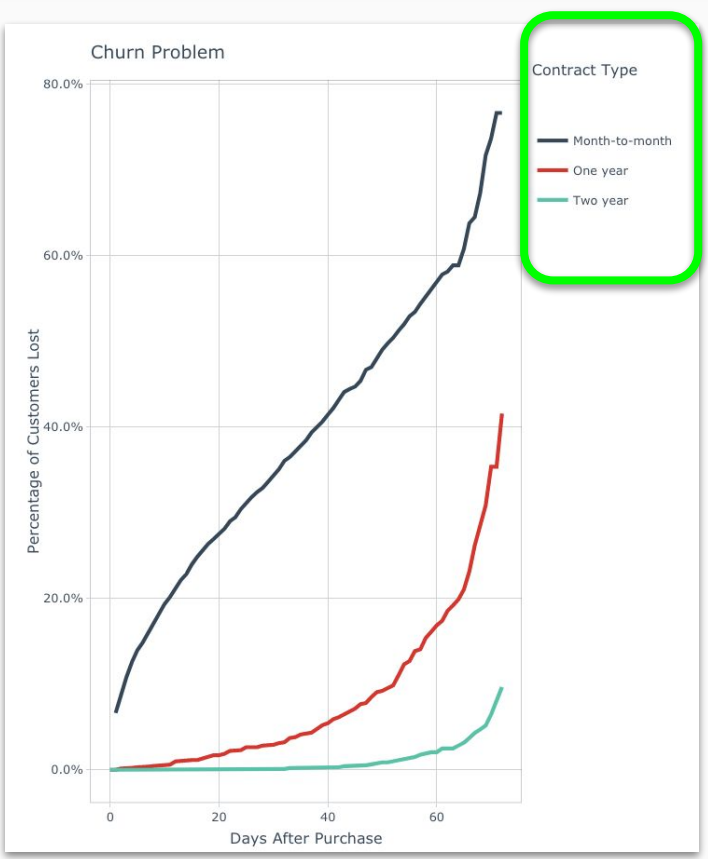
Survival Curves





Strata = Group of Interest





Survival Analysis

Methods + Pros & Cons

Modeling Churn

Strengths

Survival Curves - Communication Tool that **Business Leaders Understand**

CoxPH & Survival Regression - Used to incorporate **multivariate** analysis

Weaknesses

CoxPH & Survival Regression - Not as high performance as **Machine Learning**

Use **Machine Learning** to model true risk

Kaplan-Meier Method

Pros

Simple Method

Cons

Simple Method (**univariate**)

Does not account for other variables in the data

Only time, churn, and strata

The survival probability at time t_i, $S(t_i)$, is calculated as follow:

$$S(t_i) = S(t_{i-1})(1 - \frac{d_i}{n_i})$$

Where,

- $S(t_{i-1})$ = the probability of being alive at t_{i-1}
- n_i = the number of patients alive just before t_i
- d_i = the number of events at t_i
- $t_0 = 0$, $S(0) = 1$

Cox Proportional Hazard

Pros

Multivariate!

Super easy to get Survival Curves

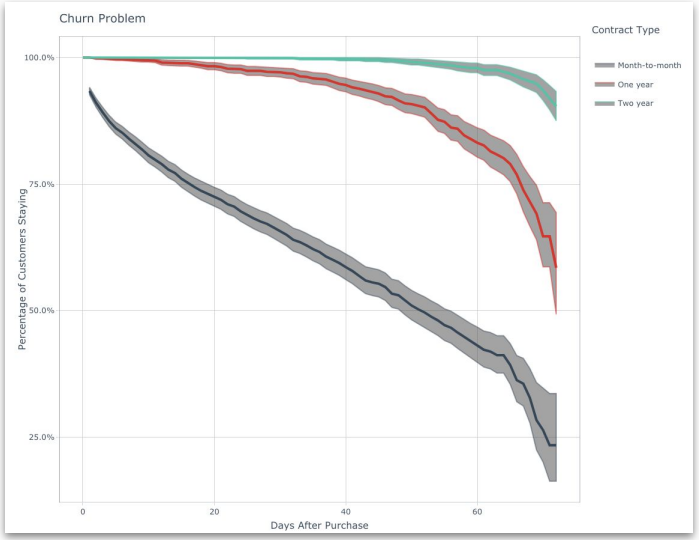
Can predict churn

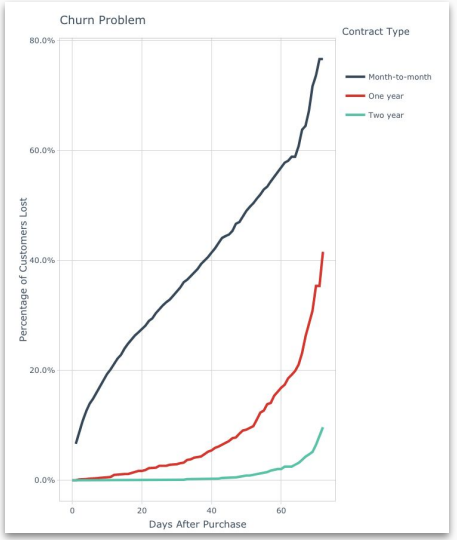
Cons

Predictive Accuracy

Underlying model assumes covariates are not time dependent

```
> model_coxph <- coxph(Surv(tenure, Churn_Yes) ~ . - Contract + strata(Contract), data = train_tbl)
> tidy(model_coxph)
# A tibble: 5 x 7
  term                                estimate std.error statistic  p.value conf.low conf.high
  <chr>                                  <dbl>     <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 OnlineSecurity_NoTRUE                  0.583    0.0600      9.71  2.75e-22    0.465     0.700
2 TechSupport_NoTRUE                     0.316    0.0598      5.29  1.25e- 7    0.199     0.434
3 InternetService_FiberOpticTRUE         0.0440   0.0537      0.820 4.12e- 1   -0.0612    0.149
4 PaymentMethod_ElectronicCheckTRUE      0.379    0.0488      7.76  8.46e-15    0.283     0.475
5 DeviceProtection_NoTRUE                0.352    0.0506      6.94  3.82e-12    0.252     0.451
```





Survival Regression

Pros

Multivariate!

Parsnip provides convenient API

```
158 # 6.3 Survival Regression w/ Parsnip
159 # 4.3 Using Parsnip ----
160 model_survreg <- parsnip::surv_reg(mode = "regression", dist = "t") %>%
161     set_engine("survreg") %>%
162     fit.model_spec(Surv(I(tenure + 1), Churn_Yes) ~ . - Contract + strata(Contract), data = train_tbl)
163
164 model_survreg$fit %>% survfit()
165
166 predict(model_survreg, new_data = train_tbl) %>%
167     bind_cols(train_tbl %>% select(Churn_Yes, everything()))
168
169
```

Cons

Predictive Accuracy

Underlying model assumes covariates are not time dependent

More difficult to obtain survival curves

```
> model_survreg$fit %>% tidy()
# A tibble: 9 x 7
  term                                estimate std.error statistic  p.value conf.low conf.high
  <chr>                                  <dbl>     <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 (Intercept)                             5.01    0.0653      76.7  0.          4.88     5.14
2 OnlineSecurity_NoTRUE                  -0.266   0.0367      -7.25 4.12e-13   -0.338   -0.194
3 TechSupport_NoTRUE                     -0.176   0.0331      -5.32 1.04e- 7   -0.241   -0.111
4 InternetService_FiberOpticTRUE         -0.0539  0.0309      -1.75 8.07e- 2   -0.114    0.00658
5 PaymentMethod_ElectronicCheckTRUE      -0.230   0.0331      -6.97 3.28e-12   -0.295   -0.165
6 DeviceProtection_NoTRUE                -0.217   0.0329      -6.58 4.86e-11   -0.281   -0.152
7 Two year                               -1.79    0.0867     -20.6  3.02e-94   NA       NA
8 Month-to-month                          0.286   0.0189      15.2  5.45e-52   NA       NA
9 One year                               -1.07    0.0523     -20.5  8.96e-94   NA       NA
>
```

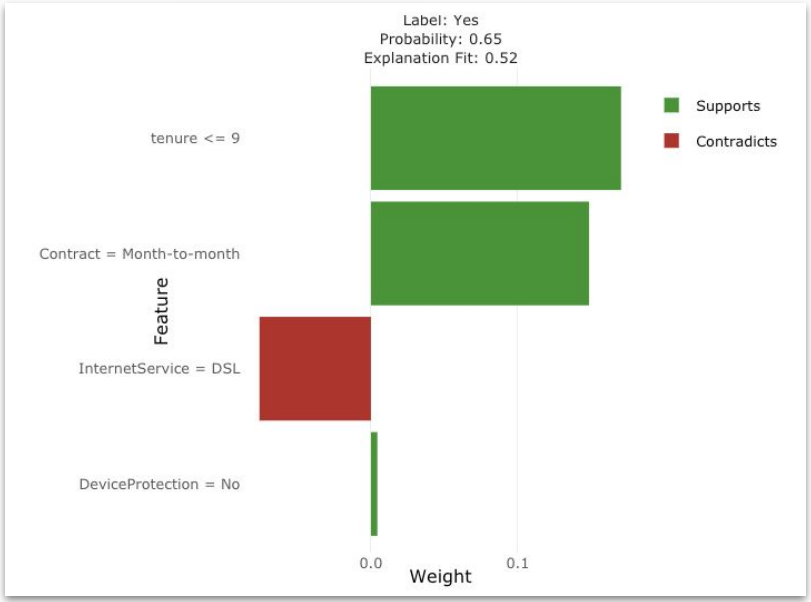
Solution to Accuracy: Machine Learning

Pros

Multivariate!
High Accuracy
Explainability
By Person/Observation

Cons

No time-varying survival curves



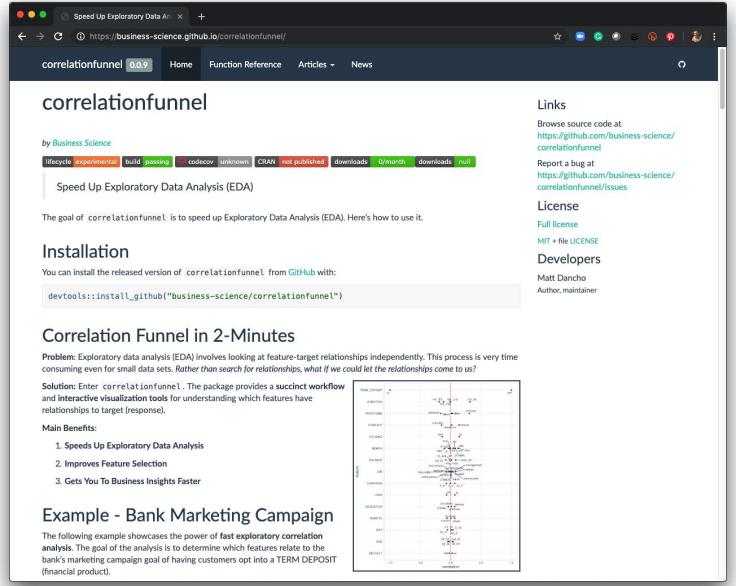
Game Plan

Using Survival Analysis & ML

Feature Selection

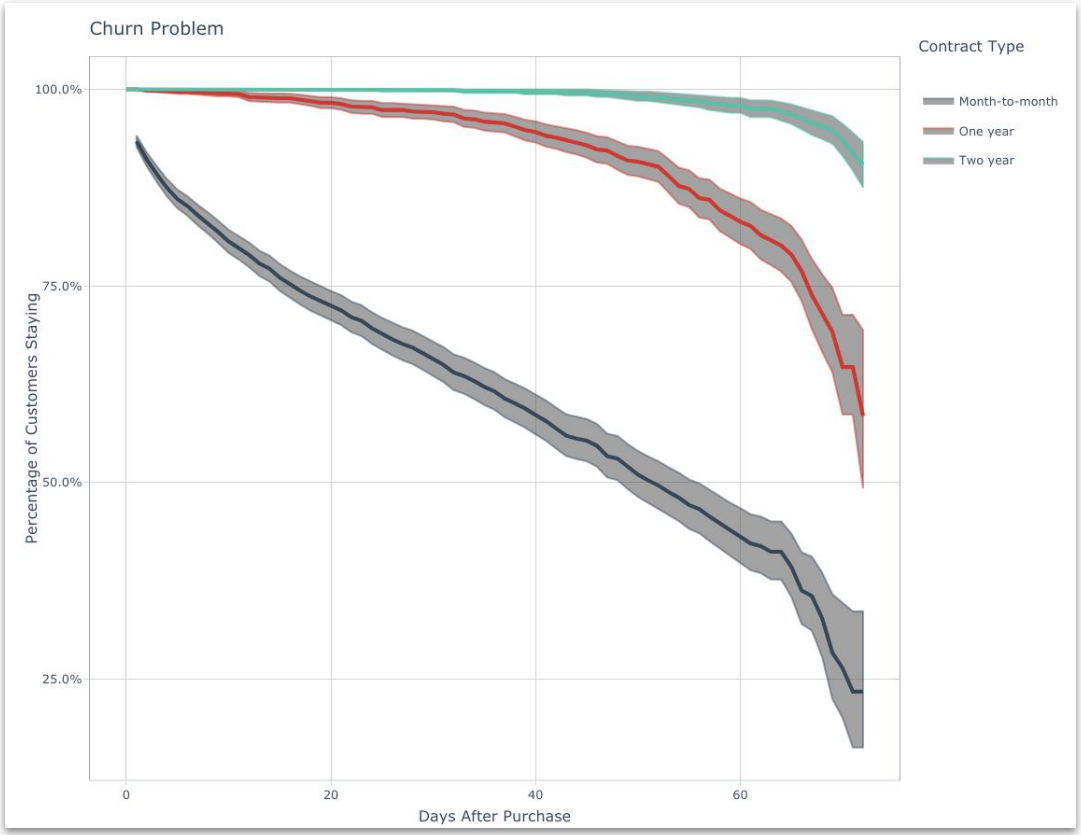
correlationfunnel

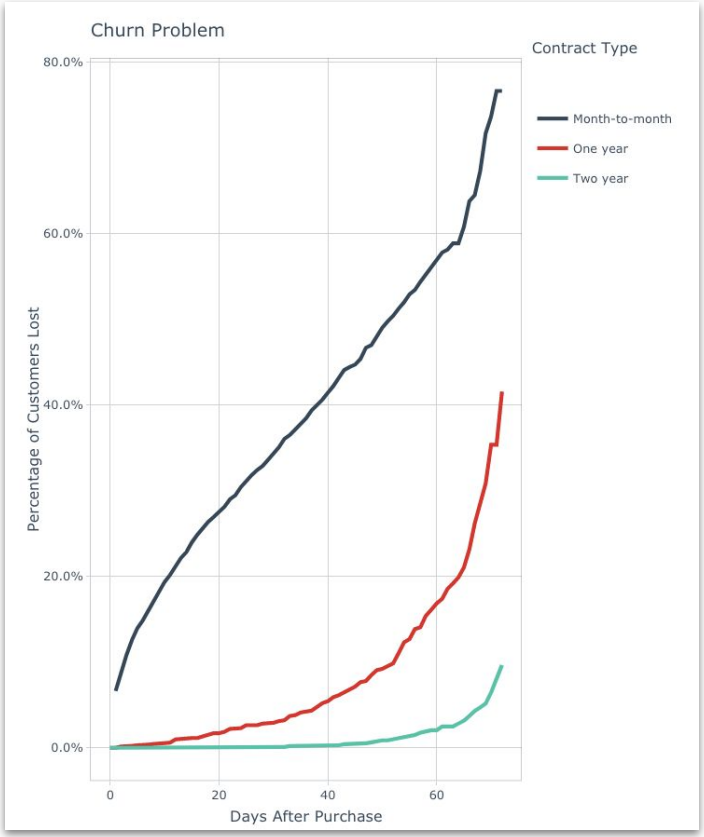
- Speeds Up Exploratory Data Analysis
- Improves Feature Selection
- Gets You To Business Insights Faster



https://business-science.github.io/correlationfunnel/

Time-Based Explanation: CoxPh Survival Curves



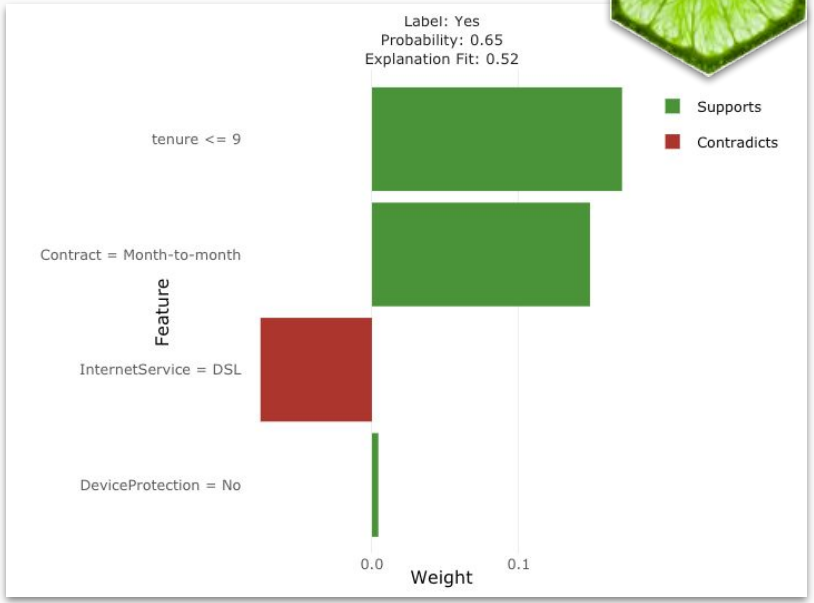


Individual Explanations & Churn Risk

```
H2OBinomialMetrics: stackedensemble
** Reported on cross-validation data. **
** 5-fold cross-validation on training data (Metrics computed for combined holdout predictions) **

MSE:  0.1348264
RMSE:  0.3671871
LogLoss:  0.4186951
Mean Per-Class Error:  0.235612
AUC:  0.848876
pr_auc:  0.6656359
Gini:  0.697752

Confusion Matrix (vertical: actual; across: predicted) for F1-optimal threshold:
         No  Yes    Error        Rate
No     4037 1137 0.219753  =1137/5174
Yes     470 1399 0.251471   =470/1869
Totals 4507 2536 0.228170  =1607/7043
```



30 Min Demo

Customer Churn Survival Analysis

Churn

Tactics for Retention

Churn

Impacts Every Company

Losing Customers Costs Millions.

We can reduce it.

Trick to Solving Churn Problems:

Shift users/people into lower probability cohorts.

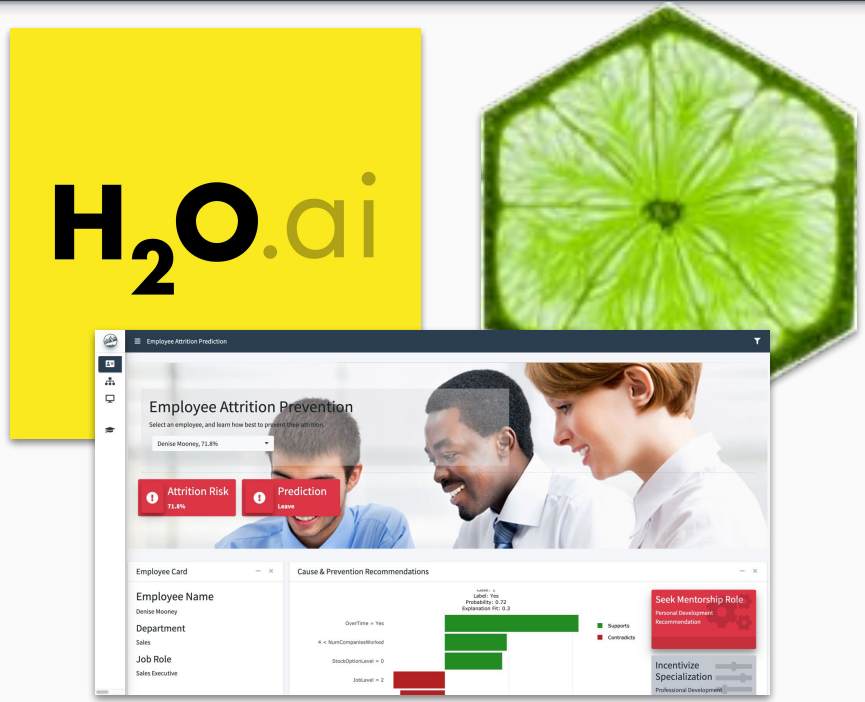
Churn

Key = Shift users

Develop insights with ML

Incentivize high risk users/people at individual level

Shift to low risk cohorts



Shift Cohorts

```
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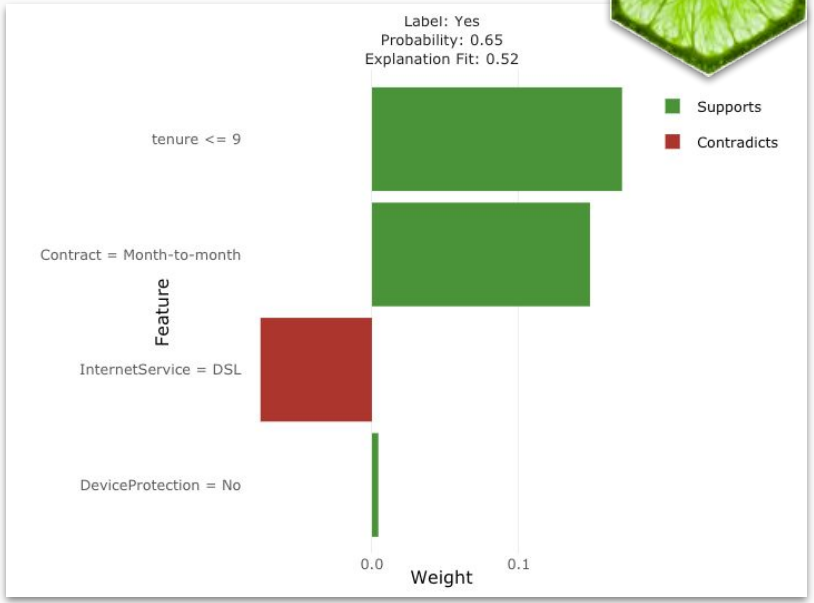


Learning Plan

Recap

Churn & Attrition Learning Plan

Learn **dplyr & ggplot2**

Gets data wrangling & visualization

Learn **parsnip**

Machine Learning

Learn **h2o & lime**

Automated ML & Local Feature Explanation

(50+ Models in seconds)

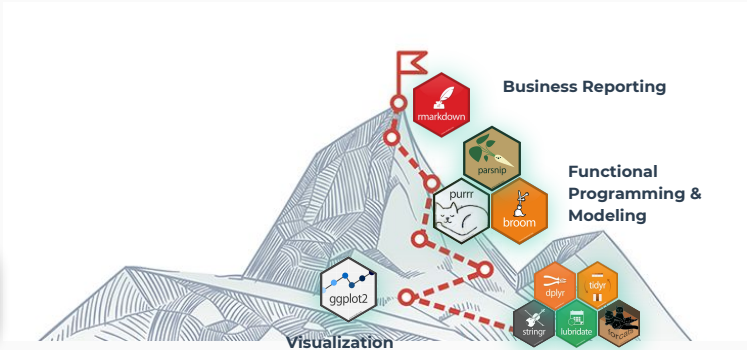
Learn the tools

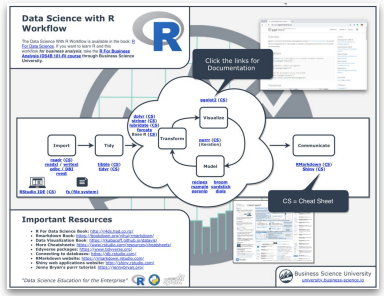
Step 1 - Learn the Foundations

Data Science Foundations

35 Hours of Video Lessons

- Machine Learning (parsnip)
- **Data Manipulation (dplyr)**
- Visualization (ggplot2)
- Reporting (rmarkdown)
- More packages



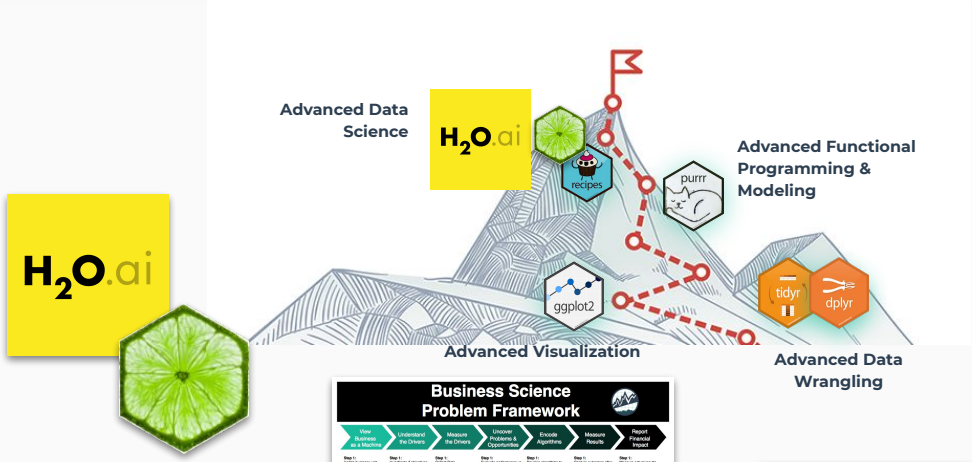


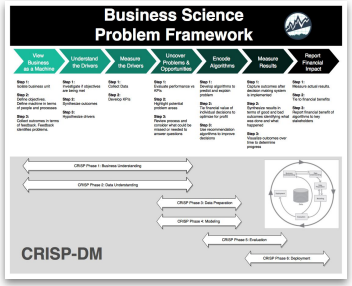
Step 2 - Learn Advanced ML

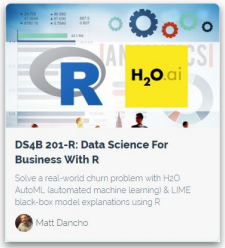
Advanced ML + Business Consulting

End-to-End Churn Project

- **Machine Learning (H2O)**
- **Data Manipulation (lime)**
- Repeatable Framework for Business Problems
- ROI Analysis for Project Benefit







3-Course R-Track System

Business Analysis with R
(DS4B 101-R)

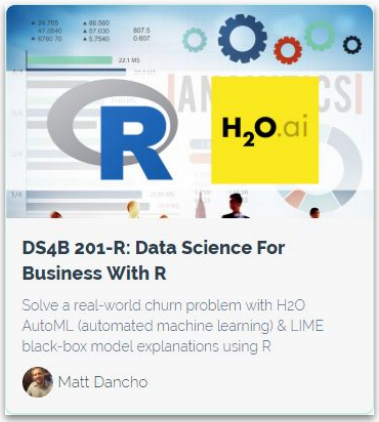
Data Science For Business with R
(DS4B 201-R)

R Shiny Web Apps For Business
(DS4B 102-R)

Project-Based Courses with Business Application

Data Science Foundations
7 Weeks

Machine Learning & Business Consulting
10 Weeks



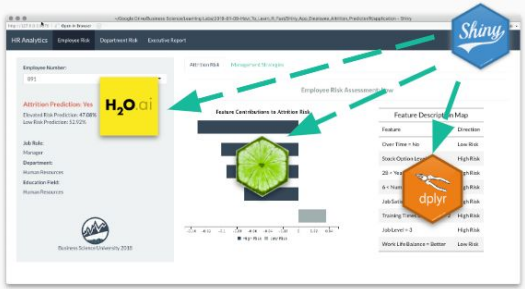
Web Application Development
4 Weeks

Program

At A Glance

How It Works

Do Business Projects
Climb the Hill



Build Production-Ready
Web Apps

Complete 1-Hour Courses
Continuous Education

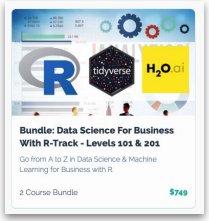
Start

1

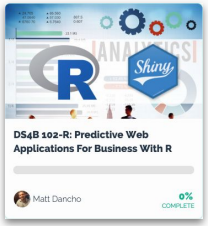
2

3

Finish



Analysis Courses

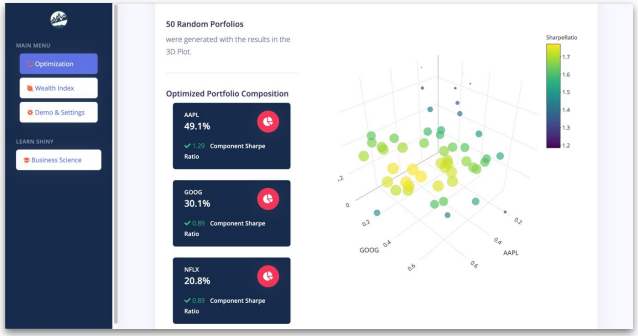


App Development Courses

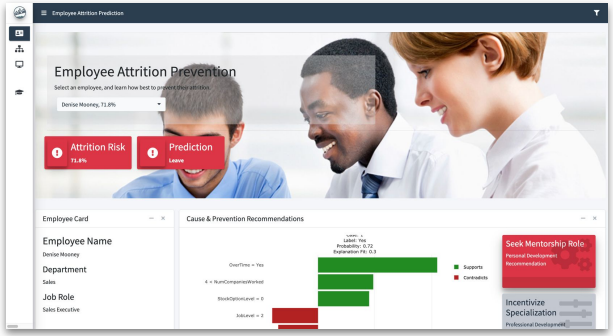
Learning Labs PRO

Everything is **Taken Care of** For You in Our Platform

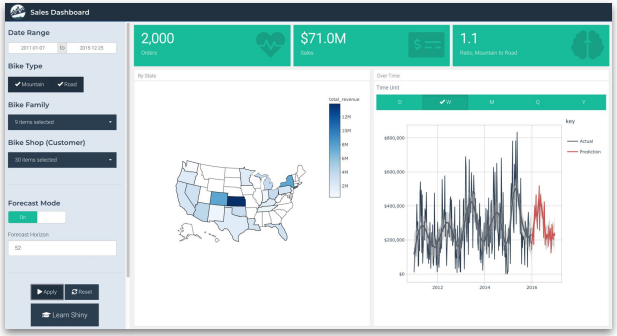
What You Build



Stock Portfolio Optimization



People Analytics Churn



Demand Forecasting

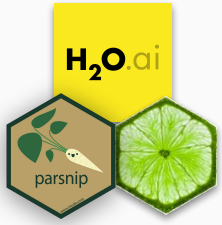
What You Learn

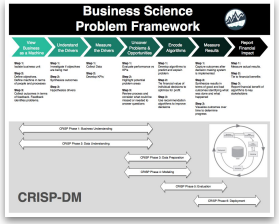
Advanced Machine Learning

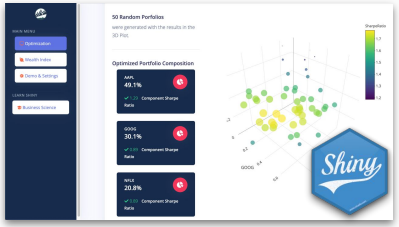
Applied to Business Problems

Following Repeatable Frameworks

Communicated with Data Products



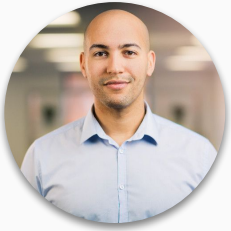




Results

*“Your program allowed me to cut down to **50% of the time** to deliver solutions to my clients.”*

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



*“I can already **apply** a lot of the early gains from the course to current working projects.”*

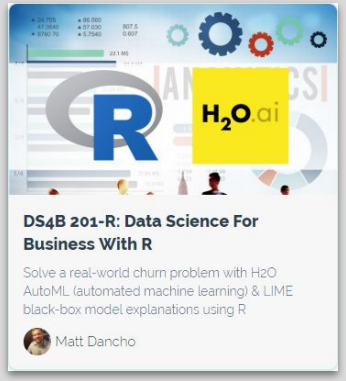
-Adam Mitchell, Data Analyst with Eurostar

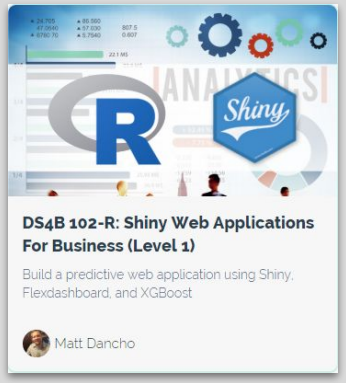
*“My work became **10X easier**. I can spend quality time asking questions rather than wasting time trying to figure out syntax.”*

-Mohana Chittor, Data Scientist with Kabbage, Inc

Achieve **Results** that Matter to the **Business**

PROMO Code: learninglabs





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