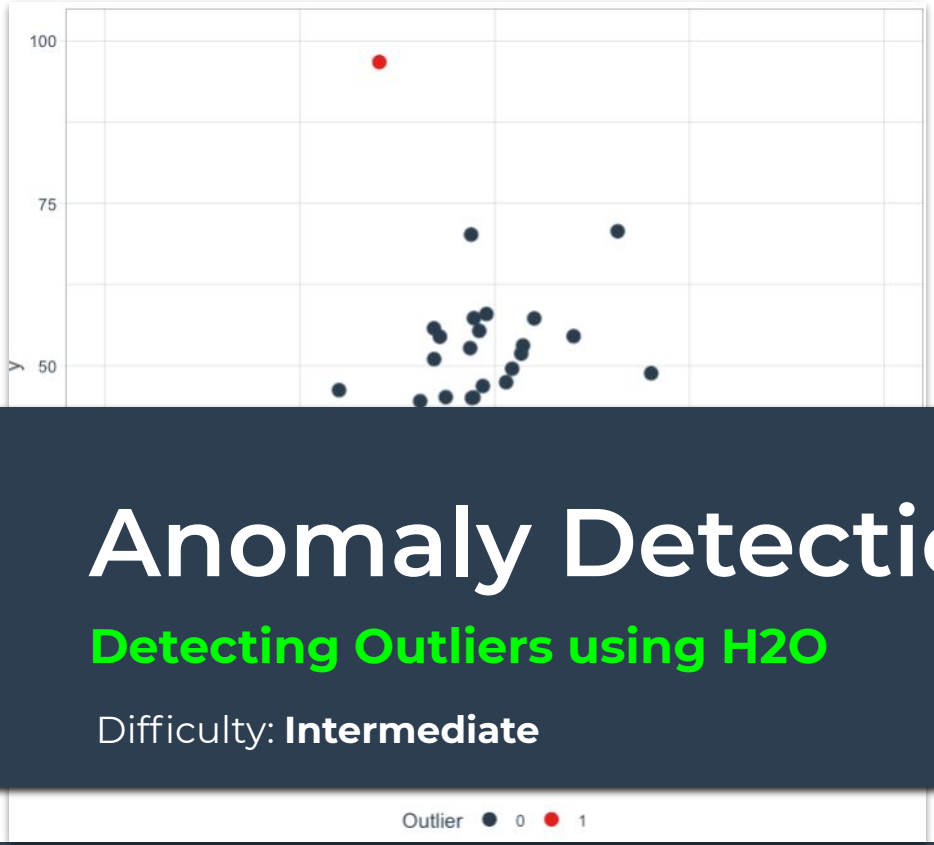
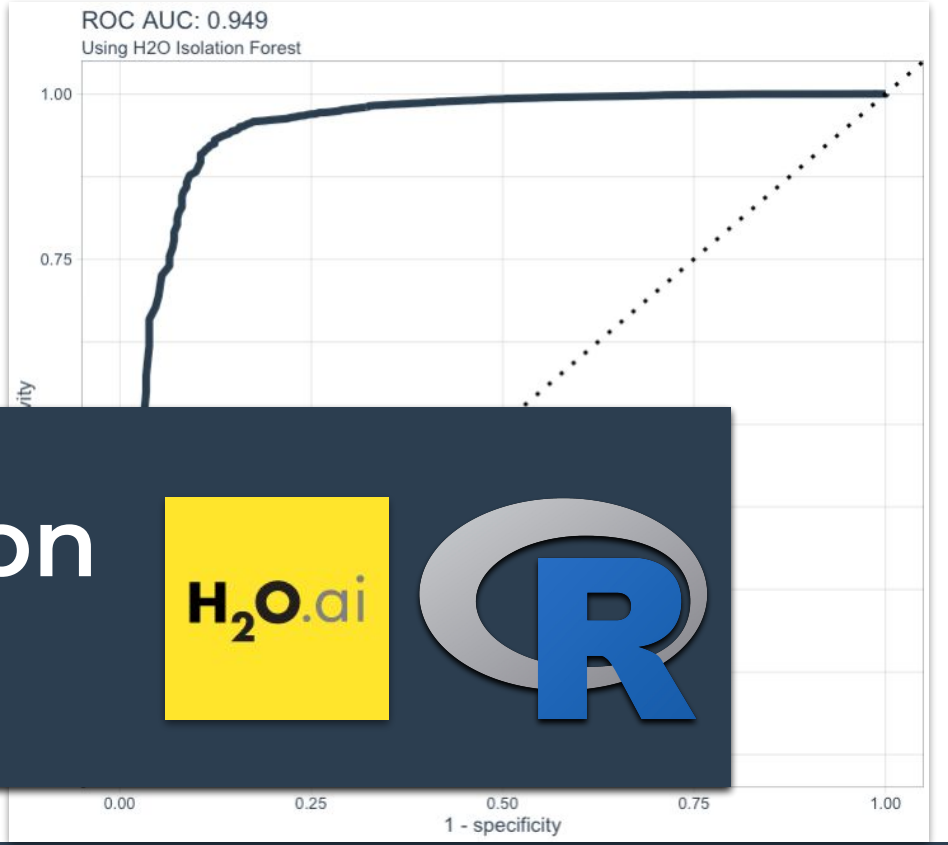




Anomaly Detection

Detecting Outliers using H2O

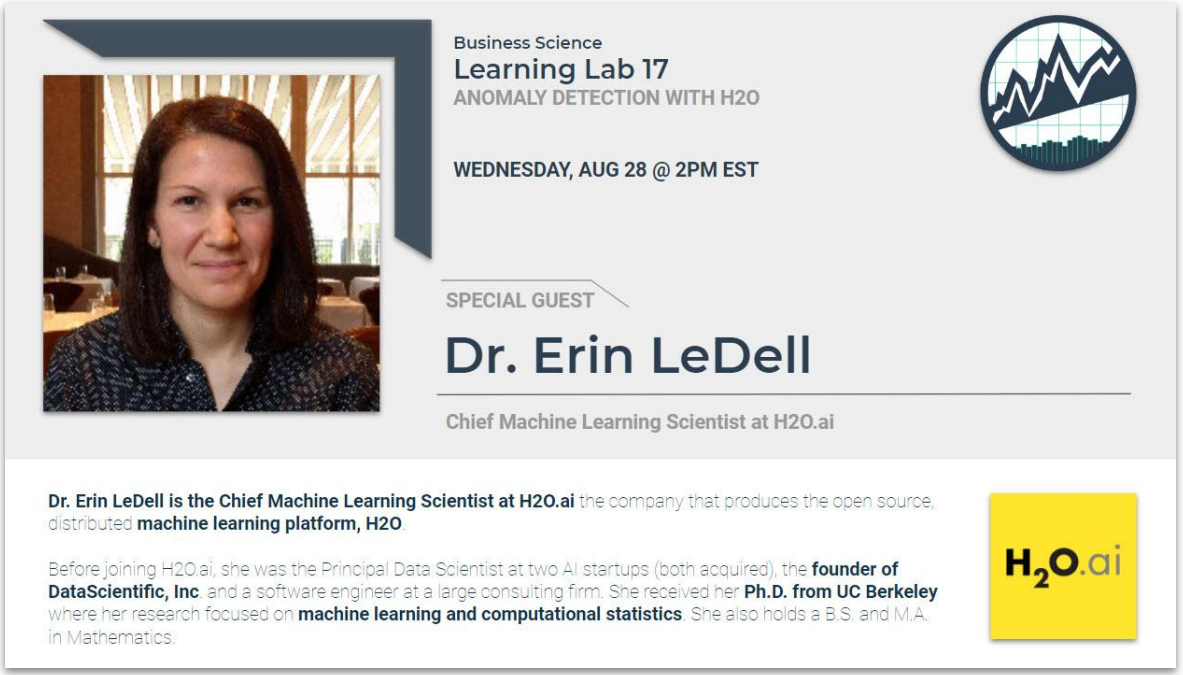
Difficulty: **Intermediate**

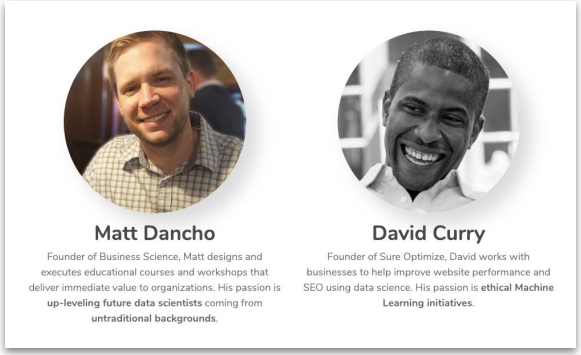
Matt Dancho & David Curry

Business Science Learning Lab

Learning Lab Structure

- **Presentation**
  (30 min)
- **Demo's**
  (30 min)
- **3 Pro-Tips**
  (15 mins)





Success Story

Robert M. Davis

- Works in EMS analytics
- Has struggled learning R & Python for **3 years!**
- Now, generating customized distributions & box plots
- Robert's **transformation** is ***"eye-opening!"***

"Spent last 3 years trying to learn Python & R... This course [DS4B 101-R] is the real deal."

Robert M. Davis, MPA • 2nd
The Analytics "Wizard"🧙‍♂️|Data Intelligent📊| Data Science in EMS🚑|The Guy In Gl...
2d

Learning #ggplot in week 4 has been a lot of fun...
After a rough week learning #forcats and categorical #datawrangling ggplot has been a nice transition

Being able to generate customized distribution, line, column, and box plots with only a few lines of code has been eye opening...

As someone that grew up with #excel as the go to data analysis and visualization platform for a decade, being able to replicate everything one would normally do in excel via #rstudio has been a trip...

Props to Matt Dancho on creating this course content via his #BusinessScienceUniversity platform...

I have spent the last 3 years trying to piece together learning #python and #r, but always coming up short and ultimately giving up...

What Matt has created here with his course DS4B-101 has been night and day in comparison to other online learning courses and resources...

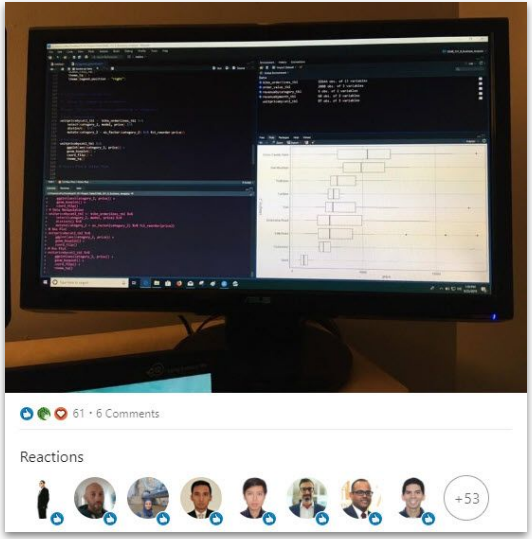
If you are looking to get it wet in R, but you find #programming intimidating, or have struggled with courses in the past...

From someone that constantly misspells "price" as "proce" as he uses select() statements during the examples...

This course is the real deal 👨‍💻🧠🔥

DS4B 101 Business Analysis with R Information:
https://lnkd.in/dx3qfFA

#datascience #continuedlearning



61 • 6 Comments

Reactions +53

#BusinessScienceSuccess

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Every 2-Weeks

1-Hour Course

Recordings + Code + Slack

$19/month

university.business-science.io

Lab 16
R's Optimization Toolchain, Part 2 - Nonlinear Programming

Lab 15
R's Optimization Toolchain, Part 1 - Linear Programming

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

Continuous Learning
Jet Fuel for your Brain

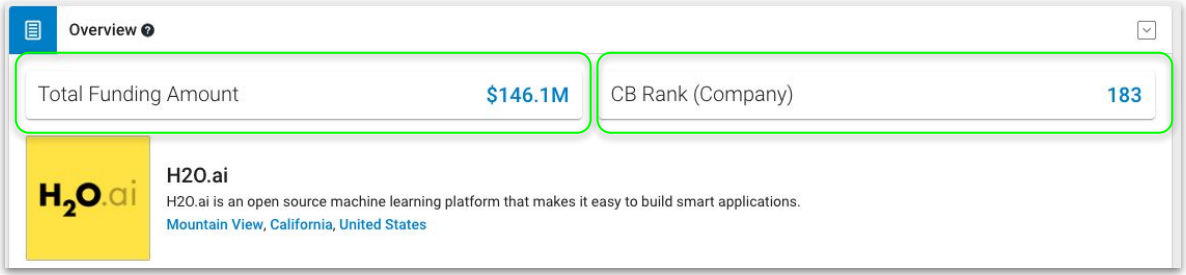
H2O Company & Technology

Updates

A Growth Company

- $146M Raised
- **Series D $72.5M**
- 18 Investors
- **Finance & AI**

H2O.ai

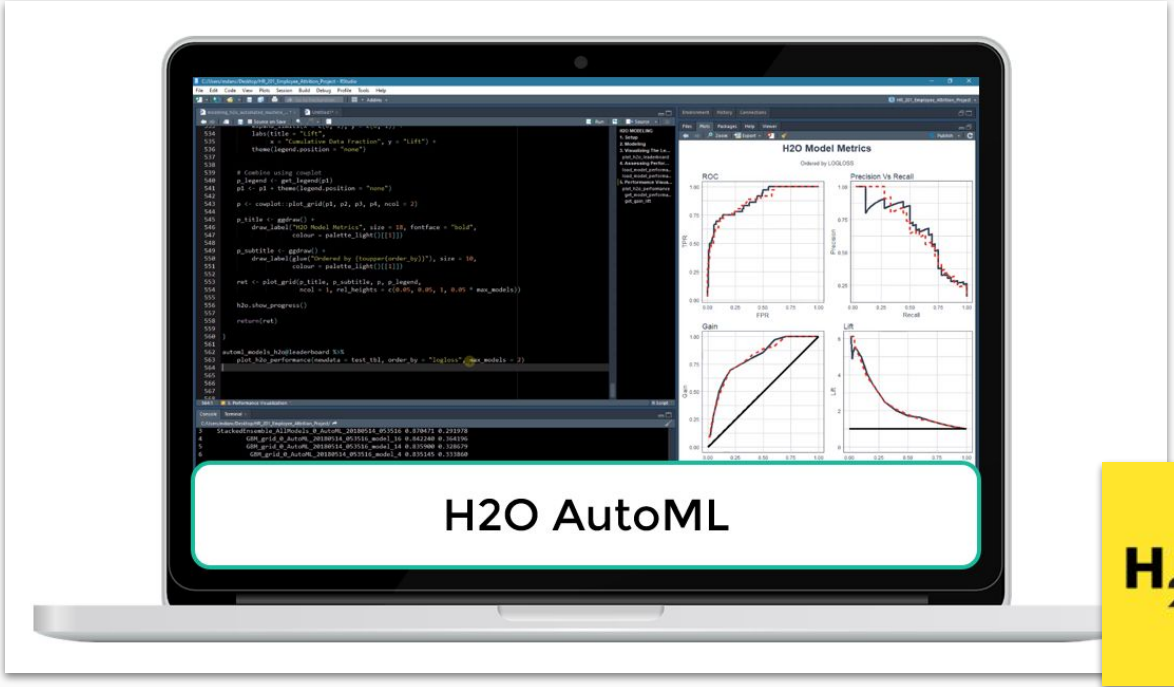


	Transaction Name	Organization Name	Funding Type	Money Raised
1.	Series D - H2O.ai	H2O.ai	Series D	$72,500,000
2.	Series C - H2O.ai	H2O.ai	Series C	$40,000,000
3.	Series B - H2O.ai	H2O.ai	Series B	$20,000,000
4.	Series A - H2O.ai	H2O.ai	Series A	$8,900,000
5.	Seed Round - H2O.ai	H2O.ai	Seed	$3,000,000

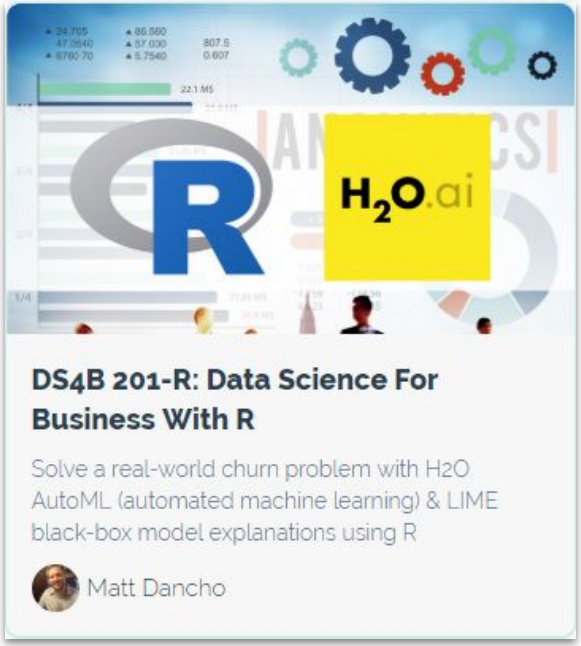
Investor Name	Lead Investor	Funding Round
Goldman Sachs	Yes	Series D - H2O.ai
Wells Fargo	–	Series D - H2O.ai
Nvidia GPU Ventures	–	Series D - H2O.ai
Nexus Venture Partners	–	Series D - H2O.ai
Ping An Global Voyager Fund	Yes	Series D - H2O.ai
Barclays Investment Bank	–	Series C - H2O.ai
CreditEase Fintech Investment Fund	–	Series C - H2O.ai
Nvidia GPU Ventures	Yes	Series C - H2O.ai
New York Life Insurance Co	–	Series C - H2O.ai
Nexus Venture Partners	–	Series C - H2O.ai

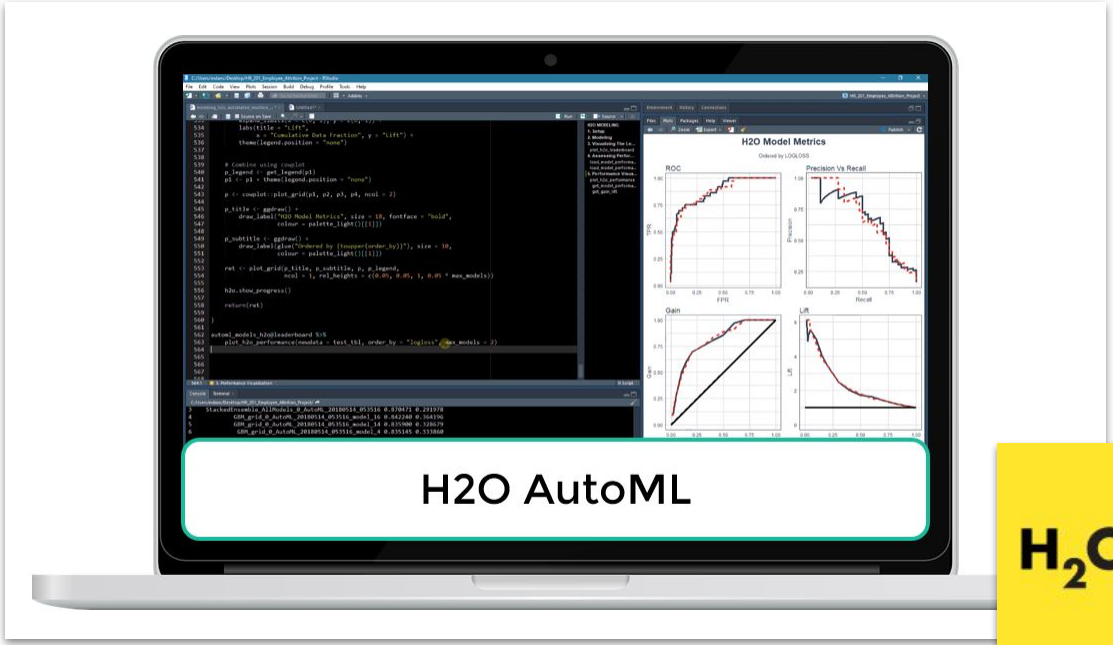
Source: https://www.crunchbase.com/organization/h2o-2

Open Source Technology Updates



Psst… We teach H2O AutoML in 201





Anomaly Detection

Business Case

Detecting Fraudulent Transactions

Credit Cards

Customer account becomes compromised

Bank is able to detect fraudulent transactions within minutes

Account is placed on hold

Saves both parties **billions** each year

Detecting Fraudulent Transactions

Key Issues

What does **abnormal behavior** mean?

How do we handle **Big Data Sets?**

Which techniques work gracefully in the presence of **High Imbalance?**

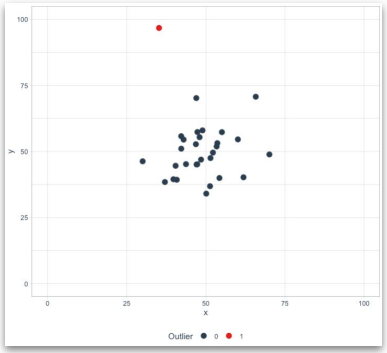
```
> # 1.1 CLASS IMBALANCE ----
> credit_card_tbl %>%
+     count(Class) %>%
+     mutate(prop = n / sum(n))
# A tibble: 2 x 3
  Class      n    prop
  <dbl>  <int>   <dbl>
1     0 284315 0.998
2     1    492 0.00173
```

Other Business Reasons to Detect Anomalies

Exploratory Analysis

Understanding data

Identifying data issues

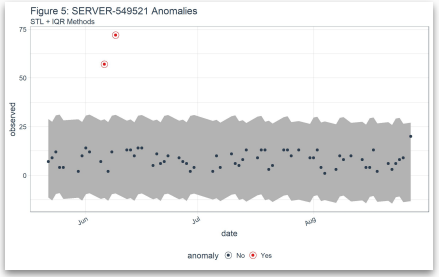


Key Business Cases

Spikes in Sales Demand

Detecting Machinery Malfunction

Identifying Malicious Behavior



What are Anomalies?

Key Terminology

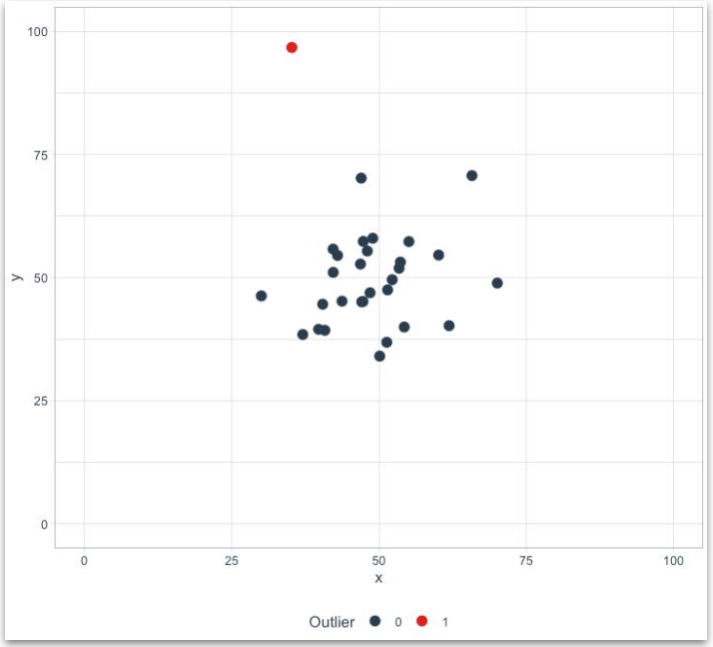
What are Anomalies?

Outliers

Must be understood

Common Causes:

1. Data Entry Errors
2. Unusual Events
3. Unusual Patterns

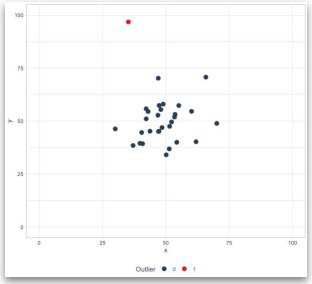


Types of Anomalies

1

Point Anomalies

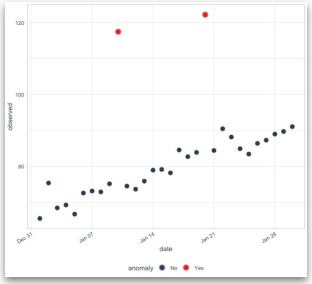
Single Point



2

Contextual

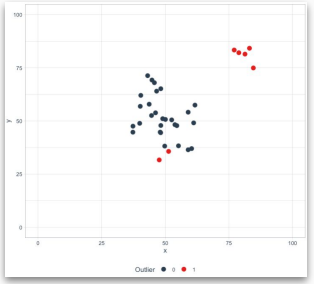
Time Series



3

Collective

Cluster of Points



Anomaly Detection

Algorithms

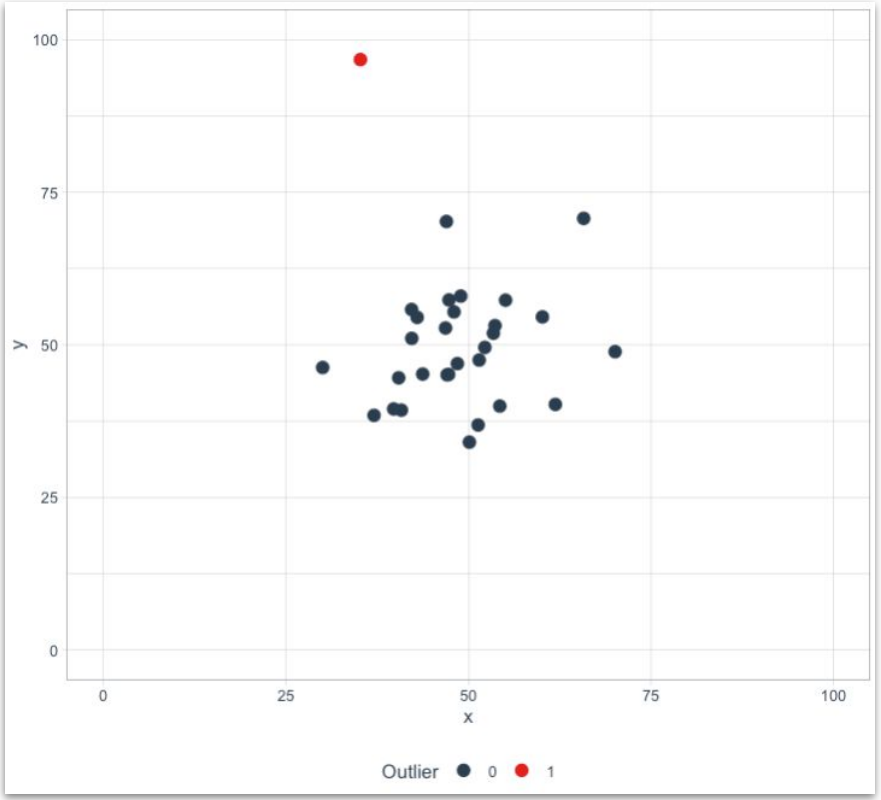
Point Anomalies

Unsupervised

- kNN
- K-Means
- **[NEW] Isolation Forest**

Supervised

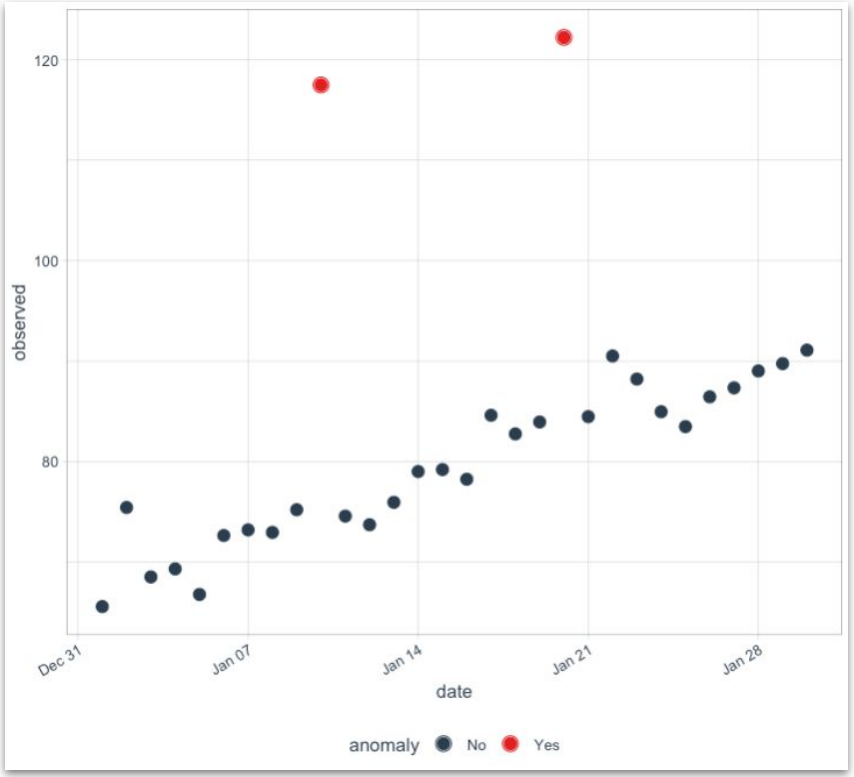
- SVM & XGBoost (great if data is labeled)



Time Series (Contextual)

Unsupervised

- Anomalize (Lab Coming Soon)



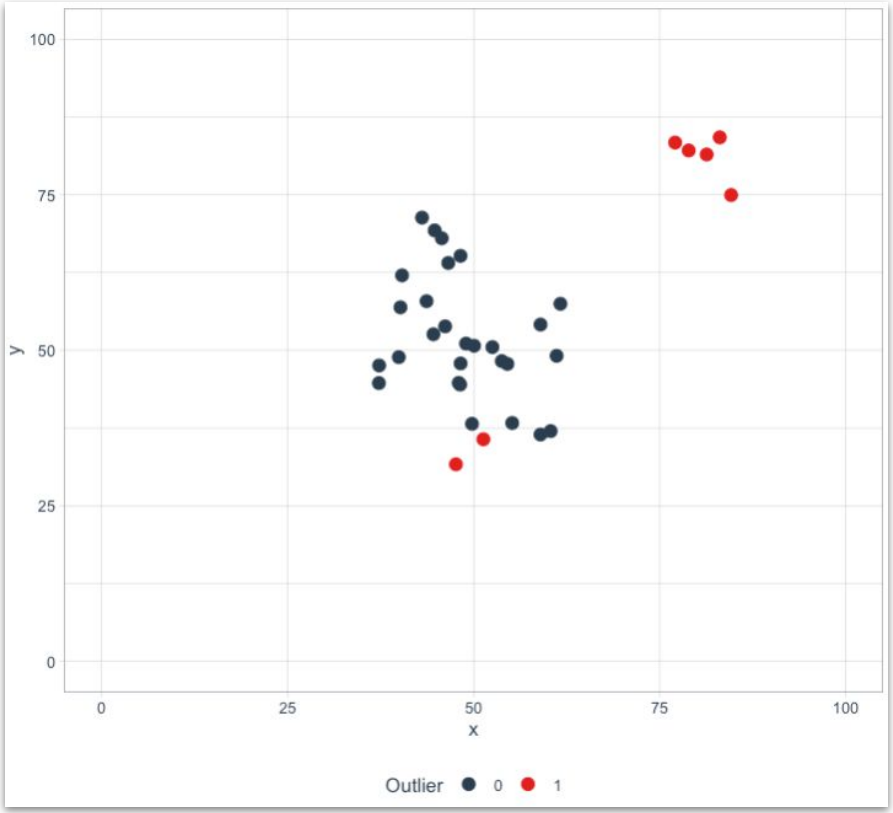
Groups (Collective)

Unsupervised

- kNN
- K-Means
- [NEW] Isolation Forest

Supervised

- SVM & XGBoost (great if data is labeled)



Point & Cluster

Not Time Series / Contextual

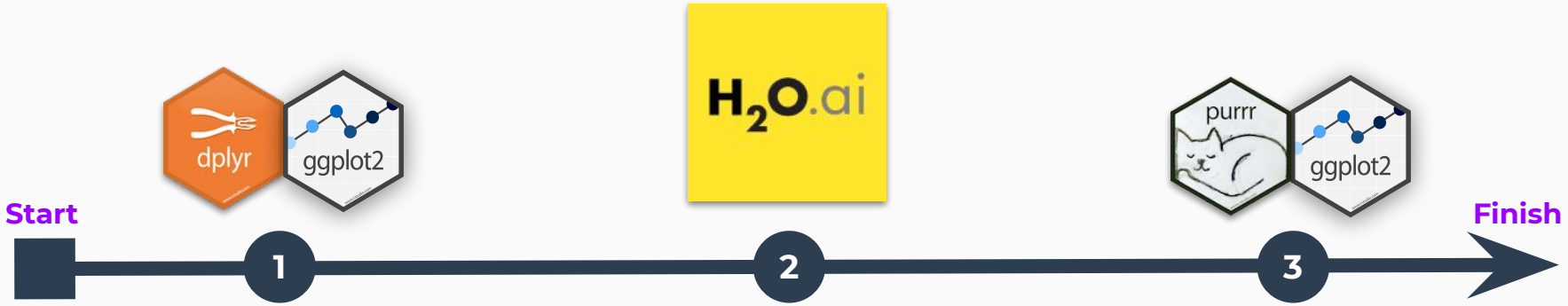
Algorithm	Unsupervised	Scalable
kNN	✓	
K-Means	✓	
Isolation Forest (H2O)	✓	✓
SVM		✓
XGBoost		✓

Process & Tools

What we need to know

Fraud Anomaly Detection

Step-By-Step



dplyr & ggplot2

Investigate Fraud Visually

H2O

Isolation Forest Algorithm

purrr & ggplot2

Stabilize & Visualize

Isolation Forest

80/20 Concepts & Important Operations

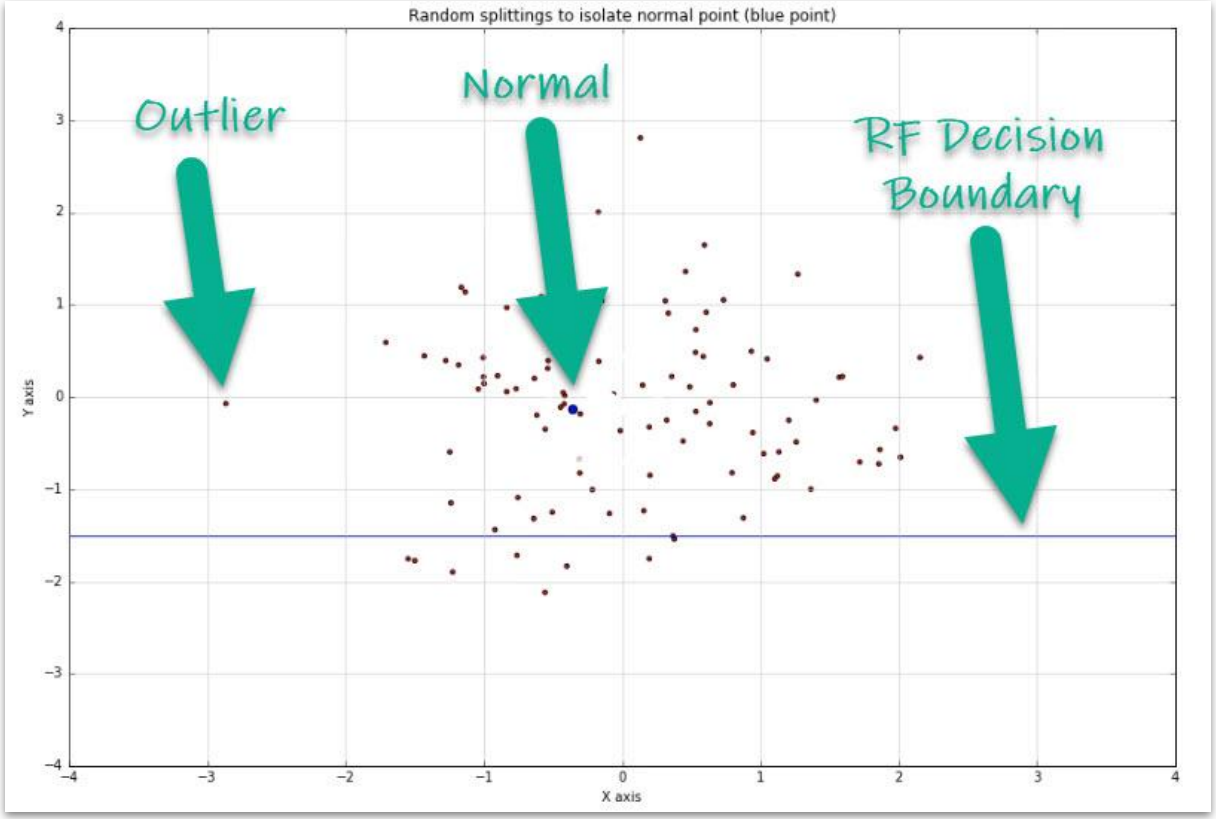
How Isolation Forest Works

Algorithm Internal Process

- Uses **Random Forest** Algorithm
- Randomly **Selects** One Feature (Target)
- Random **Splits**, Separating & Classifying Data

Key Concept

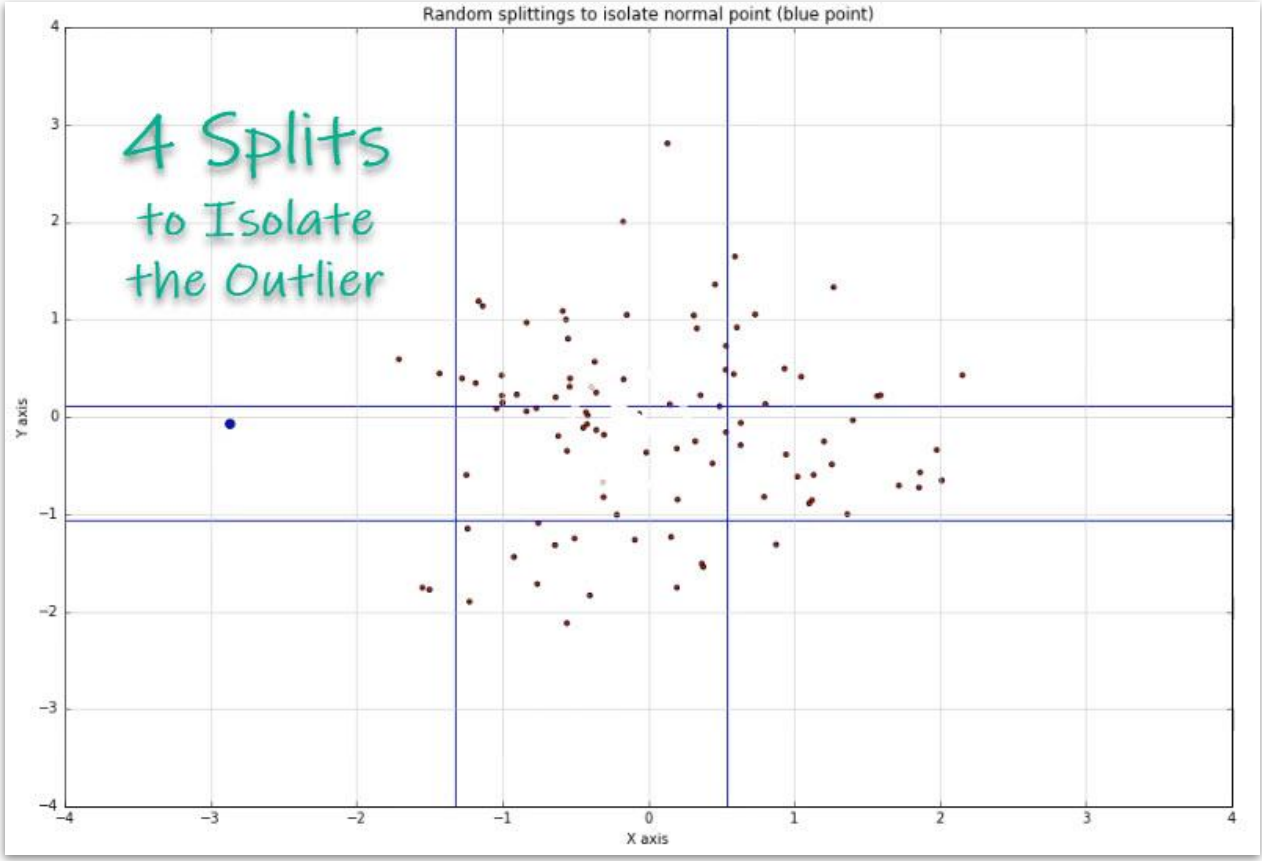
Outliers have **fewer splits** to isolate in the decision tree



How Isolation Forest Works

Anomalies (Outliers)

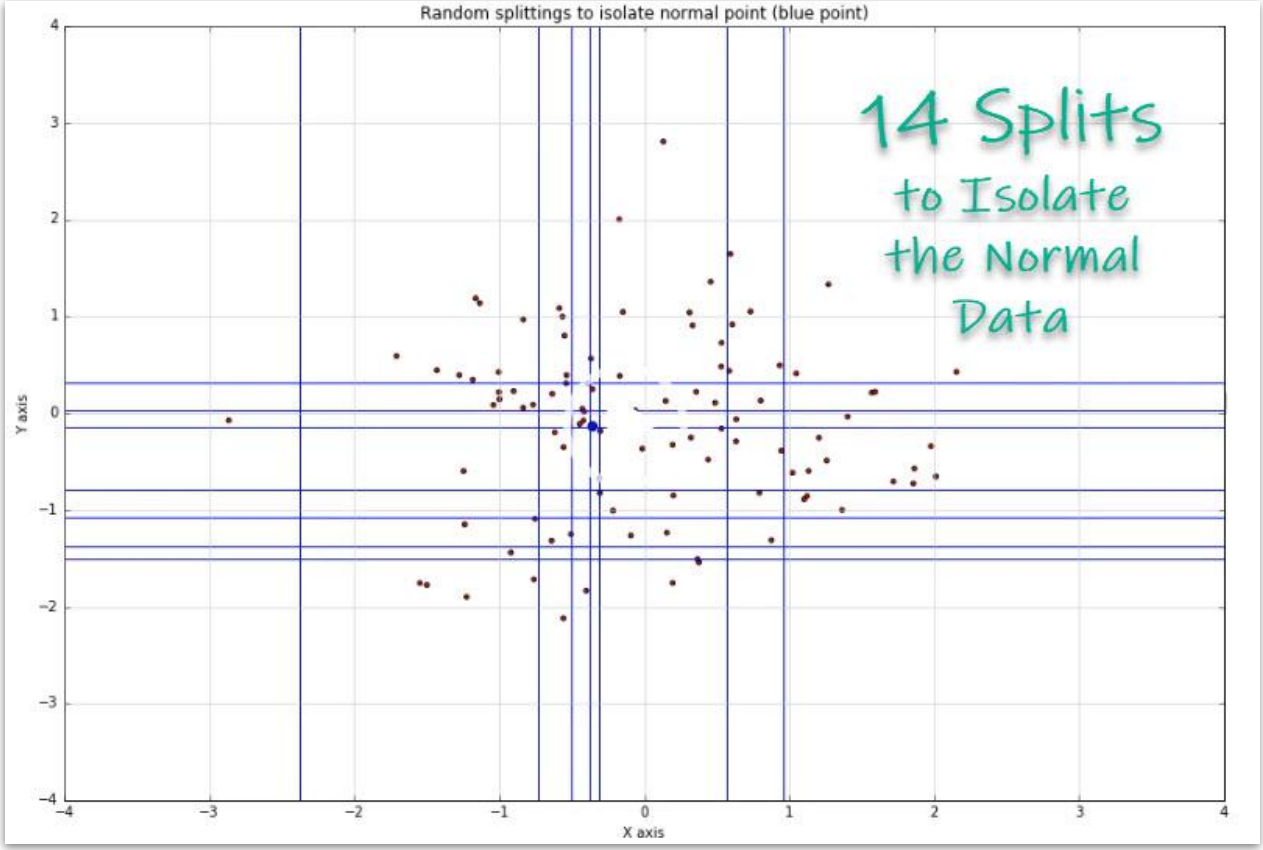
Have **fewer splits** to isolate in the decision tree



How Isolation Forest Works

Normal Data

Have **many splits** to isolate in the decision tree



30-Min Demo

Detecting Fraud with Isolation Forest

Isolation Forest

Secret Tactics & Pro Tips

Secret Tactics for

Getting Great Results

Use these tips to

increase your anomaly detection performance

Pro Tip #1

Run Algorithm Multiple Times & Average to Stabilize

Isolation Forest Algorithm

- Randomly assigns a single target
- If selects bad target, will get bad results

Prevent Bad Results

- Run multiple times
- Change Seed Parameter
- Average Results

Single Run

```
> predictions_tbl %>% pr_auc(class, predict)
# A tibble: 1 x 3
  .metric .estimator .estimate
  <chr>   <chr>          <dbl>
1 pr_auc  binary         0.933
```

Stabilized Performance after Averaging Multiple Runs

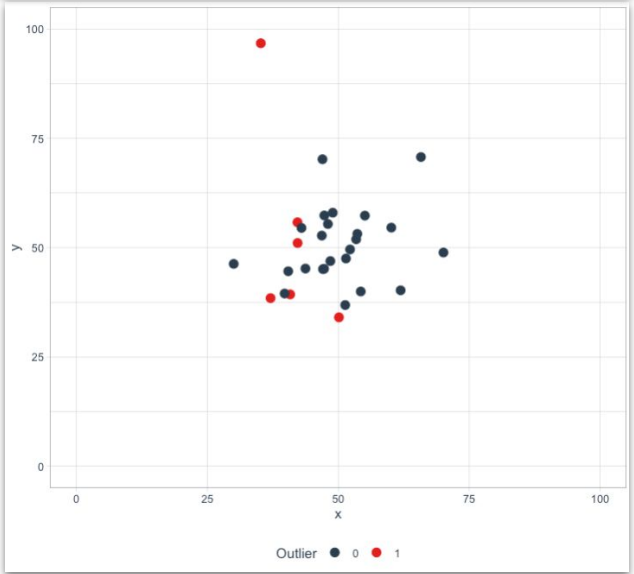
```
> stabilized_predictions_tbl %>% pr_auc(Class, mean_predict)
# A tibble: 1 x 3
  .metric .estimator .estimate
  <chr>   <chr>          <dbl>
1 pr_auc  binary         0.987
```

Pro Tip #2

Adjust Quantile / Threshold Based On Visualizing Outliers

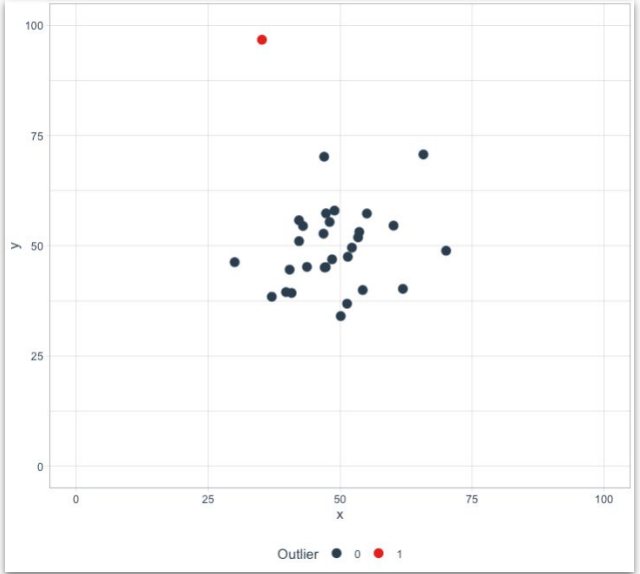
Too Low

```
50  quantile <- h2o.quantile(predictions, probs = 0.80)
51  quantile
```



Just Right

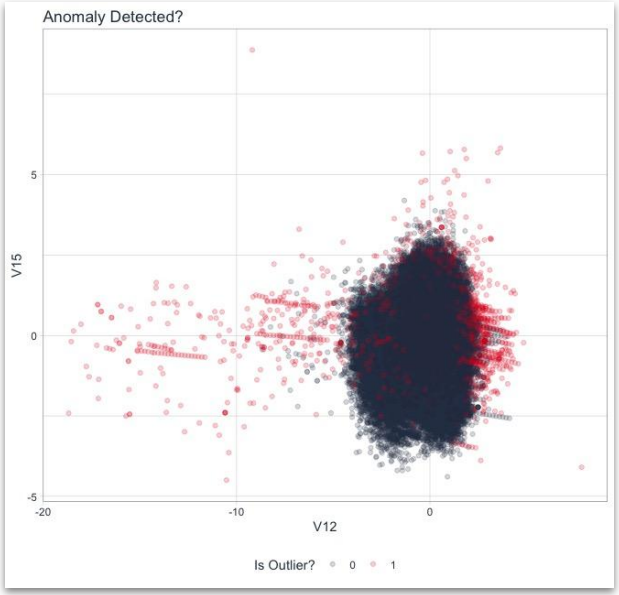
```
50  quantile <- h2o.quantile(predictions, probs = 0.99)
51  quantile
```



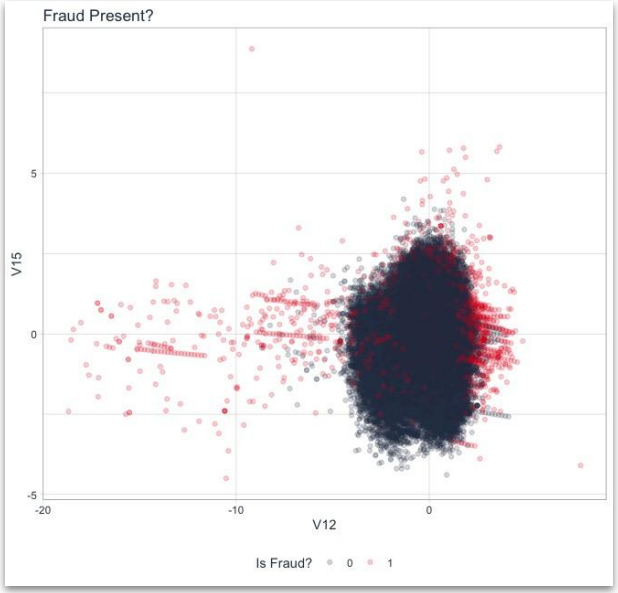
Pro Tip #3

Visualize to See What's Going On

Anomalies



Fraud

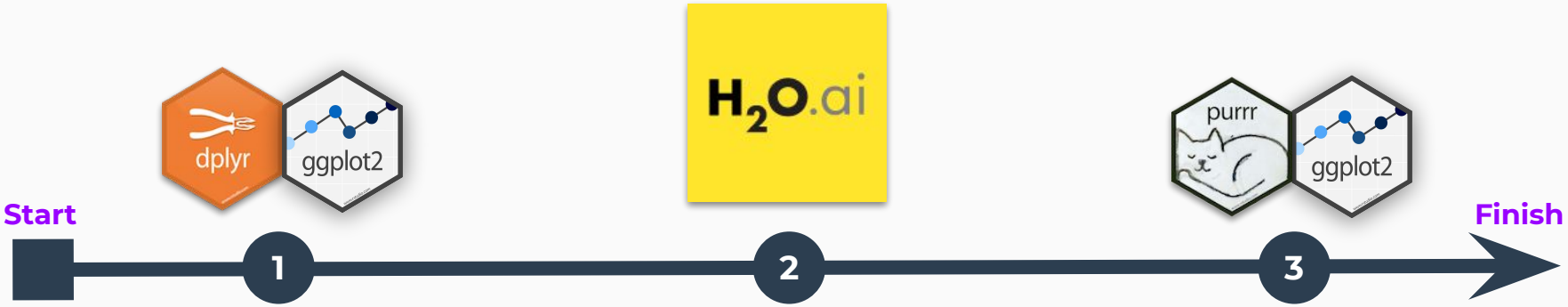


Data Science Transformational

Learning Plan

Fraud Anomaly Detection

Step-By-Step



dplyr & ggplot2

Investigate Fraud Visually

101

H2O

Isolation Forest Algorithm

201 & Lab 17

purrr & ggplot2

Stabilize & Visualize

101 & 201

dplyr


```r
# 6.3 CALCULATE AVERAGE PREDICTIONS ----
stabilized_predictions_tbl <- multiple_predictions_tbl %>%
    unnest(predictions) %>%
    select(row, seed, predict) %>%

    # Calculate stabilized predictions
    group_by(row) %>%
    summarize(mean_predict = mean(predict)) %>%
    ungroup() %>%

    # Combine with original data & important columns
    bind_cols(
        credit_card_tbl
    ) %>%
    select(row, mean_predict, Time, V12, V15, Amount, Class) %>%

    # Detect Outliers
    mutate(outlier = ifelse(mean_predict > quantile(mean_predict, probs = 0.99), 1, 0)) %>%
    mutate(Class = as.factor(Class))

# 6.4 MEASURE ----
stabilized_predictions_tbl %>% pr_auc(Class, mean_predict)
```

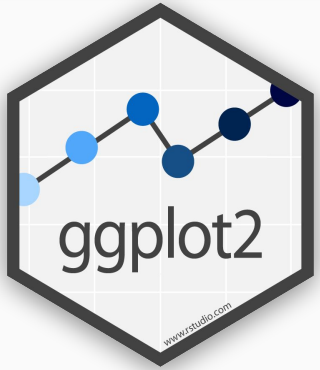
101 & 201

H2O


```
39  # 2.0 H2O ISOLATION FOREST ----
40  h2o.init()
41
42  credit_card_h2o <- as.h2o(credit_card_tbl)
43  credit_card_h2o
44
45  target <- "Class"
46  predictors <- setdiff(names(credit_card_h2o), target)
47
48  isoforest <- h2o.isolationForest(
49      training_frame = credit_card_h2o,
50      x      = predictors,
51      ntrees = 100,
52      seed   = 1234
53  )
54
55  isoforest
```

201
Lab 17

ggplot2 & purrr




```
24 # 1.2 AMOUNT SPENT VS FRAUD -----
25 g <- credit_card_tbl %>%
26     select(Amount, Class) %>%
27     ggplot(aes(Amount, fill = as.factor(Class))) +
28     geom_histogram() +
29     # geom_density(alpha = 0.3) +
30     facet_wrap(~ Class, scales = "free_y", ncol = 1) +
31     scale_x_log10(label = scales::dollar_format()) +
32     scale_fill_tq() +
33     theme_tq() +
34     labs(title = "Fraud by Amount Spent",
35          fill = "Fraud")
36
37 ggplotly(g)
```

101 + 201


```
151 # 6.2 MAP TO MULTIPLE SEEDS -----
152 multiple_predictions_tbl <- tibble(seed = c(158, 8546, 4593)) %>%
153     mutate(predictions = map(seed, iso_forest))
154
155 multiple_predictions_tbl
156
```

101 + 201

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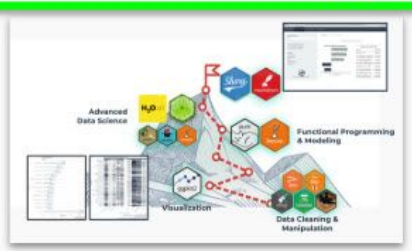
The program that will deliver YOUR Transformation

R-TRACK

LEARNING LABS PRO



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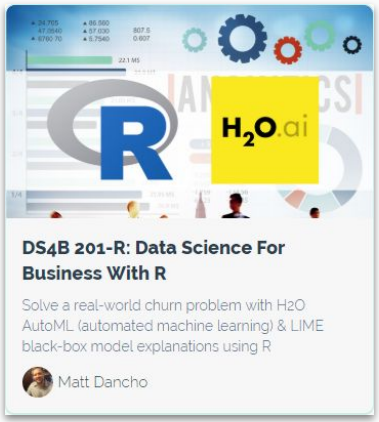
Project-Based Courses with Business Application

Data Science Foundations
7 Weeks

Machine Learning & Business Consulting
10 Weeks



Web Application Development
4 Weeks

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

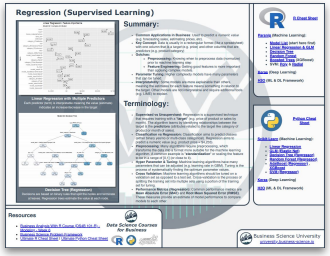
- **Machine Learning - Week 6 (8 hours of Video Lessons)**
  - **Clustering (3 hours)**
  - **Regression (5 hours)**
  - **2 Challenges**

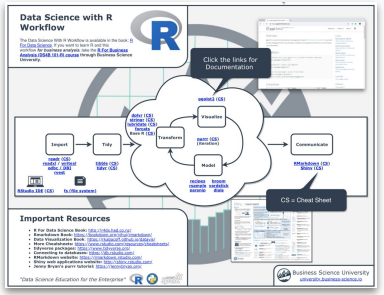
- Learn Business Reporting - Week 7
  - RMarkdown & plotly
  - 2 Project Reports:
    1. Product Pricing Algo
    2. Customer Segmentation

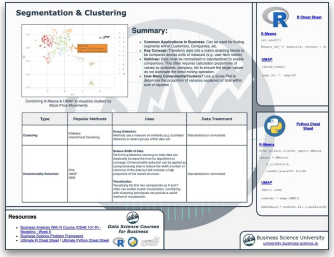
Business Analysis with R (DS4B 101-R)

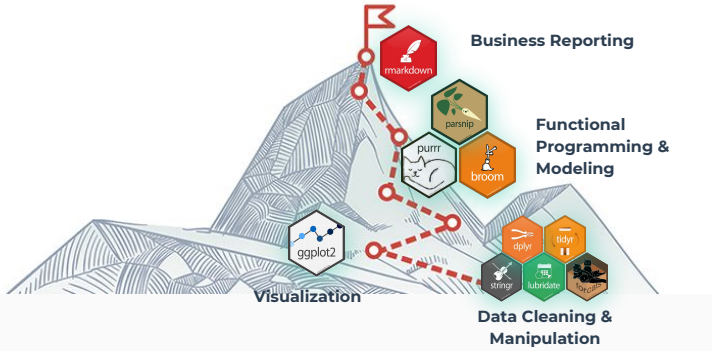
Data Science Foundations

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**

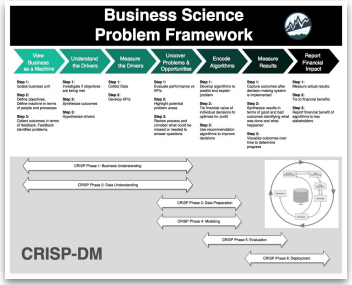
Return-On-Investment - Weeks 7, 8, 9

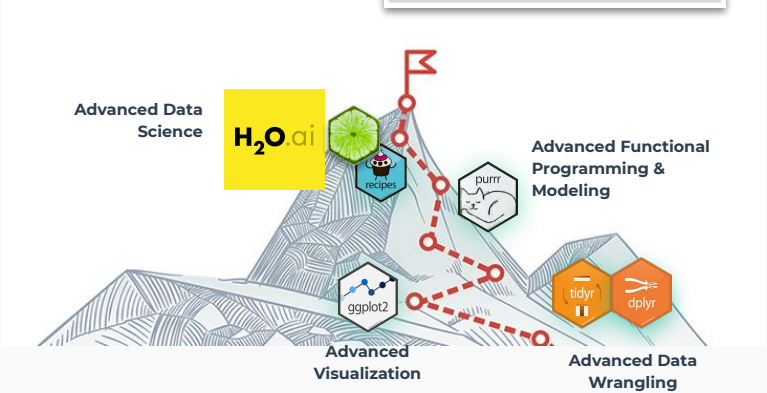
- **Expected Value Framework**
- **Threshold Optimization**
- **Sensitivity Analysis**
- **Recommendation Algorithm**

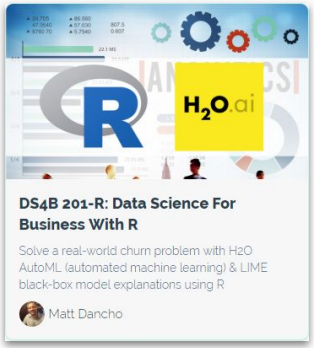
Data Science For Business (DS4B 201-R)

Machine Learning & Business Consulting

10 Weeks







Key Benefits

Learn Shiny & Flexdashboard
- Build Applications
- Learn Reactive Programming
- Integrate Machine Learning

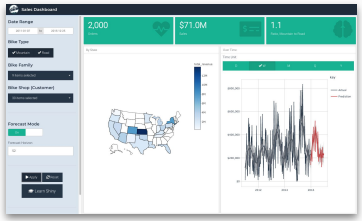
App #1: Predictive Pricing App
- Model Product Portfolio
- XGBoost Pricing Prediction
- Generate new products instantly

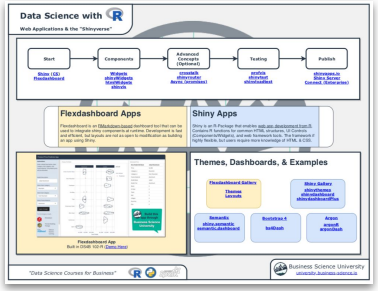
App #2: Sales Dashboard with Demand Forecasting
- Model Demand History
- Segment Forecasts by Product & Customer
- XGBoost Time Series Forecast
- Generate new forecasts instantly

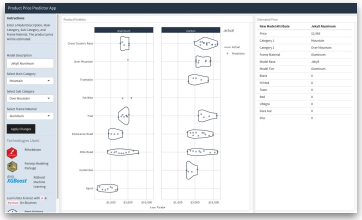
Shiny Apps for Business (DS4B 102-R)

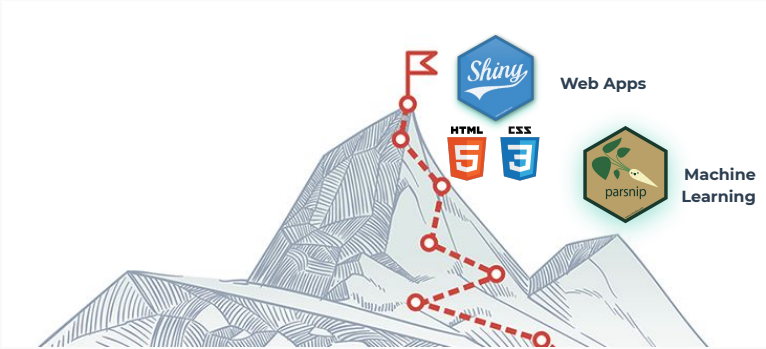
Web Application Development

4 Weeks





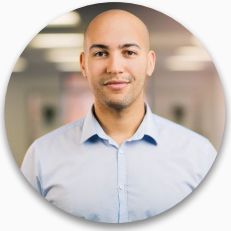




Testimonials

*“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

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Matt Dancho

DS4B 201-R: Data Science For Business With R

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Matt Dancho

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

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