

HUMAN RESOURCES: APPLIED PREDICTIVE ANALYTICS

DATA SCIENCE FOR BUSINESS

A Systematic Approach With Applications in **R** and **H2O**

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PATH TO ROI



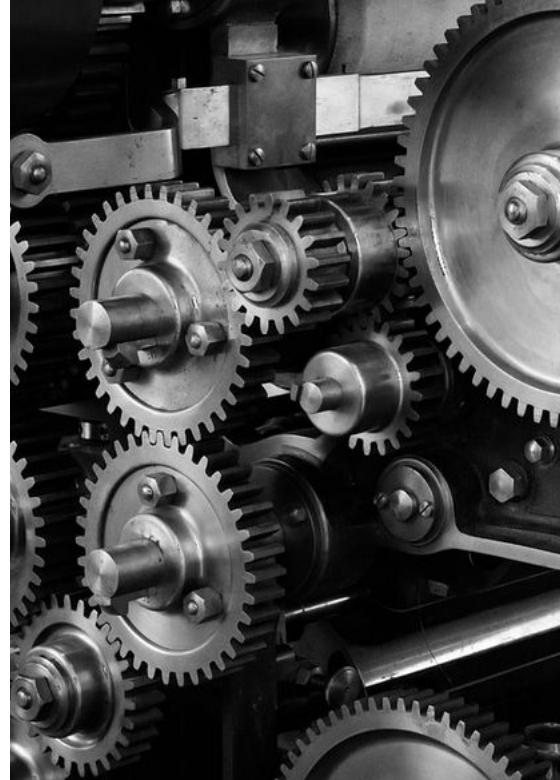
EMPLOYEE TURNOVER

\$15M / Year Problem



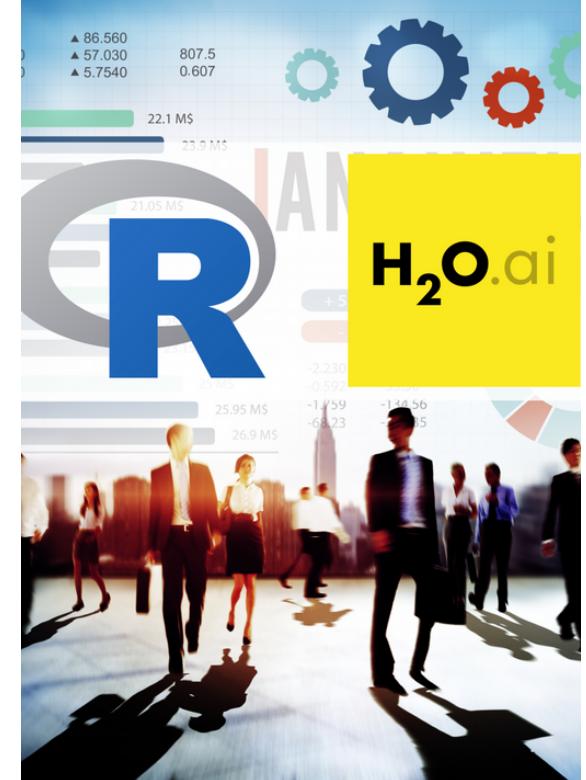
THE BSPF FRAMEWORK

The most critical tool in your arsenal



HOW IT WORKS

Generate ROI for businesses using data science



PROJECT WITH R & H20

Tools that make complex business analysis simple

SECTION 1

WHAT HAPPENS WHEN AN EMPLOYEE LEAVES?

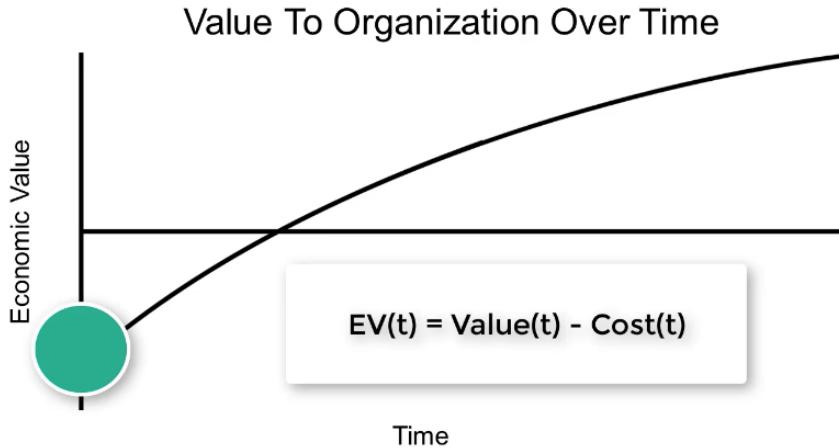




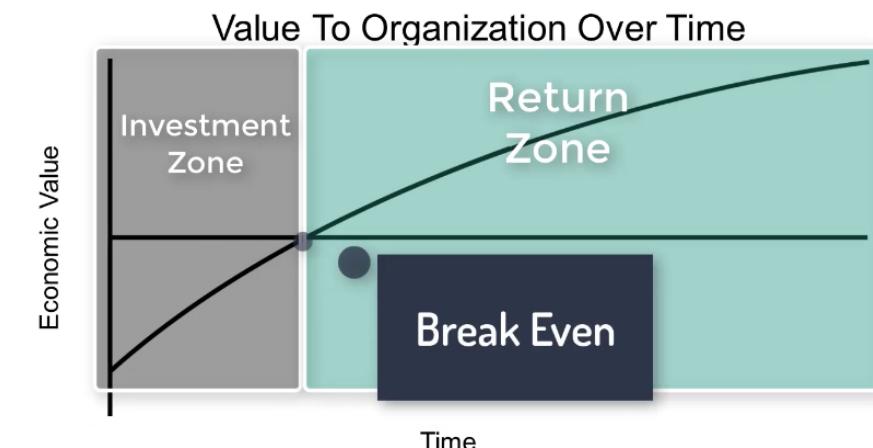
**YOU TAKE AWAY OUR TOP 20
EMPLOYEES AND WE BECOME A
MEDIocre COMPANY**

- Bill Gates

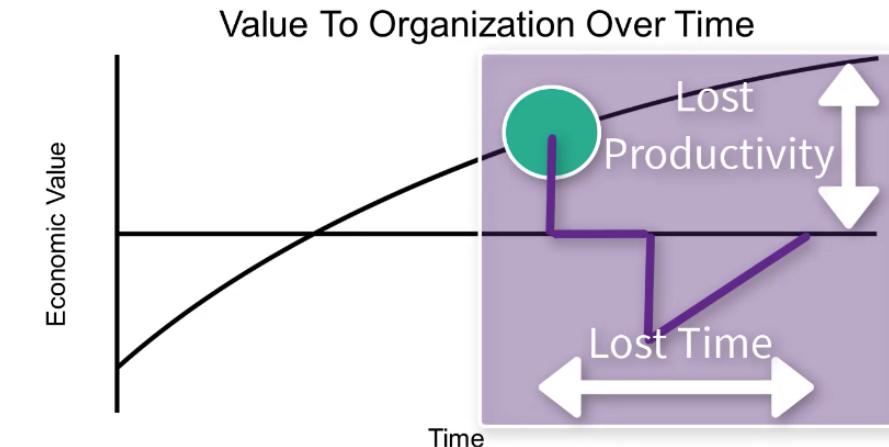
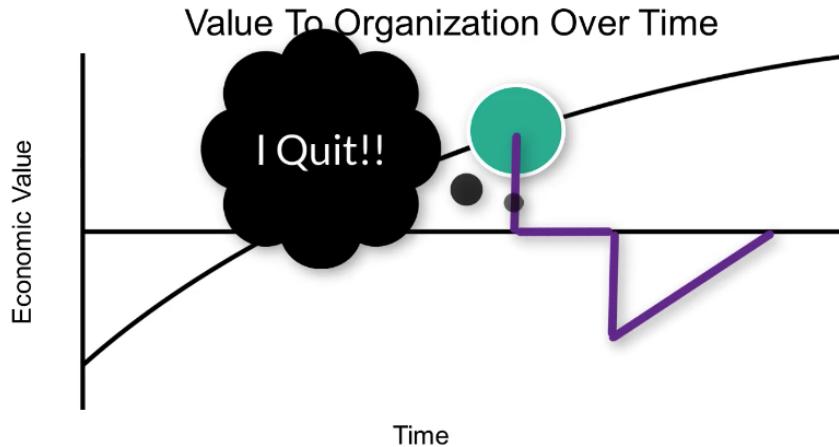
ECONOMIC VALUE OF EMPLOYEE OVER TIME



1 2



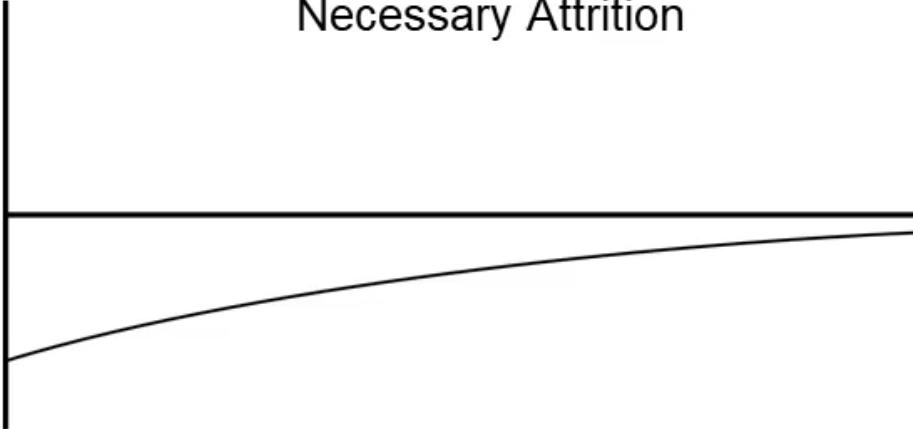
3 4



GOOD ATTRITION VS BAD ATTRITION

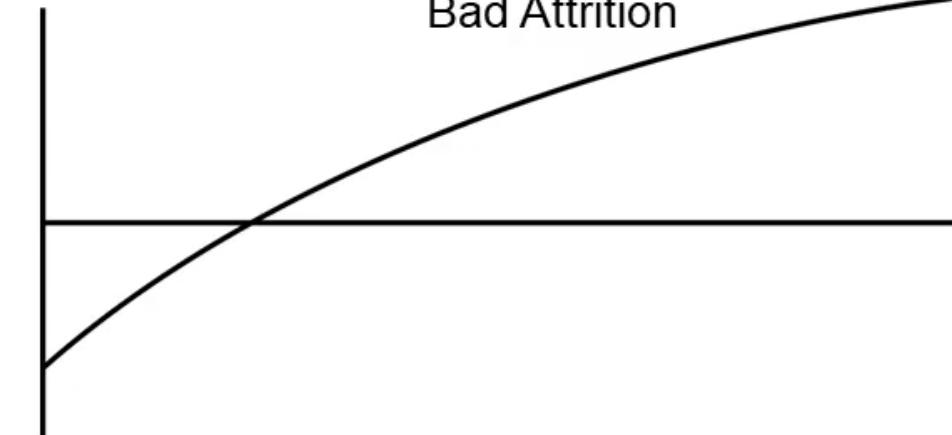
1. POOR PERFORMERS

Necessary Attrition



2. HIGH PERFORMERS

Bad Attrition



Sometimes attrition is OK

COST OF ATTRITION

A Massive Hidden Cost

| A | B | C | D | E | F | G | H |
|----|---|---------------|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | Employee Turnover Cost Calculator | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | Average Employee Salary + Benefits | \$ 80,000 | | | | | |
| 8 | Direct Costs | | | | | | |
| 9 | Item | | | | | | |
| 10 | 1. Average Separation | \$ 500 | | | | | |
| 11 | 2. Average Vacancy (Temporary Help + Overtime) | \$ 10,000 | | | | | |
| 12 | 3. Average Acquisition (Ads, Travel, Interviews, Physicals, Bonuses, ...) | \$ 4,900 | | | | | |
| 13 | 4. Average Placement (New Supplies, Onboarding, Training) | \$ 3,500 | | | | | |
| 14 | Total | \$ 18,900 | | | | | |
| 15 | Lost Productivity | | | | | | |
| 16 | Item | | | | | | |
| 17 | 1. Annual Revenue (less COGS) Per Employee | \$ 250,000 | | | | | |
| 18 | 2. Workdays Per year | 240 | | | | | |
| 19 | 3. Average Workdays Position Is Open | 40 | | | | | |
| 20 | 4. Average Onboarding / Training Period | 60 | | | | | |
| 21 | 5. Effectiveness During Onboarding/Training | 50% | | | | | |
| 22 | Total (Calculation: 1. / 2. x 3. + 4. x 5.) | \$ 72,917 | | | | | |
| 23 | Savings of Salary + Benefits | | | | | | |
| 24 | Item | | | | | | |
| 25 | 1. Average Salary + Benefits | \$ 80,000 | | | | | |
| 26 | 2. Workdays Per year | 240 | | | | | |
| 27 | 3. Average Workdays Position Is Open | 40 | | | | | |
| 28 | Total (Calculation: 1. / 2. x 3.) | \$ 13,333 | | | | | |
| 29 | Estimated Turnover Cost Per Employee | | | | | | |
| 30 | Item | | | | | | |
| 31 | 1. Direct Costs | \$ 18,900 | | | | | |
| 32 | 2. Lost Productivity | \$ 72,917 | | | | | |
| 33 | 3. Savings of Salary + Benefits | \$ 13,333 | | | | | |
| 34 | Total (Calculation: 1. + 2. - 3.) | \$ 78,483 | | | | | |
| 35 | Total Cost of Employee Turnover | | | | | | |
| 36 | Item | | | | | | |
| 37 | Annual Employee Churn | 200 | | | | | |
| 38 | Total Cost | \$ 15,696,667 | | | | | |
| 39 | | | | | | | |
| 40 | | | | | | | |
| 41 | | | | | | | |

• SIMPLE CALCULATION

Direct costs

Lost Productivity

Savings (Salary & Benefits)

• \$78K COST / EMPLOYEE

• IF ORGANIZATION LOSES 200 HIGH PERFORMERS EACH YEAR...



**\$15M / YEAR
PROBLEM**

SECTION 2

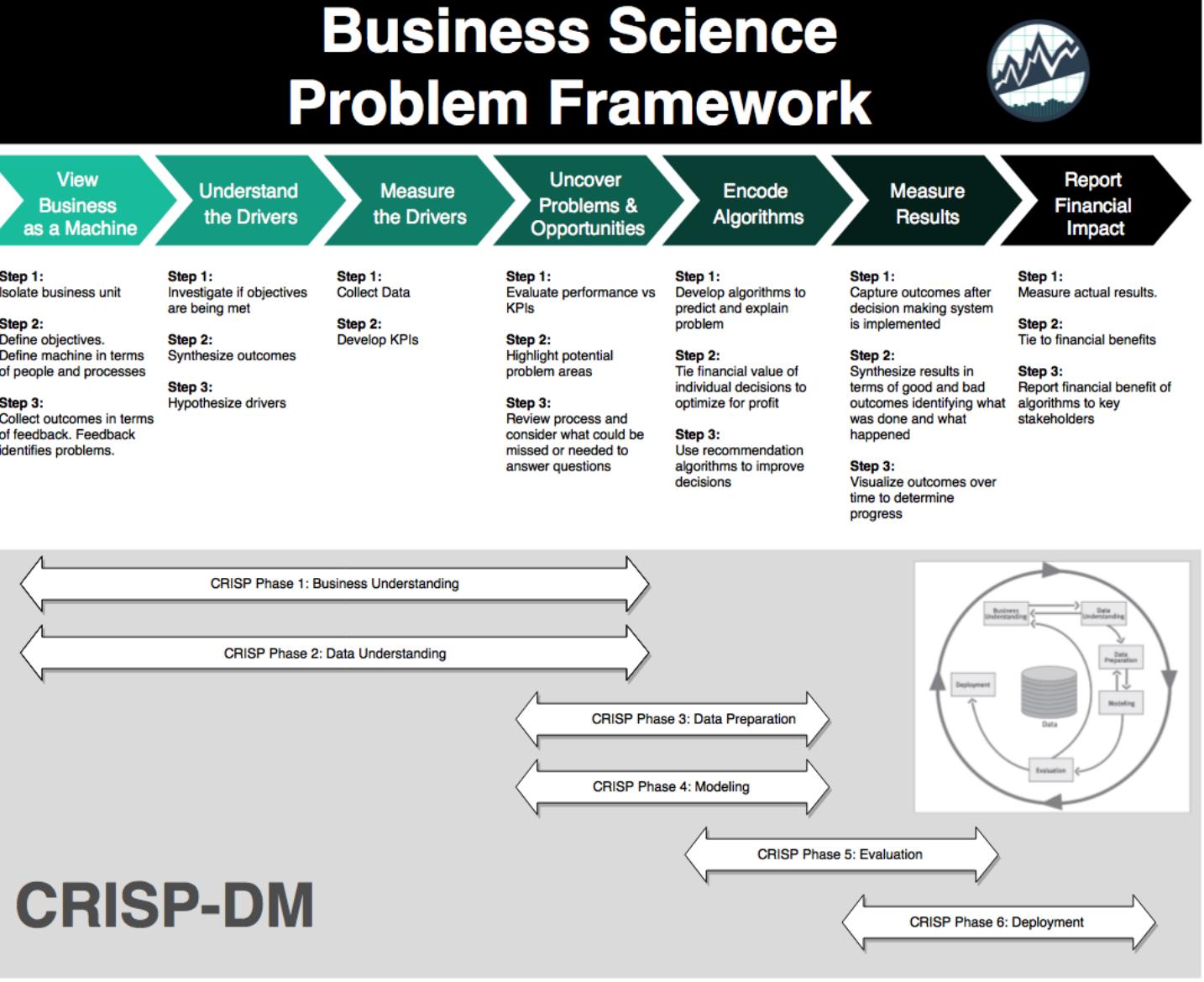
THE BSPF FRAMEWORK





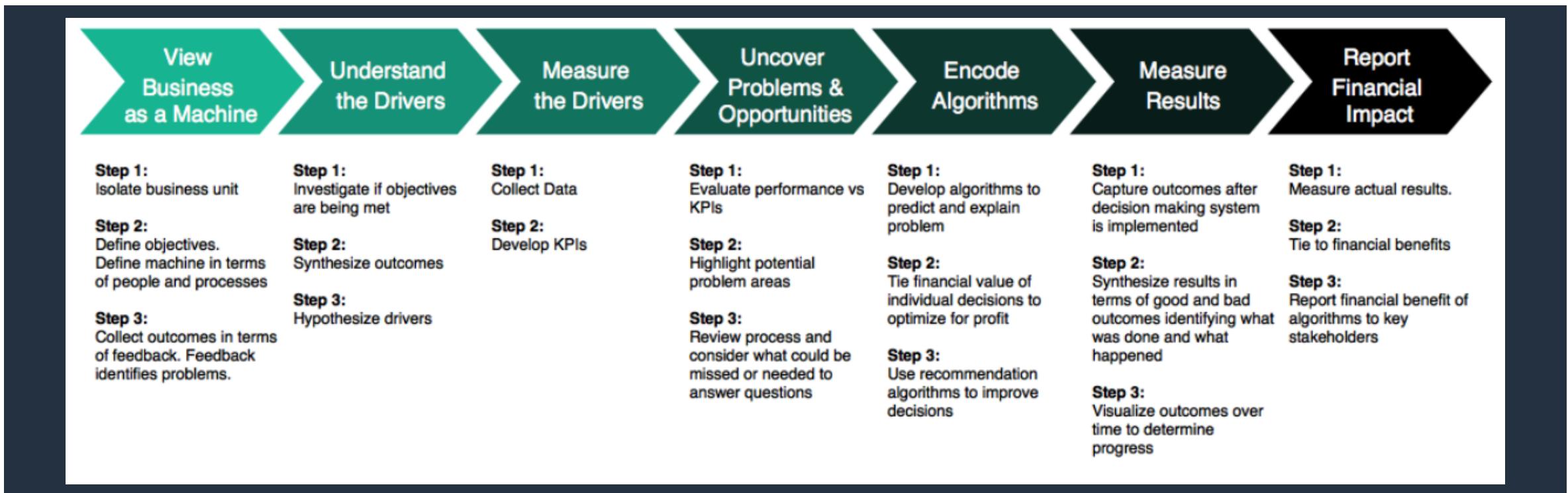
A WAY TO CONNECT DATA SCIENCE WITH THE BUSINESS

That generates ROI



TOP: DETAILED

Designed for **Business Analysis**

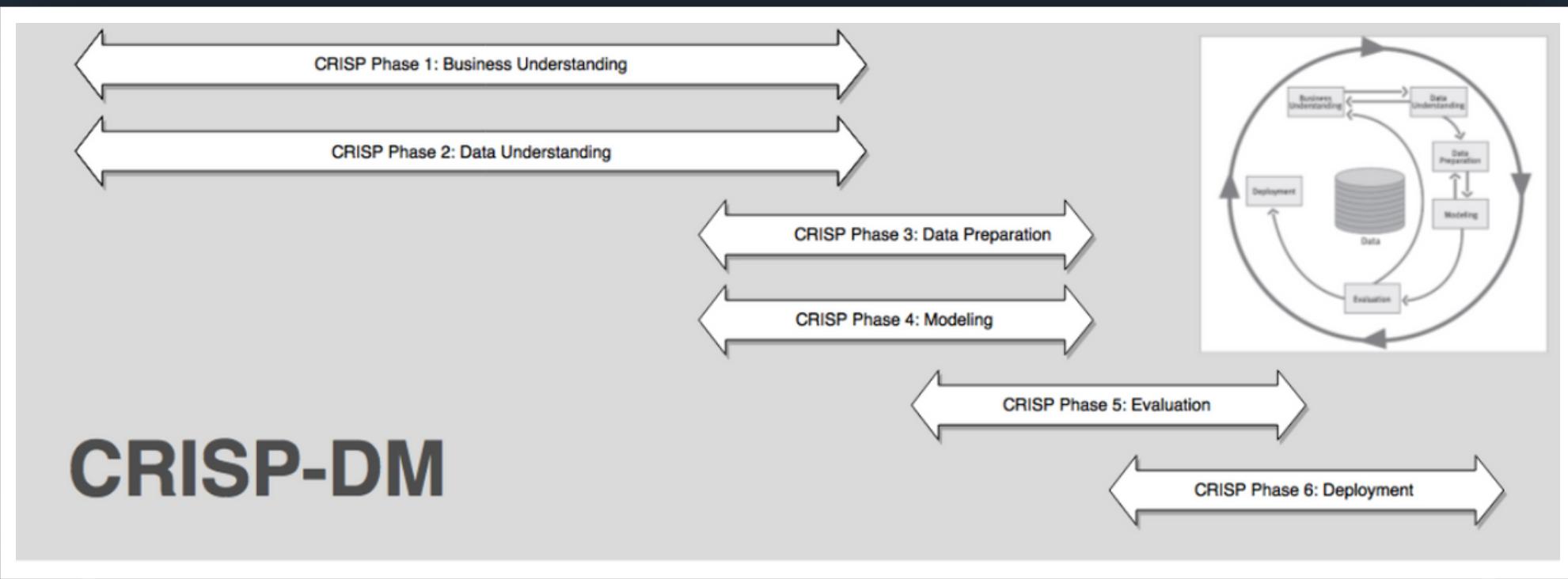


COLLECT OUTCOMES & SIZE PROBLEM --> IDENTIFY DRIVERS --> INCORPORATE DATA SCIENCE --> CONNECT TO ROI

Focuses on Communication with Stakeholders & Subject Matter Experts

BOTTOM: HIGH-LEVEL

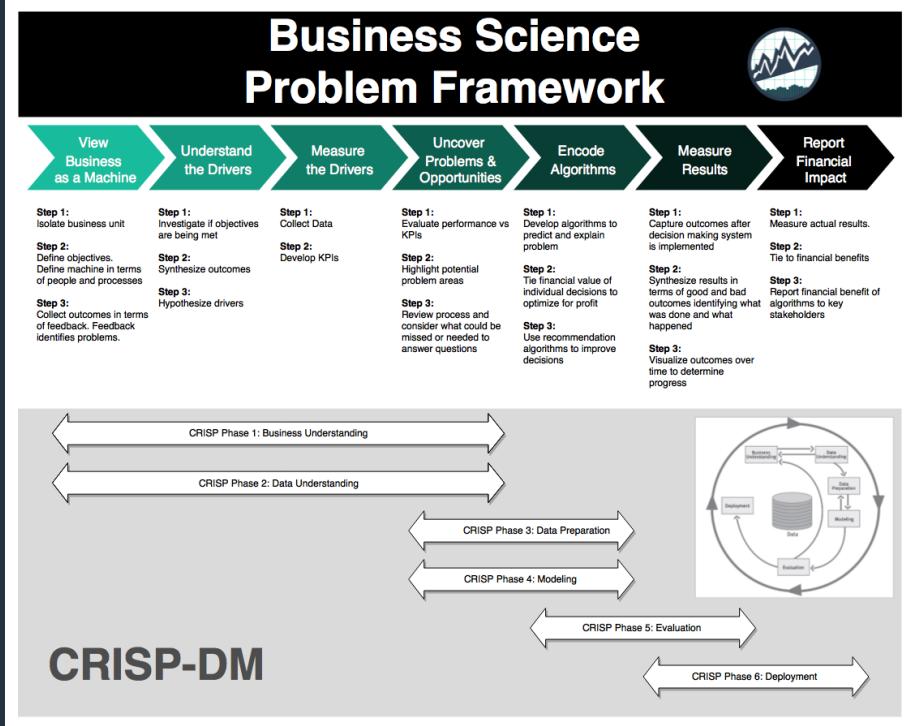
Designed for **Data Science Project Management**



CRISP-DM FRAMEWORK

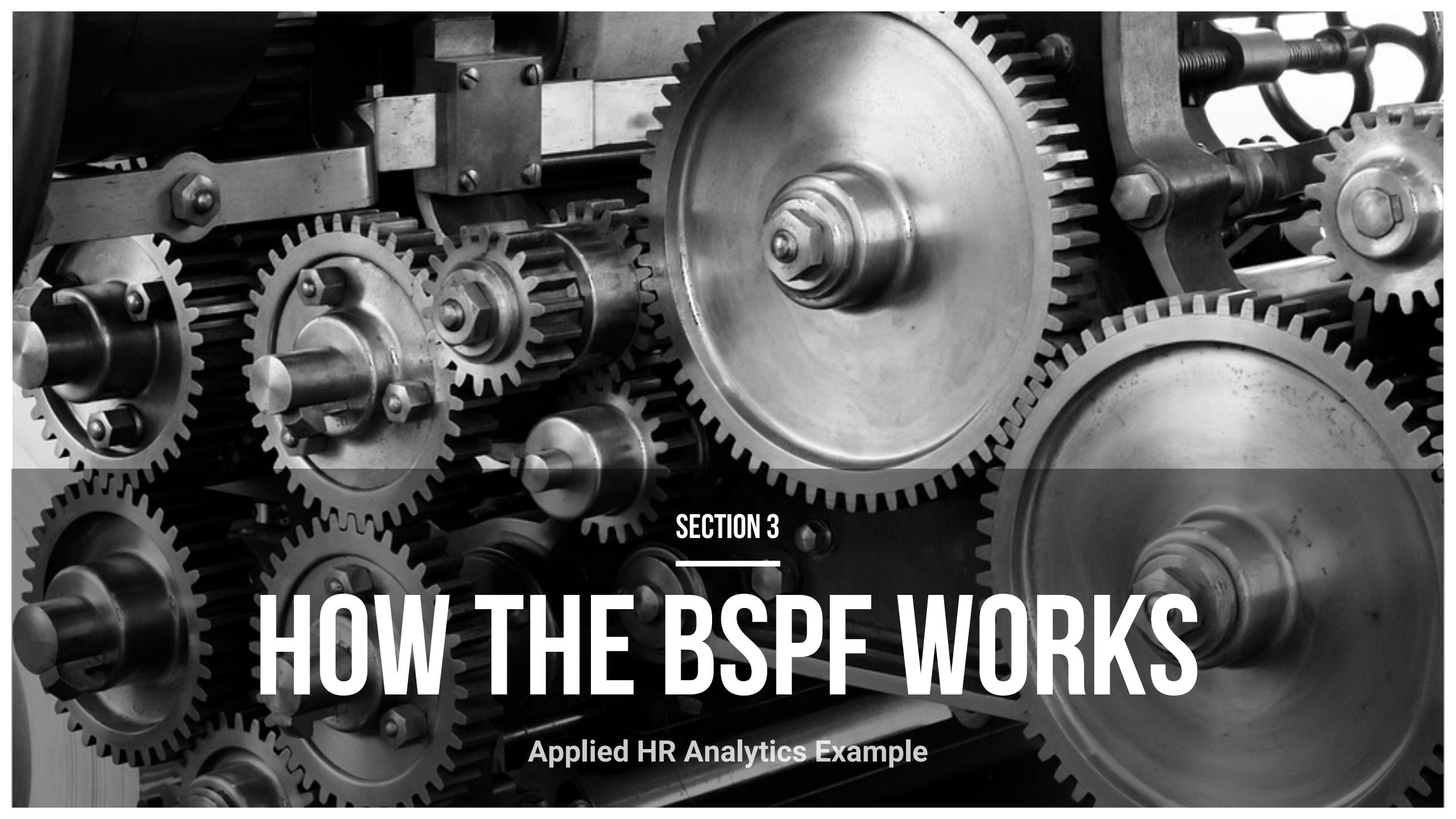
Ties the data science phases to the business analysis stages

IT WORKS! BUT WHY?



- FOCUSES TEAM ON BUSINESS OBJECTIVES
- PROVIDES A CLEAR PLAN
- EXPOSES KEY STEPS IN PROCESS
- ANSWERS THE QUESTION: WHY DOES IT TAKE SO MUCH TIME?
- HELPS BRING QUESTIONS UP FRONT
- GIVES EVERYONE A SENSE OF CONFIDENCE

Data science becomes an efficient investigation in the pursuit of ROI

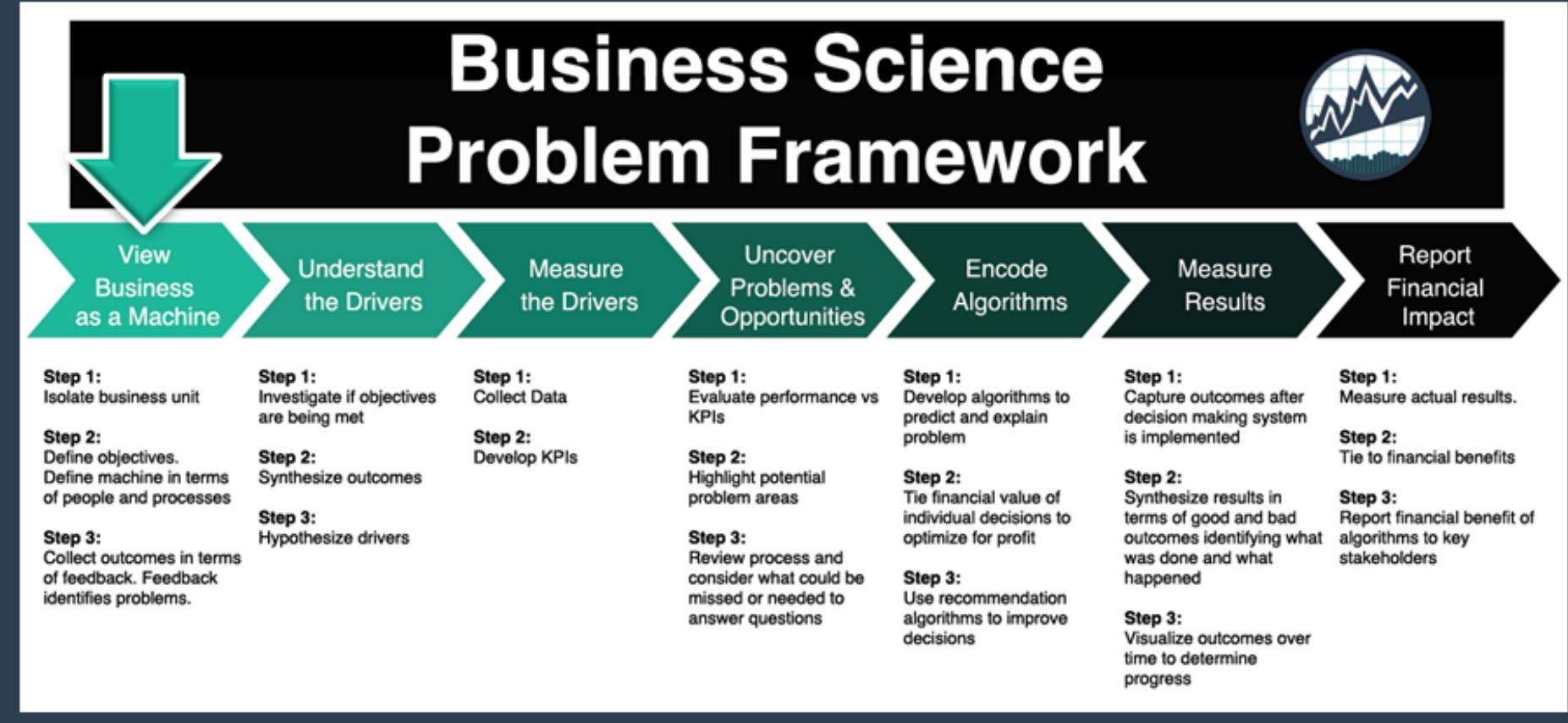


SECTION 3

HOW THE BSPF WORKS

Applied HR Analytics Example

View Business As A Machine



Stage 1: View The Business As A Machine

1. PARTS OF THE BUSINESS

1. Business As A Machine

Business has many parts



1. Business As A Machine



2. THE MACHINE

Source: Principles by Ray Dalio

3. RUNNING THE MACHINE



...Business As A Machine



When the machine is running well...

...the organization is happy!

Source: Principles by Ray Dalio

Stage 1: View The Business As A Machine

1. COLLECT BASIC ATTRITION DATA

```
```{r}
dept_job_role_tbl
```

| EmployeeNumber | Department             | JobRole                   | PerformanceRating | Attrition |
|----------------|------------------------|---------------------------|-------------------|-----------|
| 1              | Sales                  | Sales Executive           | 3                 | Yes       |
| 2              | Research & Development | Research Scientist        | 4                 | No        |
| 4              | Research & Development | Laboratory Technician     | 3                 | Yes       |
| 5              | Research & Development | Research Scientist        | 3                 | No        |
| 7              | Research & Development | Laboratory Technician     | 3                 | No        |
| 8              | Research & Development | Laboratory Technician     | 3                 | No        |
| 10             | Research & Development | Laboratory Technician     | 4                 | No        |
| 11             | Research & Development | Laboratory Technician     | 4                 | No        |
| 12             | Research & Development | Manufacturing Director    | 4                 | No        |
| 13             | Research & Development | Healthcare Representative | 3                 | No        |

1-10 of 1,250 rows

Previous [1] 2 3 4 5 6 ... 100 Next

## 3. CALCULATE TURNOVER COUNT & PROPORTION

```
```{r}
# 1. Business Science Problem Framework ----

# 1A. View Business As Machine ----

# BSU's: Department and Job Role
# Define Objectives: Retain High Performers
# Assess Outcomes: TBD

dept_job_role_tbl %>%
  group_by(Attrition) %>%
  summarize(n = n()) %>%
  ungroup() %>%
  mutate(pct = n / sum(n))
```


| Attrition | n | pct |
|-----------|------|--------|
| No | 1049 | 0.8392 |
| Yes | 201 | 0.1608 |

2 rows


```

## 2. GLIMPSE OF DATA

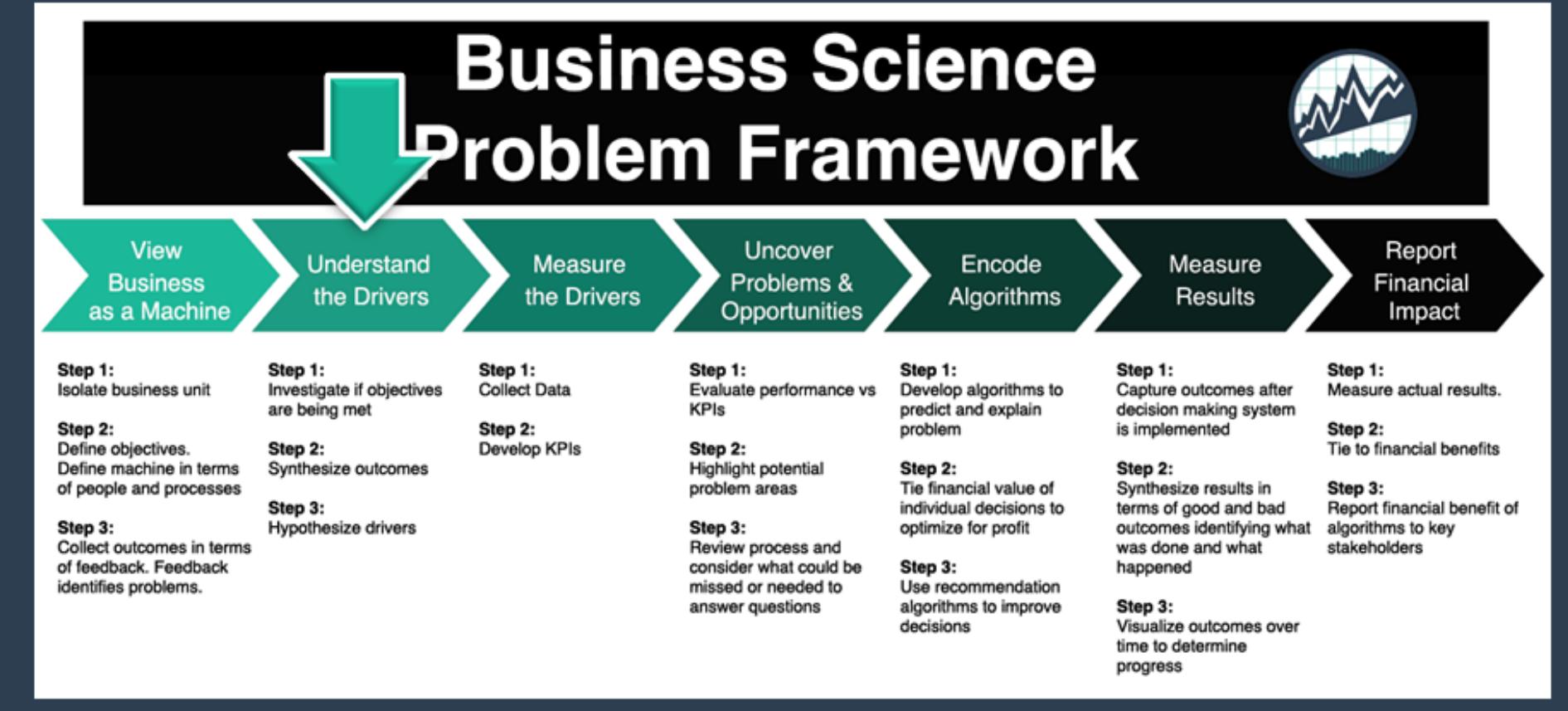
```
```{r}
dept_job_role_tbl %>% glimpse()
```
```

Observations: 1,250  
Variables: 5

|                      |       |                              |
|----------------------|-------|------------------------------|
| \$ EmployeeNumber    | <dbl> | 1, 2, 4, 5, 7, 8, 10, 11...  |
| \$ Department        | <chr> | "Sales", "Research & Dev..." |
| \$ JobRole           | <chr> | "Sales Executive", "Rese..." |
| \$ PerformanceRating | <dbl> | 3, 4, 3, 3, 3, 4, 4, ...     |
| \$ Attrition         | <chr> | "Yes", "No", "Yes", "No"...  |

Stage 1: View The Business As A Machine

# Understand The Drivers



## Stage 2: Understand The Drivers

## 2. Understand What Drives Machine



- Start with business objectives
- Synthesize outcomes
- Hypothesize drivers



Stage 2: Understand The Drivers

```

```{r}
# 1B. Understand The Drivers ----

# Investigate Objectives: Retain Good Employees
# Synthesize Outcomes: 16% Pct Attrition, High Counts and High percentages
# Hypothesize Drivers: Job Role and Departments

# Department ----
dept_job_role_tbl %>%
  group_by(Department, Attrition) %>%
  summarize(n = n()) %>%
  ungroup() %>%
  group_by(Department) %>%
  mutate(pct = n / sum(n))
```

```

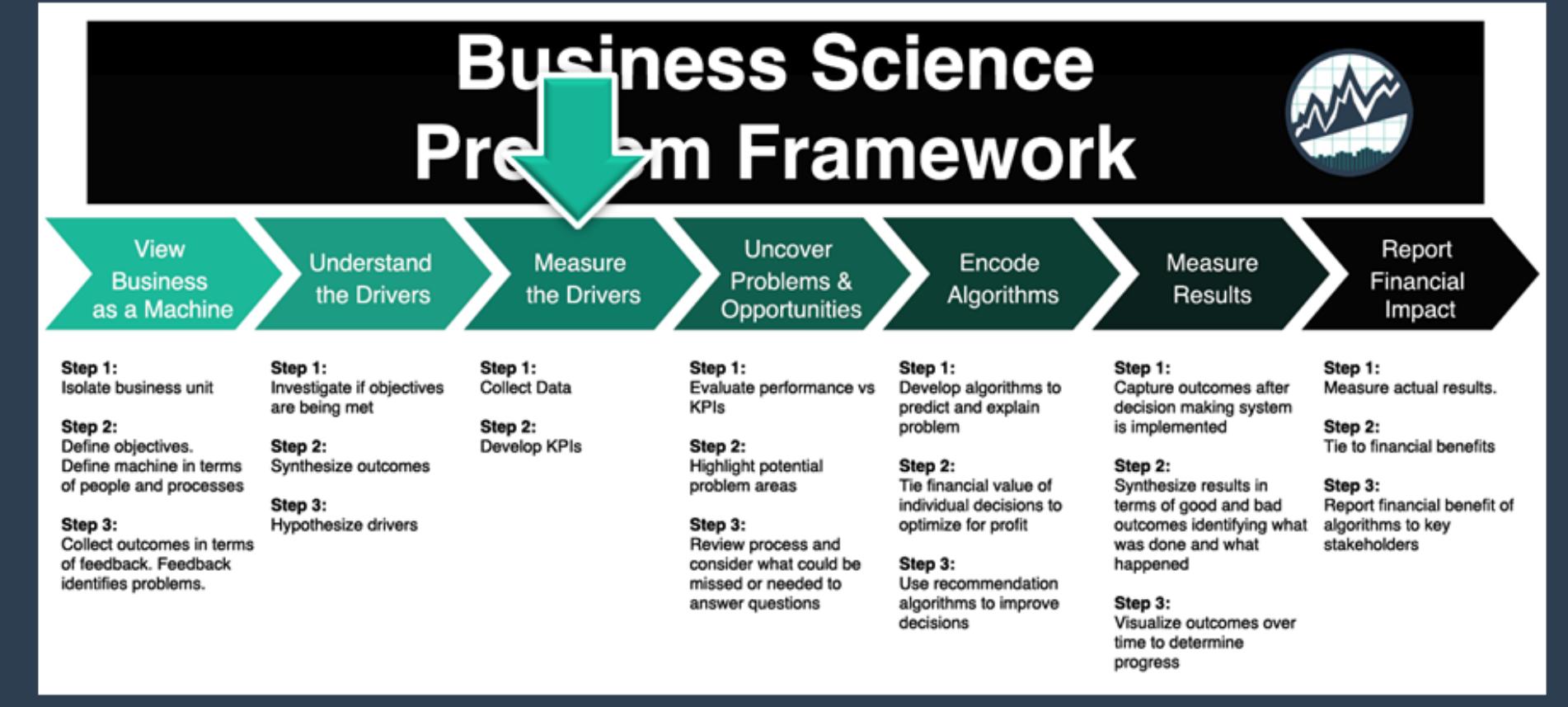
| Department             | Attrition | n     | pct       |
|------------------------|-----------|-------|-----------|
|                        |           | <int> | <dbl>     |
| Human Resources        | No        | 37    | 0.7551020 |
| Human Resources        | Yes       | 12    | 0.2448980 |
| Research & Development | No        | 721   | 0.8665865 |
| Research & Development | Yes       | 111   | 0.1334135 |
| Sales                  | No        | 291   | 0.7886179 |
| Sales                  | Yes       | 78    | 0.2113821 |

6 rows



## Stage 2: Understand The Drivers

# Measure The Drivers



## Stage 3: Measure The Drivers

### 3. Measure Drivers



- Collect data
  - No excuse for not collecting data
  - Treat information as assets
  - Build strategic data bases
  
- Develop KPIs
  - Benchmark industry metrics
  - Develop internal metrics



**Stage 3: Measure The Drivers**

# COLLECT DATA

---

CRITICAL: COMMUNICATE WITH **SUBJECT MATTER EXPERTS**



## DESCRIPTIVE

Age, Gender, Sex



## PERFORMANCE

Job Involvement Rating,  
Performance Rating



## EMPLOYMENT

Job Role, Job Level



## WORK-LIFE

Overtime, Business Travel



## COMPENSATION

Salary



## TRAINING & EDUCATION

Degree, Highest Level of  
Education



## SURVEY

Work-Life Balance, Satisfaction



## TIME-BASED FEATURES

Tenure, Years in Current Role

COLLECT IN 2  
BATCHES:

**1. MINIMUM  
FEATURES NEEDED  
TO CALCULATE  
ATTRITION FOR  
HYPOTHESIS**

**2. FOLLOWING  
APPROVAL OF  
PROJECT, ALL  
FEATURES THAT  
COULD RELATE TO  
PROBLEM**

DEVELOP KPI'S

---

# KPI TURNOVER: 8.8%

Industry Average

9.38

-0.1%

CTR  
14.65%  
+ 18.6%



# Uncover Problems & Opportunities



## Business Science Problem Framework



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Tie financial value of  
individual decisions to  
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**Step 1:**  
Capture outcomes after  
decision making system  
is implemented

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Synthesize results in  
terms of good and bad  
outcomes identifying what  
was done and what  
happened

**Step 3:**  
Visualize outcomes over  
time to determine  
progress

**Step 1:**  
Measure actual results.

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Tie to financial benefits

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Report financial benefit of  
algorithms to key  
stakeholders

## Stage 4: Uncover Problems & Opportunities

# IDENTIFY WHERE ATTRITION IS COSTING THE MOST

```
1C. Measure The Drivers ----

Collect Information on Employee Attrition: On going

Develop KPI's: Industry KPIs: 8.8%

dept_job_role_tbl %>%

 count(Department, JobRole, Attrition) %>%

 count_to_pct(Department, JobRole) %>%

 assess_attrition(Attrition, attrition_value = "Yes", baseline_pct = 0.088) %>%

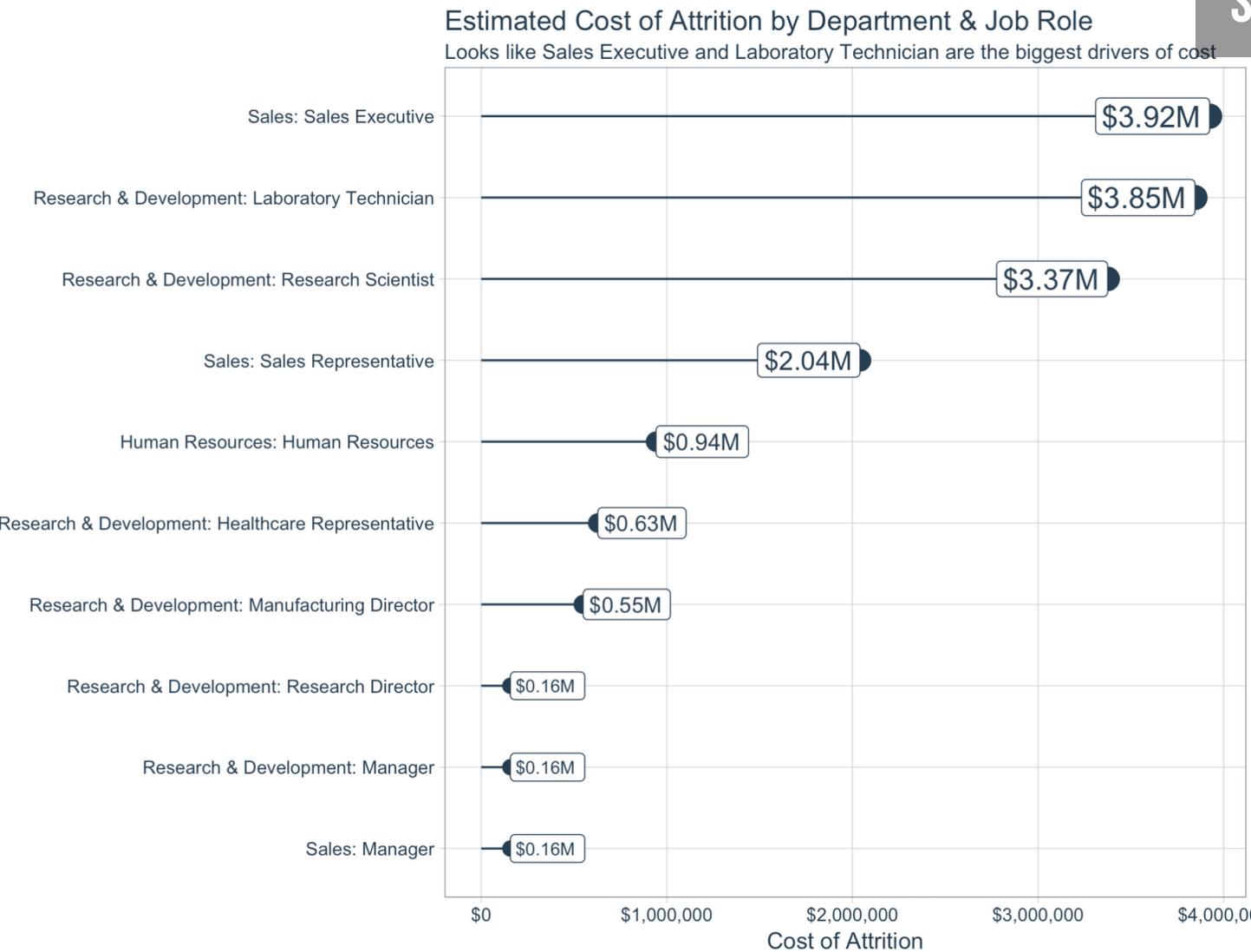
 mutate(
 cost_of_attrition = calculate_attrition_cost(n = n, salary = 80000)
 ...)
```

| Department<br><chr>    | JobRole<br><chr>          | Attrition<br><chr> | n<br><int> | pct<br><dbl> | above_industry_avg<br><chr> | cost_of_attrition<br><dbl> |
|------------------------|---------------------------|--------------------|------------|--------------|-----------------------------|----------------------------|
| Sales                  | Sales Representative      | Yes                | 26         | 0.40000000   | Yes                         | 2040566.7                  |
| Human Resources        | Human Resources           | Yes                | 12         | 0.30769231   | Yes                         | 941800.0                   |
| Research & Development | Laboratory Technician     | Yes                | 49         | 0.21875000   | Yes                         | 3845683.3                  |
| Sales                  | Sales Executive           | Yes                | 50         | 0.18315018   | Yes                         | 3924166.7                  |
| Research & Development | Research Scientist        | Yes                | 43         | 0.16602317   | Yes                         | 3374783.3                  |
| Research & Development | Healthcare Representative | Yes                | 8          | 0.07619048   | No                          | 627866.7                   |
| Sales                  | Manager                   | Yes                | 2          | 0.06451613   | No                          | 156966.7                   |
| Research & Development | Manufacturing Director    | Yes                | 7          | 0.05691057   | No                          | 549383.3                   |
| Research & Development | Manager                   | Yes                | 2          | 0.04166667   | No                          | 156966.7                   |
| Research & Development | Research Director         | Yes                | 2          | 0.02739726   | No                          | 156966.7                   |

1-10 of 10 rows

## Stage 4: Uncover Problems & Opportunities

# SHOW FINANCIAL IMPACT



## Stage 4: Uncover Problems & Opportunities

# Encode Algorithms



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## Stage 5: Encode Algorithms

## 5. Encode Decision Making Algorithms

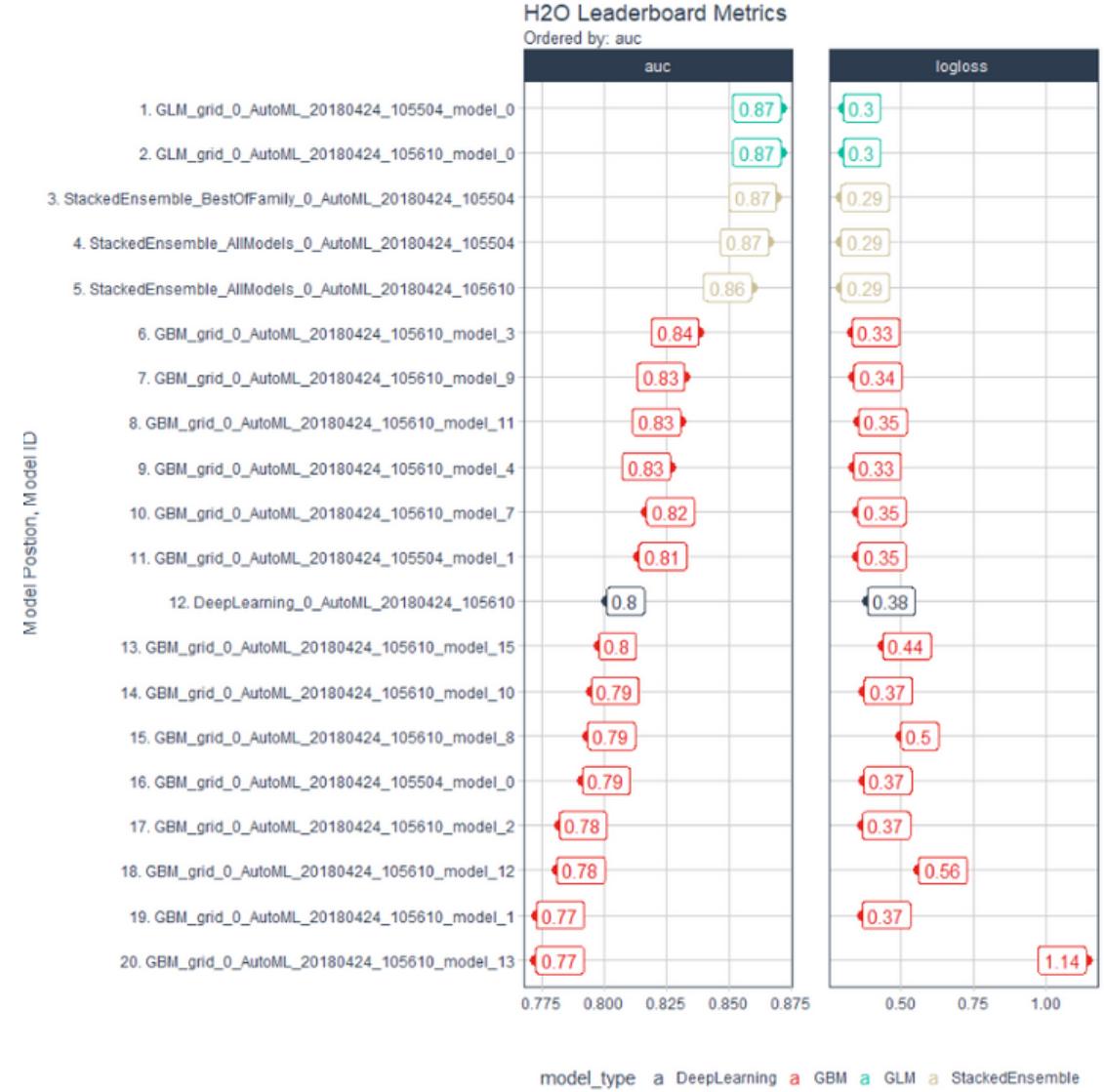


- Develop algorithms
  - Predict target
  - Explain in terms of business levers
- Maximize Profit
  - Optimization problem
  - Expected value framework
- Recommendation Systems

**Stage 5: Encode Algorithms**

# AUTOML

```
6 # 2. Modeling ----
7
8 h2o.init()
9
10 split_h2o <- h2o.splitFrame(as.h2o(train_tbl), ratios = c(0.85), seed = 1234)
11
12 train_h2o <- split_h2o[[1]]
13 valid_h2o <- split_h2o[[2]]
14 test_h2o <- as.h2o(test_tbl)
15
16 y <- "Attrition"
17 x <- setdiff(names(train_h2o), y)
18
19 automl_models_h2o <- h2o.automl(
20 x = x,
21 y = y,
22 training_frame = train_h2o,
23 validation_frame = valid_h2o,
24 leaderboard_frame = test_h2o,
25 max_runtime_secs = 30,
26 nfolds = 5
27)
```



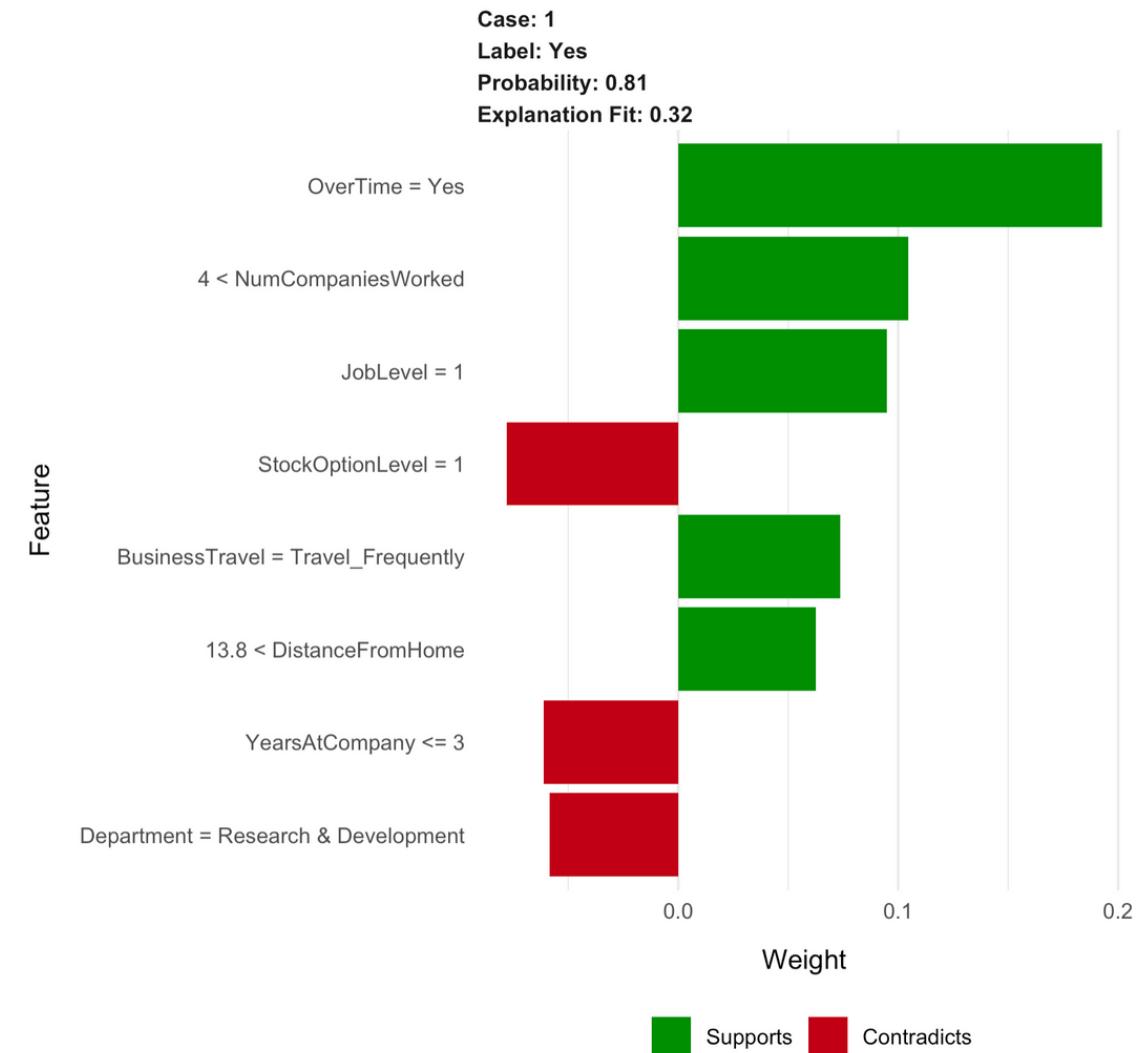
## Stage 5: Encode Algorithms

# LIME MODEL INTERPRETABILITY

```
explainer <- train_tbl %>%
 select(-Attrition) %>%
 lime(
 model = automl_leader,
 bin_continuous = TRUE,
 n_bins = 4,
 quantile_bins = TRUE
)

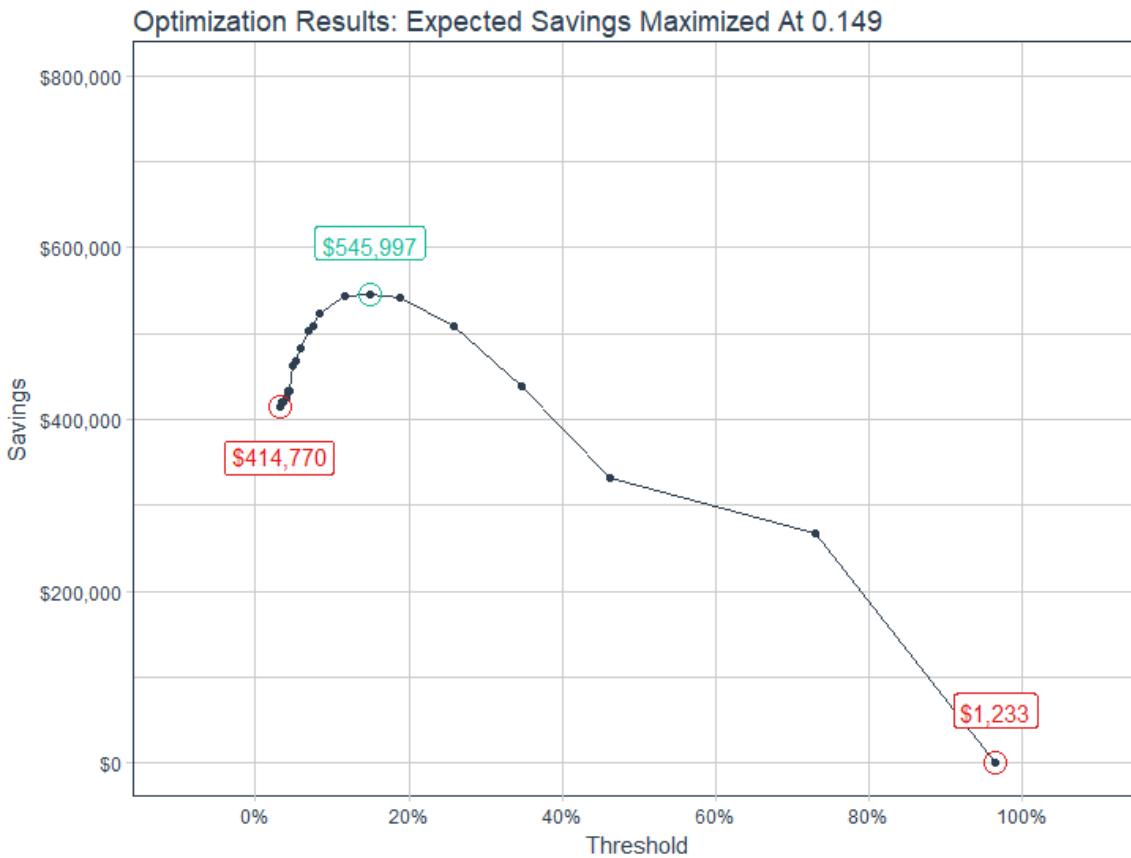
explainer

explanation <- test_tbl %>%
 slice(5) %>%
 select(-Attrition) %>%
 lime::explain(
 explainer = explainer,
 n_labels = 1,
 n_features = 8,
 n_permutations = 5000,
 kernel_width = 1
)
```

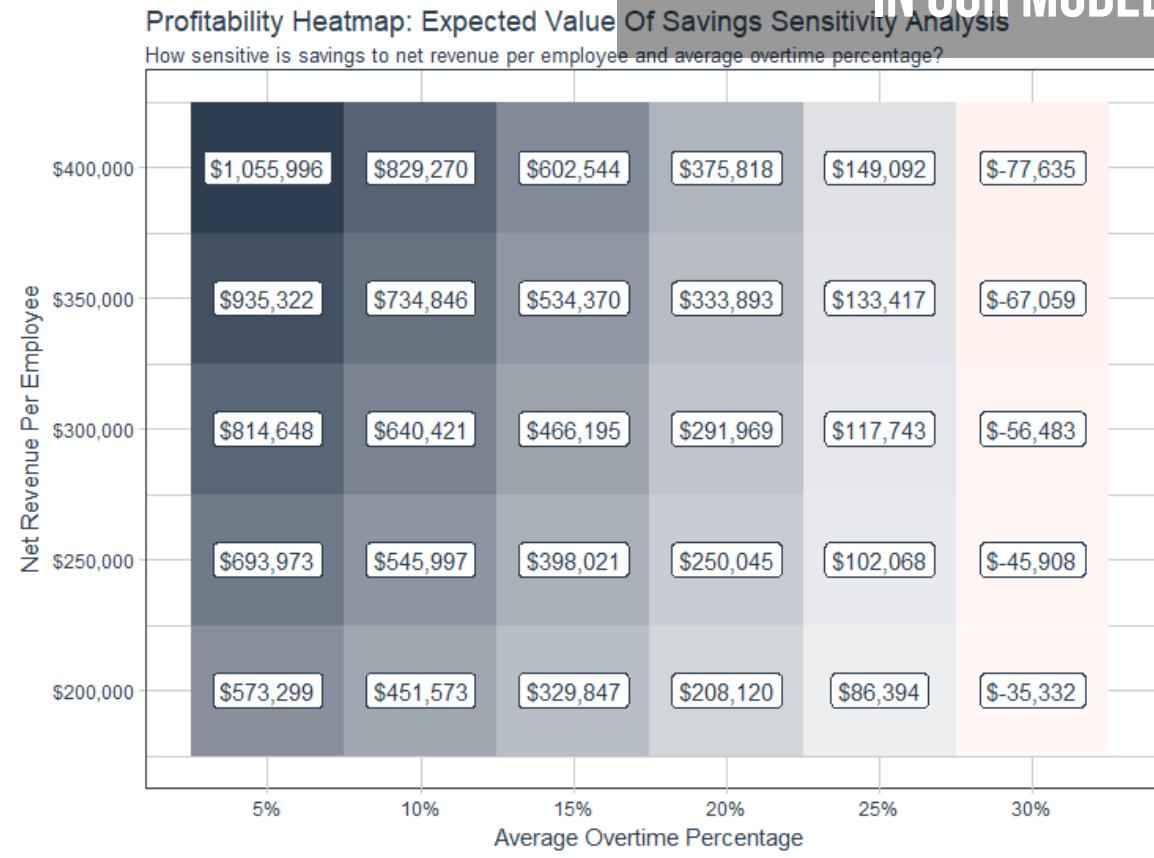


## Stage 5: Encode Algorithms

## OPTIMIZATION: WHAT THRESHOLD TO USE?



## SENSITIVITY ANALYSIS: WHAT ASSUMPTIONS ARE IN OUR MODEL?



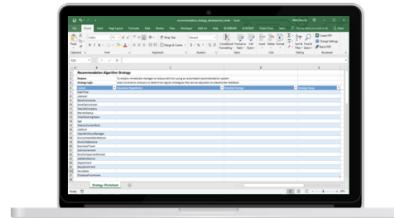
Stage 5: Encode Algorithms

## Recommendation Algorithm Development Process

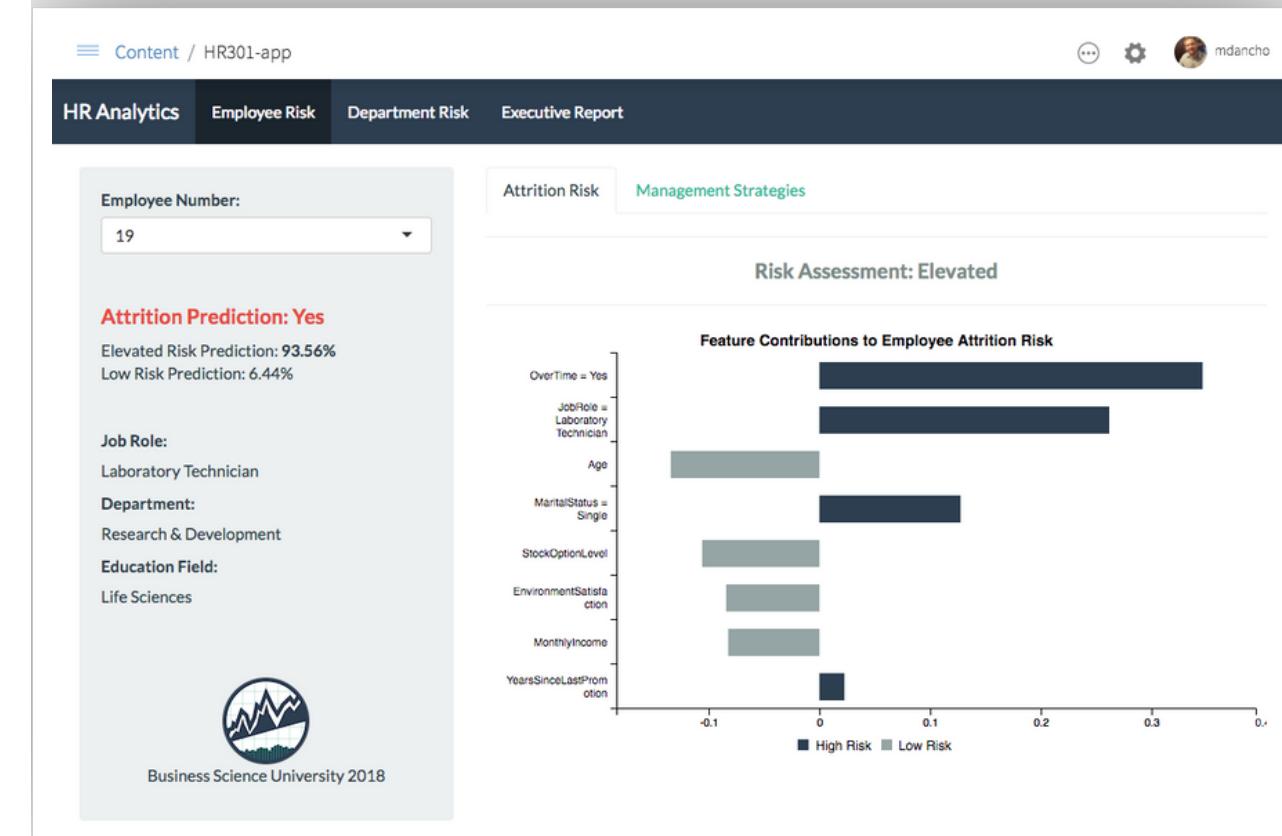
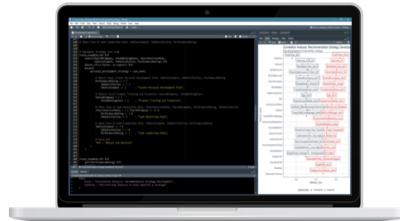


**Step 1:**  
Discretized Correlation  
Visualization

**Step 2:**  
Recommendation  
Algorithm Worksheet to  
Develop Strategies



**Step 3:**  
Implement Strategies  
into R Code



**Stage 5: Encode Algorithms**

# Business Science Problem Framework



## Business Science Problem Framework



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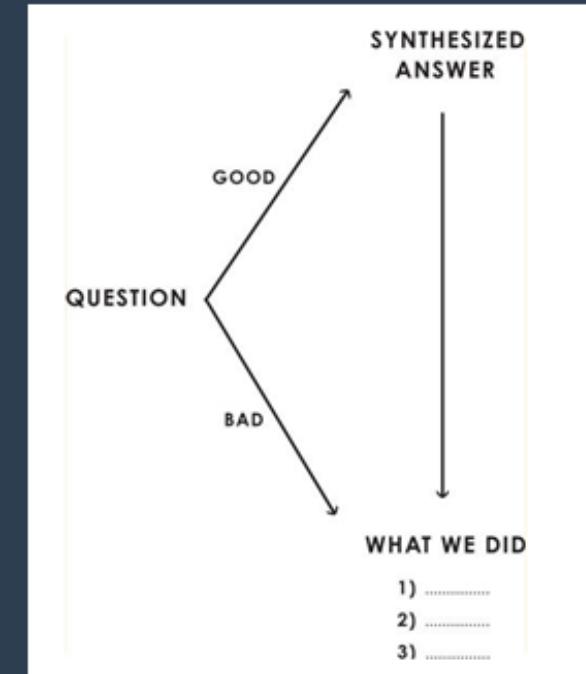
**Step 3:**  
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## Stage 6: Measure Results

## 6. Measure The Results

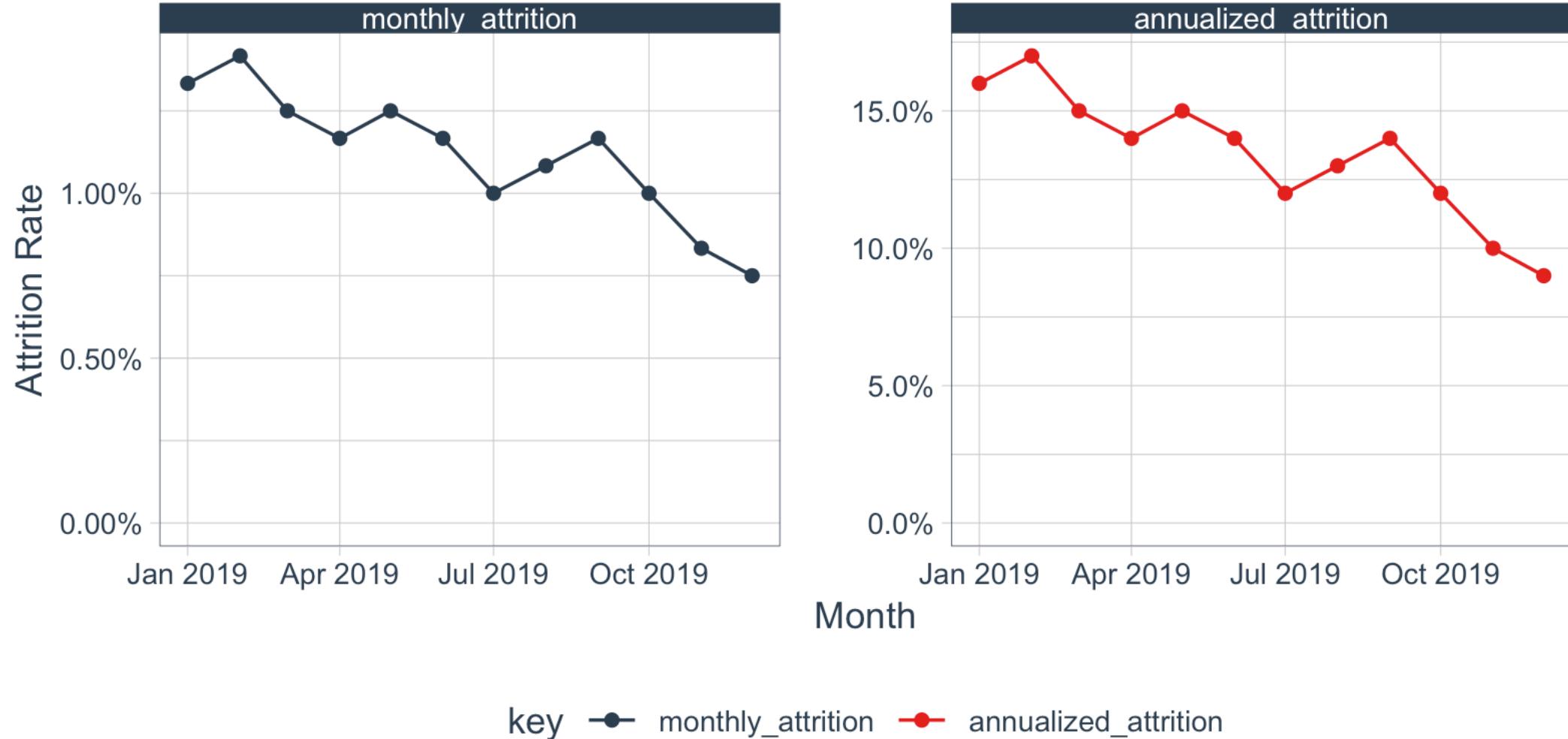


- Capture outcomes
- Synthesize results
- Visualize over time



*Source: Principles by Ray Dalio*

## Measuring Monthly Attrition Rates



**Stage 6: Measure Results**

# Business Science Problem Framework



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Uncover Problems &  
Opportunities

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**Step 2:**  
Highlight potential  
problem areas

**Step 3:**  
Review process and  
consider what could be  
missed or needed to  
answer questions

**Step 1:**  
Encode Algorithms

**Step 1:**  
Develop algorithms to  
predict and explain  
problem

**Step 2:**  
Tie financial value of  
individual decisions to  
optimize for profit

**Step 3:**  
Use recommendation  
algorithms to improve  
decisions

**Step 1:**  
Measure Results

**Step 1:**  
Capture outcomes after  
decision making system  
is implemented

**Step 2:**  
Synthesize results in  
terms of good and bad  
outcomes identifying what  
was done and what  
happened

**Step 3:**  
Visualize outcomes over  
time to determine  
progress

**Step 1:**  
Report Financial  
Impact

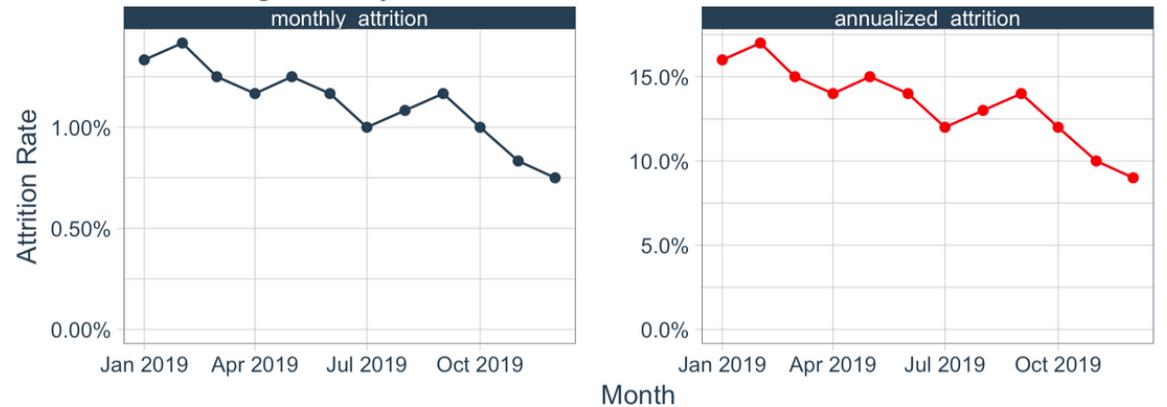
**Step 1:**  
Measure actual results.

**Step 2:**  
Tie to financial benefits

**Step 3:**  
Report financial benefit of  
algorithms to key  
stakeholders

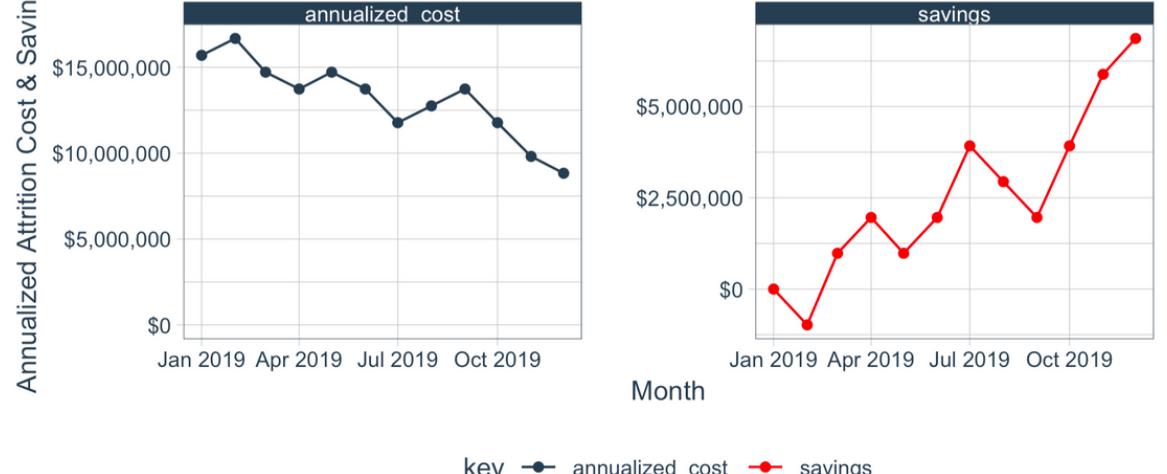
## Stage 7: Report Financial Impact

### Measuring Monthly Attrition Rates



key ● monthly\_attrition ● annualized\_attrition

### Report Financial Impact



key ● annualized\_cost ● savings

**10% REDUCTION =  
\$1.5M / YEAR SAVINGS**

**REDUCTION TO INDUSTRY  
AVERAGE =  
\$7M / YEAR SAVINGS**

**Stage 7: Report Financial Impact**



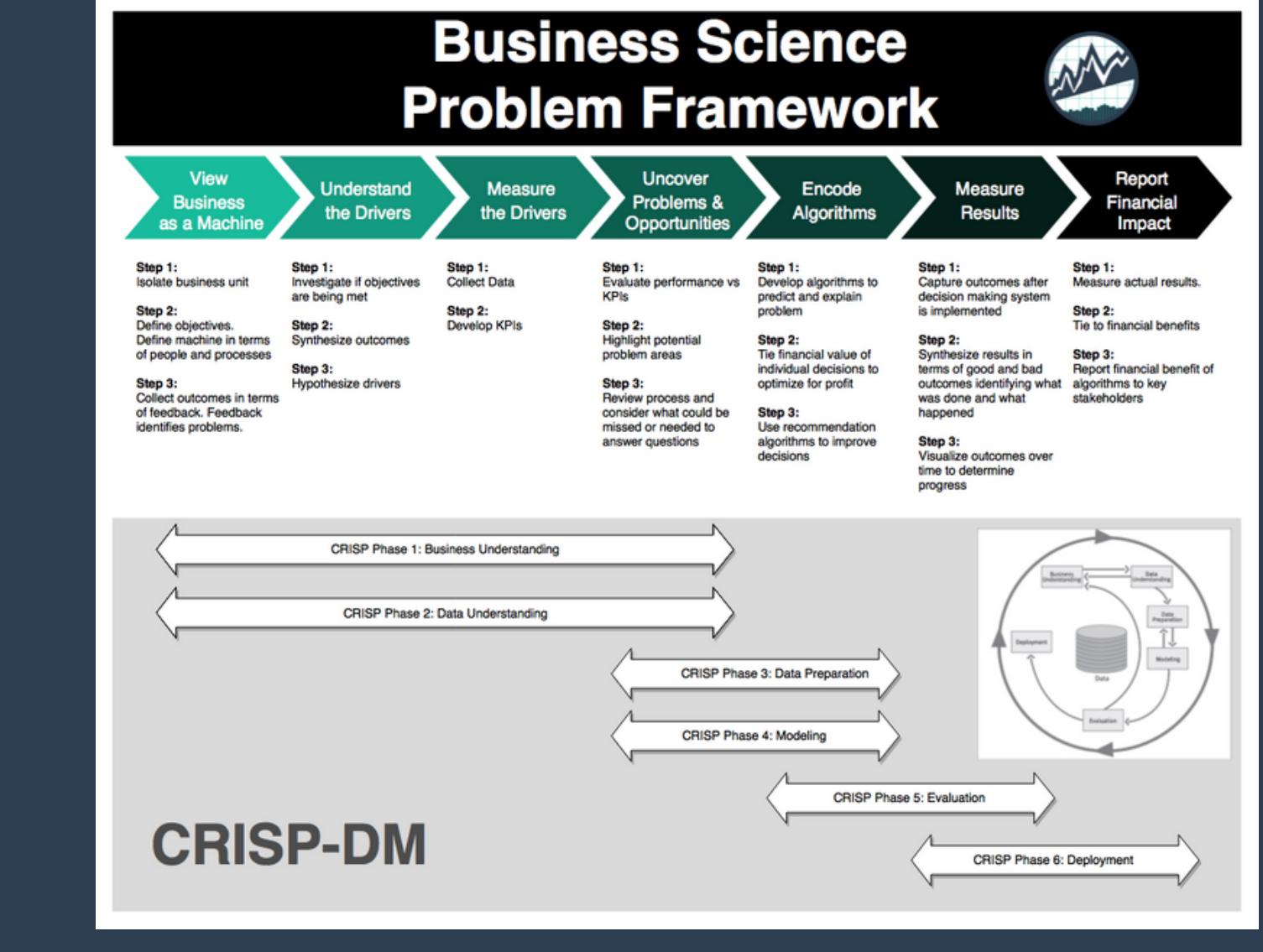
SECTION 4

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# THE PROGRAM THAT'S TRANSFORMING DATA SCIENTISTS

# BUSINESS SCIENCE UNIVERSITY

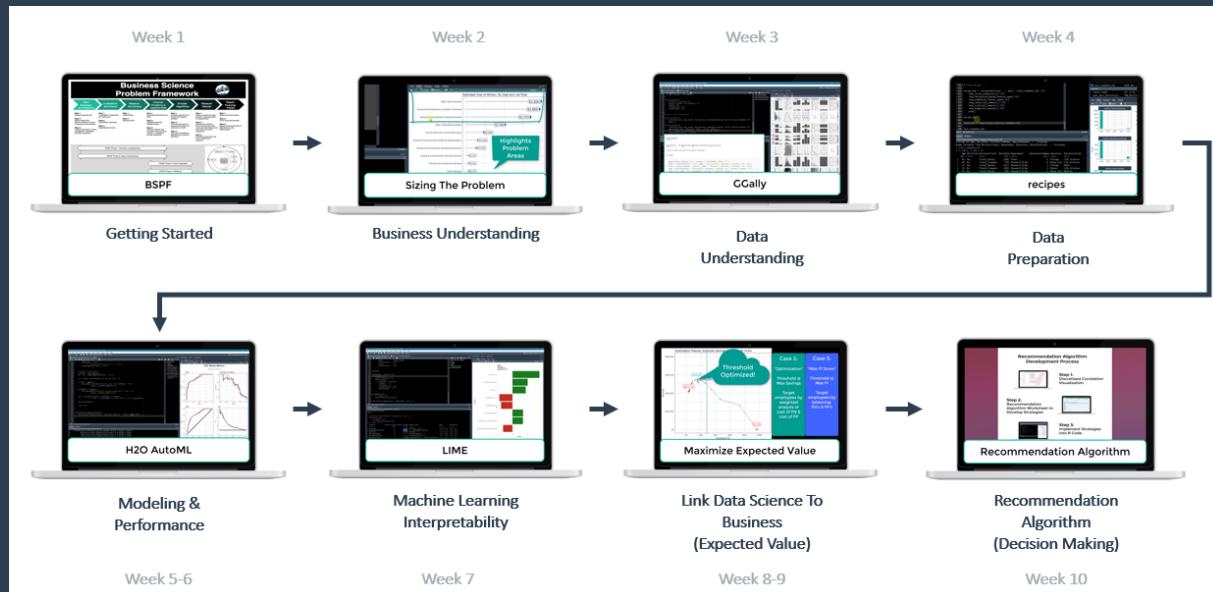
Data Science For  
Business  
with  
R  
(DS4B 201-R)



I began teaching the BSPF

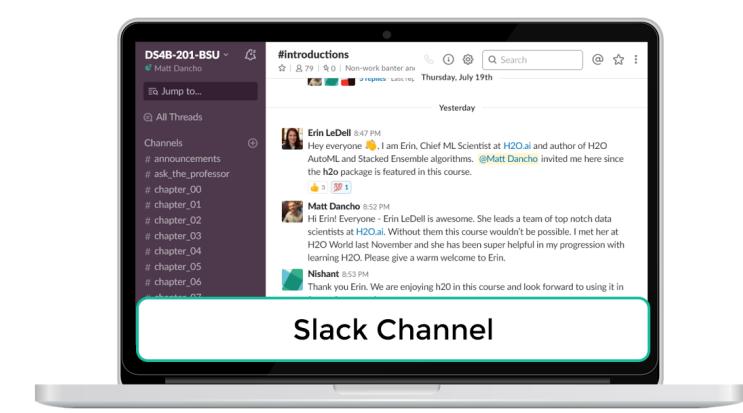
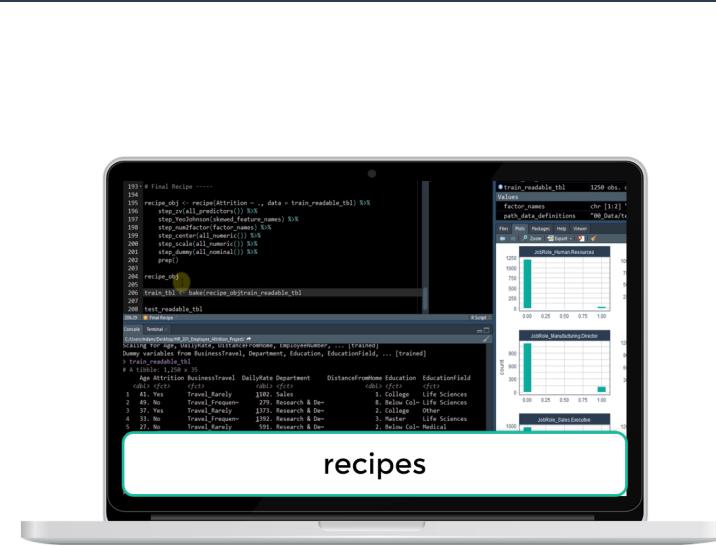
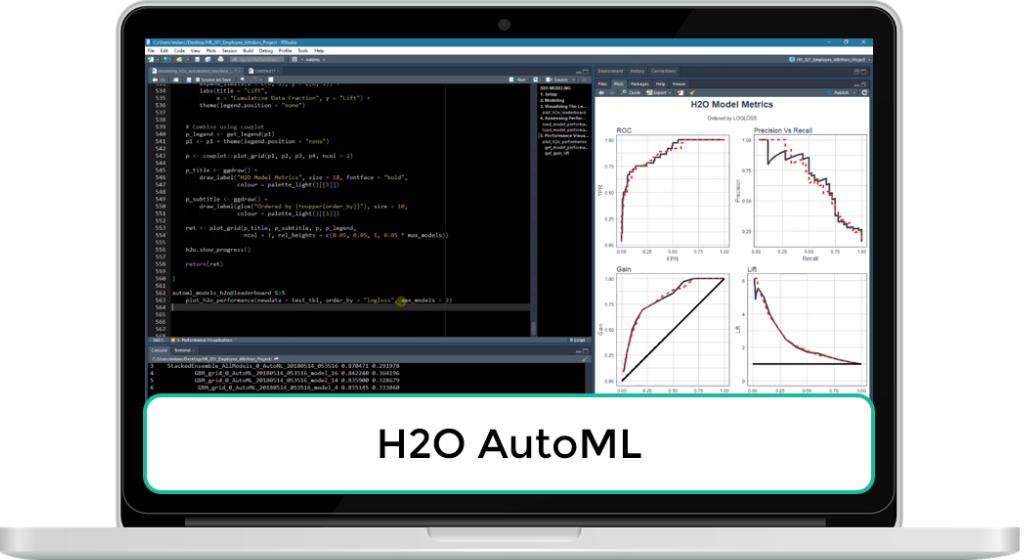
# 10-WEEK SYSTEM

## Data Science For Business With R (DS4B 201-R)



**BUSINESS ANALYSTS  
DATA SCIENTISTS  
CONSULTANTS  
STUDENTS**

Are learning tools & generating ROI for their businesses



# RODRIGO PRADO

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Managing Partner, Big Data Analytics & Strategy - Genesis Partners

## Consultant Testimonial



Rodrigo Prado • 12:18 PM

Hi Matt,

I just wanted to tell you that your Business University program is great. I'm a management consultant recently graduated from the MSc in Applied Analytics from Columbia University. I enrolled in that program looking to get a more applied approach to solve business problems through analytics, and Columbia created the program to close the gap between business and data science. The program was great, but it has a missing piece.

I have a strong background in machine learning, but this wasn't enough. Your program allowed me to cut down to 50 % of the time to deliver solutions to my clients. Soon I'll enrol all consultants in your program.

It would be great if we could talk sometime to tell you more about my experience and the impact that your program had in the way we provide services in my firm.

All the best,

Rodrigo

**"My Masters from Columbia University left a gap. Your course connected data science to the business."**

**"The framework enables me to get right to the results"**

**"The BSPF cut my project time in half"**

# SCOTT MCPHERSON-MONCRIEF

Business Intelligence & Analytics Developer at Meridian



Scott McPherson-Moncrief • 1st  
Business Intelligence & Analytics Developer at Meridian  
1h

I just completed the 6-week Data Science for Business course created by [Matt Dancho](#) on behalf of Business Science University. Over the last year I've completed a variety of online courses for advanced analytics, programming, and machine learning but [this is by far the MOST comprehensive course I've come across](#) for the application of Data Science techniques/concepts to actual business problems. In addition it is the ONLY course I've come across that explains in detail how to accurately estimate the ROI for data science project implementation.

[Many businesses are struggling](#) to effectively couple the computational power of machine learning algorithms with the nuts-and-bolts needs of business processes. The benefits of Machine learning/Data Science solutions are admired by many but realized by few because of the challenge of estimating the direct financial impact for decision makers/stakeholders.

For anyone with solid knowledge of R programming, data analysis, and machine learning algorithms [this course serves to solidify that knowledge into a systematic approach to conducting data science projects end-to-end](#). Highly recommend.



**"This is by far the **MOST comprehensive course** I've come across for the **application of Data Science to actual business problems**"**

**"Many businesses are **struggling**"**

**"This course serves to solidify the [Data Science] knowledge into a **systematic approach to conducting data science projects end-to-end**"**

# EXCLUSIVE OFFER

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**DS4B 201-R: Data Science For  
Business With R**



**20% OFF**

**DSG020**

[university.business-science.io](http://university.business-science.io)

A scenic landscape featuring a person standing triumphantly on a rocky mountain ridge. The person is wearing an orange shirt and black shorts, with their arms raised in a gesture of achievement. Below them, a vast valley stretches out, filled with green fields and small settlements. In the background, a range of majestic mountains rises against a sky filled with dramatic, white and grey clouds.

# THANK YOU!

[university.business-science.io](http://university.business-science.io)