Inspire…Educate…Transform.

# Data Science: Big Picture

## Also, introduction to CPEE program

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# Introduction

- An exciting and interesting career path
  - Visualization, communication skills
  - Programming and hacking skills
  - Mathematical skills

# Program

- Mentors
- Scientists
- Piazza
- R and Hadoop programming environment

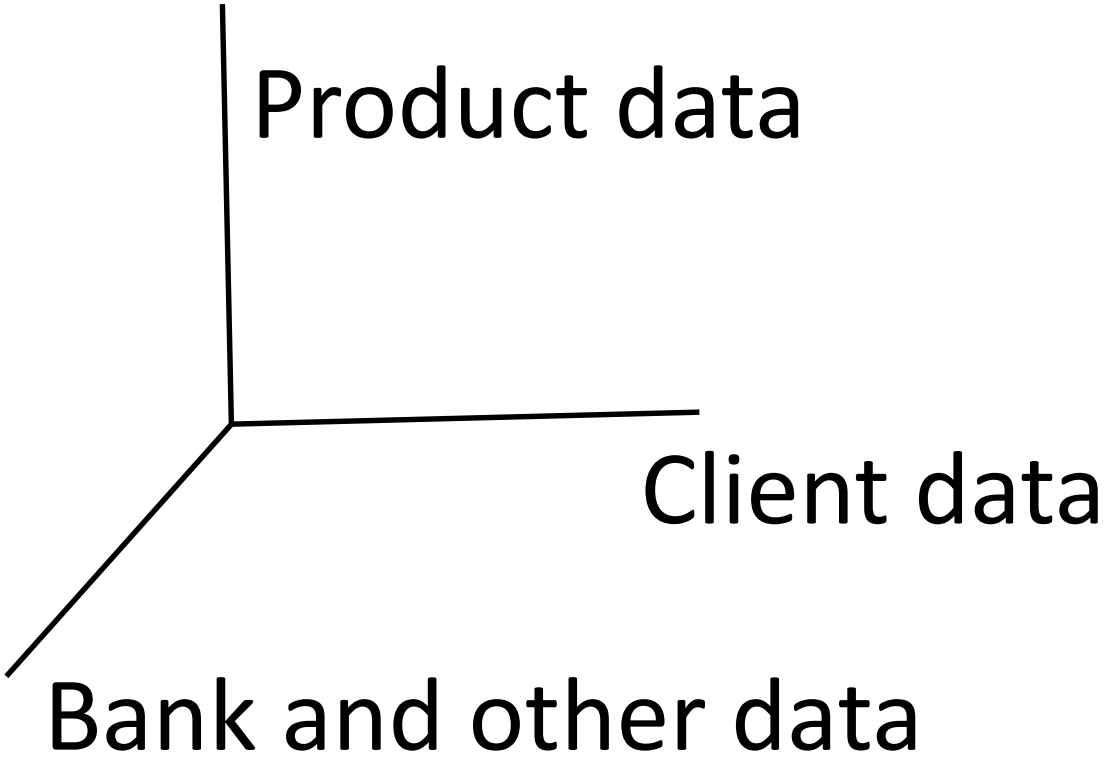
# Structure

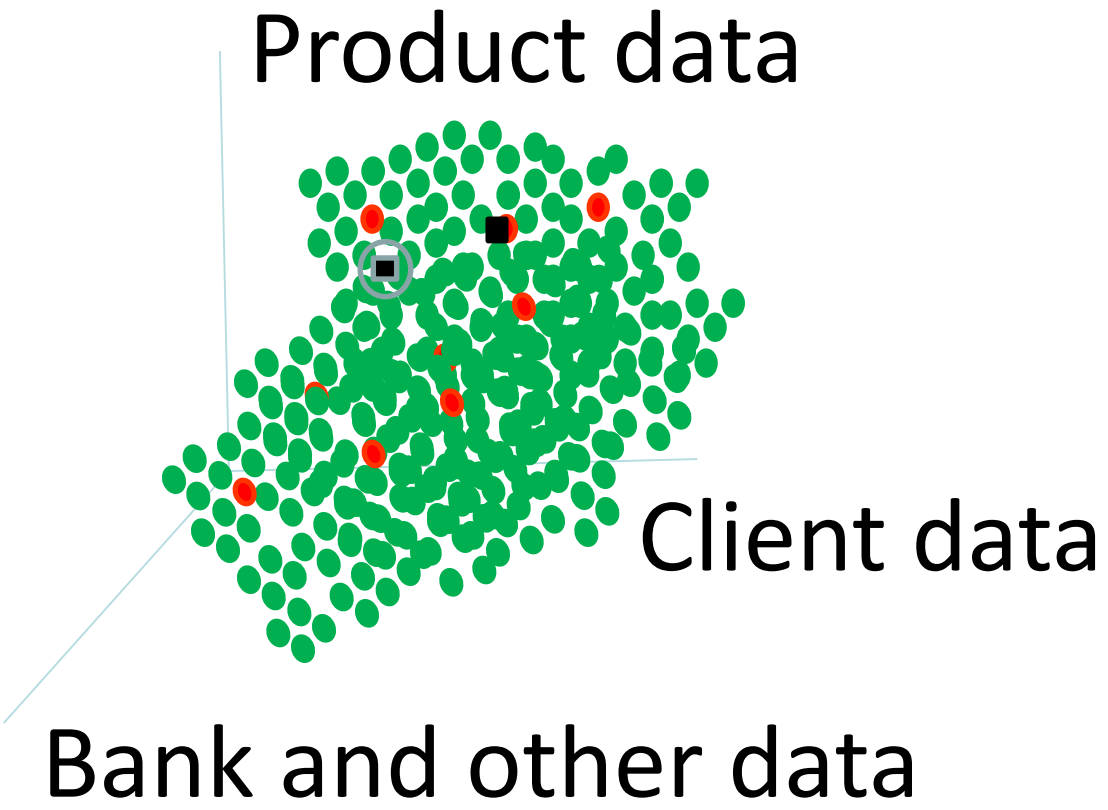
- Lectures:  Morning

- Afternoon:  Quizzes (written), lab and project

# Help banks minimize loss?

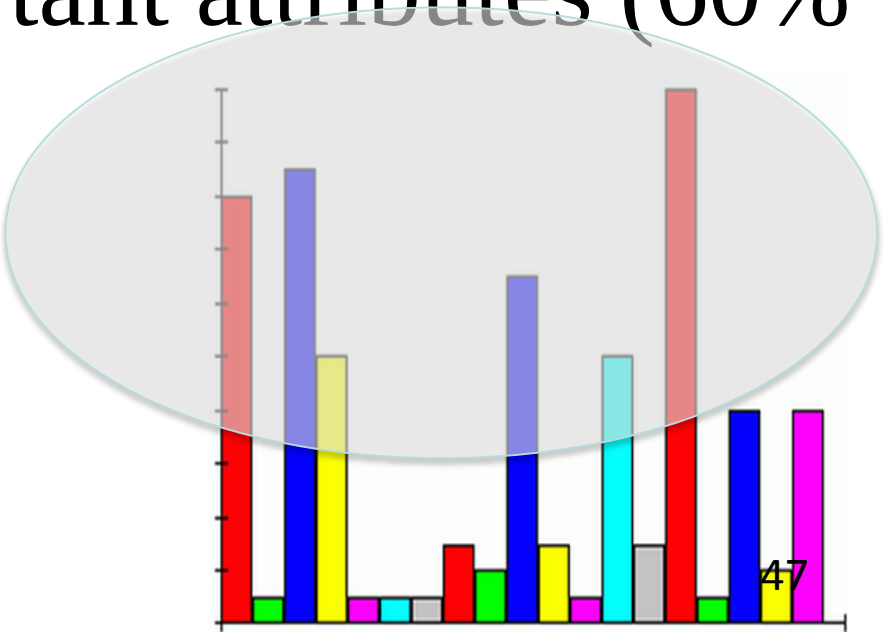
- What is the probability of default?
- Can we predict who is likely to not pay?


Product data
Client data
Bank and other data


Product data
Client data
Bank and other data

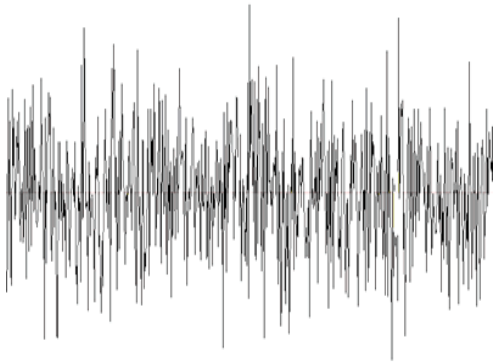
# Lots of experiments

- What attributes to use
  - Use all attributes on 10% data (50% accuracy)
  - Use only the important attributes (60% accuracy)



# Refining the attributes

- Is a 25 year old going to be different from 26?
- Group all below 30 as young
- Accuracy went up to 65%



# Data scientist's way of thinking

# GOAL

# Search for patterns and not theories

A specific metallic component is wearing out with use in an acidic environment.

How do we understand and use this component

# Approach 1…Science

- A chemist studies what happens to the material in acid and understands that the metal is reacting with the hydrogen in the acid to form a vapor. She develops the equations and science behind them that the wearing is a function of acidity and temperature.

# Approach 1…Engineering

- An engineer tests the degradation in a few concentrations and temperature, plots the degradation, validates the theory and comes up with thumb rules

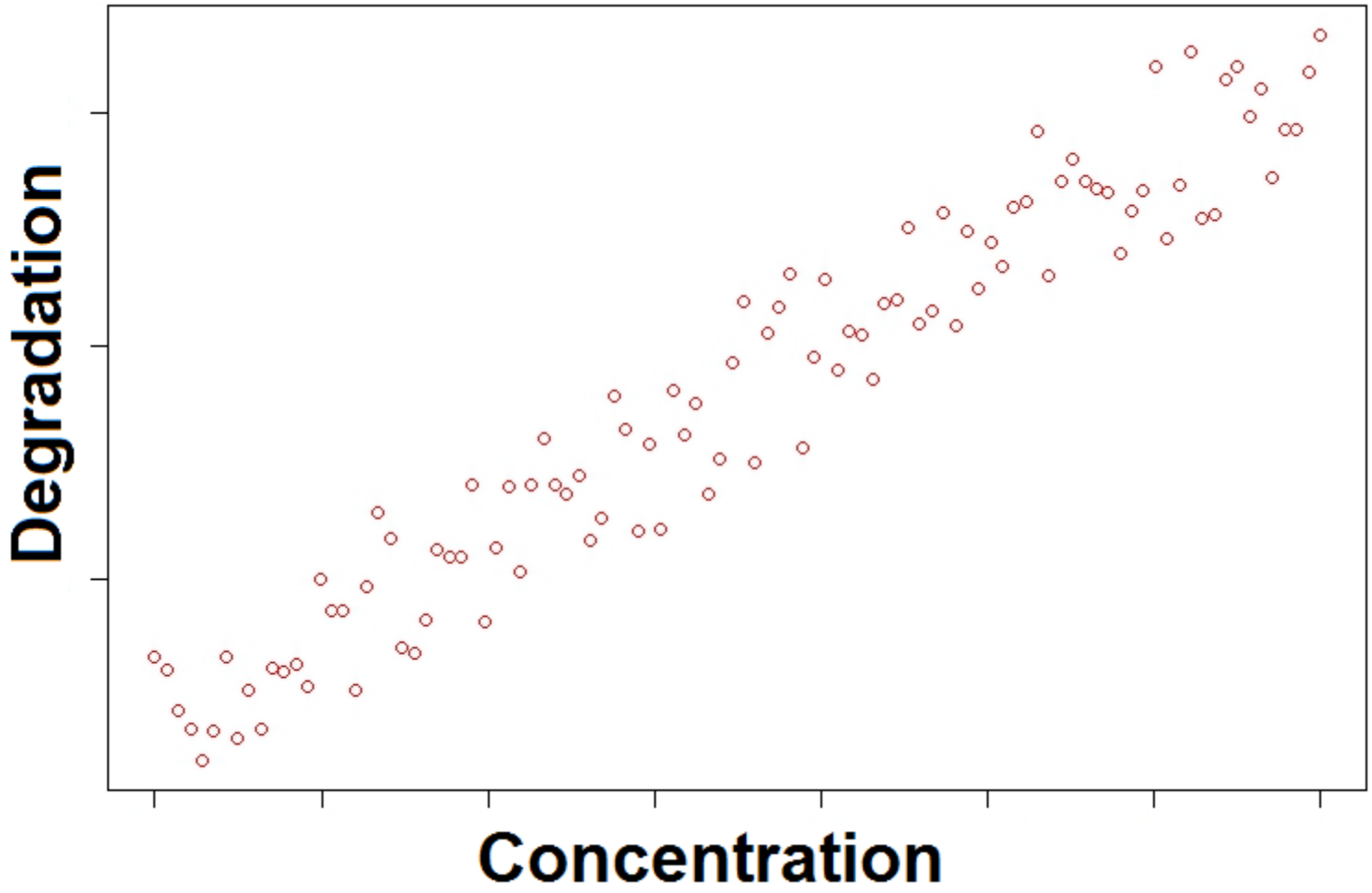
# Deductive learning

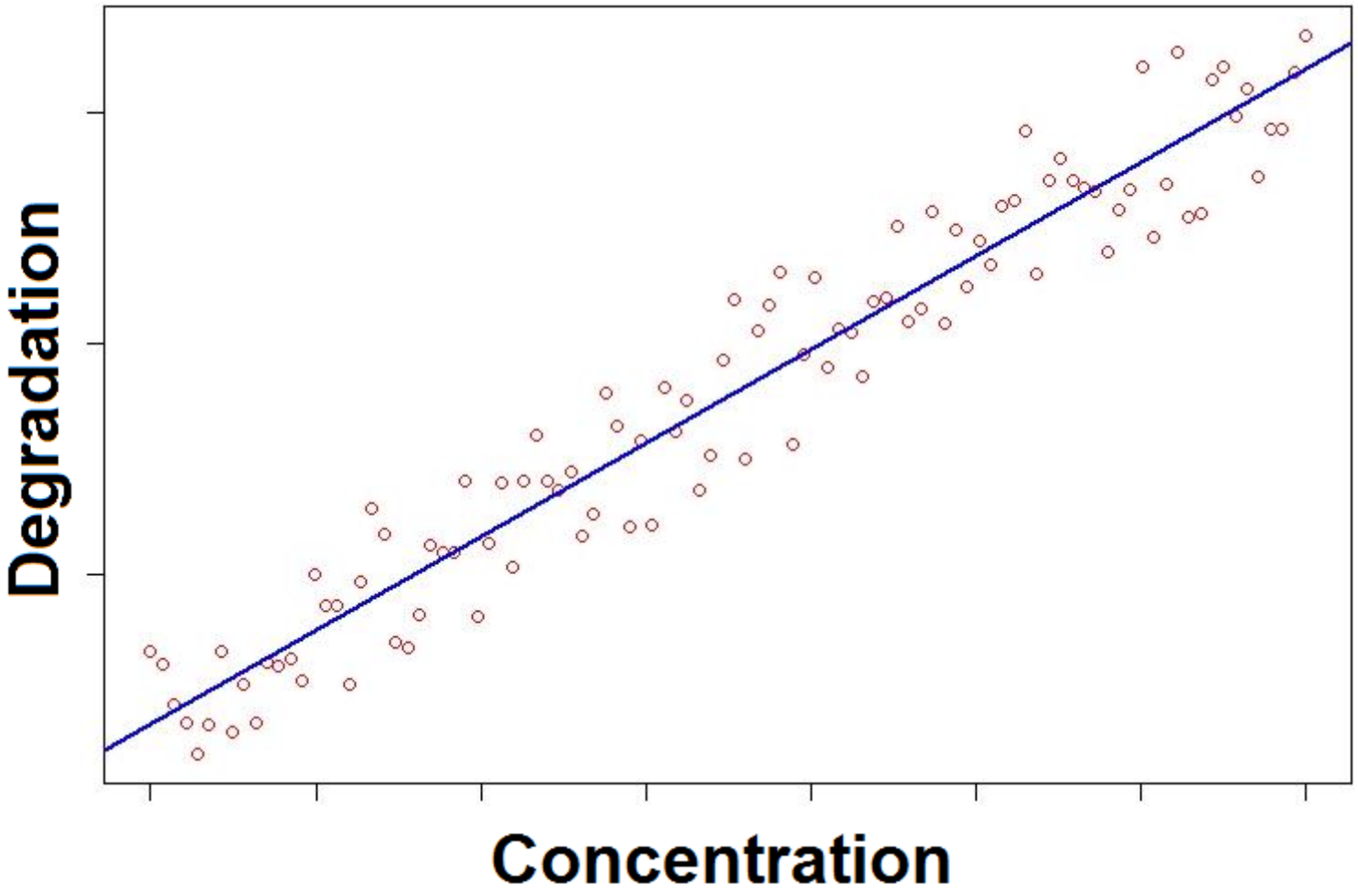
- A few hypothesis that cannot be proved.
- Rest of the science is developed by extending these using mathematics and experimentation.

# WELCOME TO THE INDUCTIVE MODELS

# Approach 2

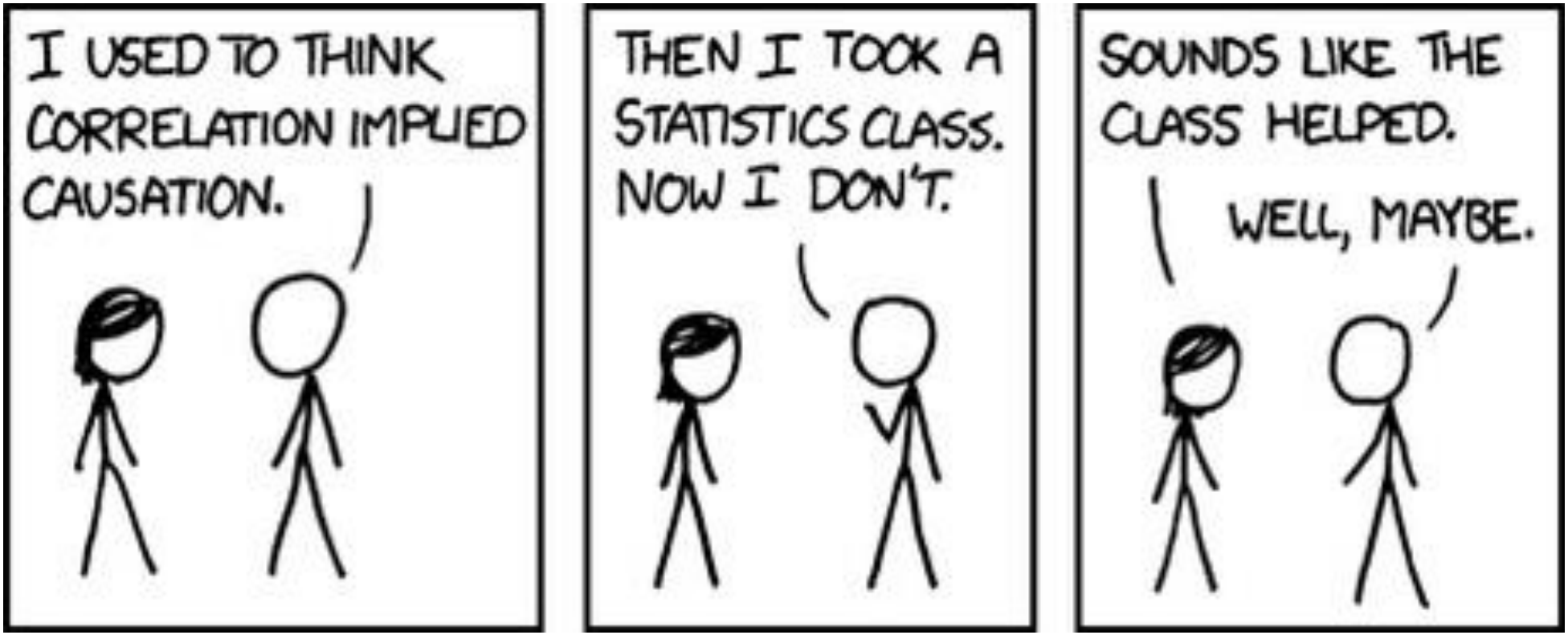
- Measure the degradations in hundreds of conditions (temperatures and concentrations for various times)


Degradation
Concentration


Degradation
Concentration

# Result is same but

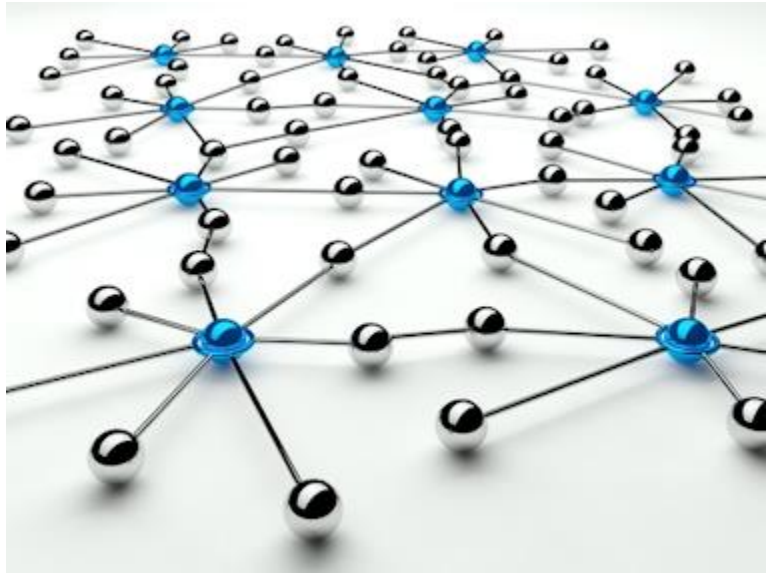
- Do not know the reasons (causations are not known and only correlations are identified)
  - Walmart example (does not tell how to act)


I USED TO THINK CORRELATION IMPLIED CAUSATION.
THEN I TOOK A STATISTICS CLASS. NOW I DON'T.
SOUNDS LIKE THE CLASS HELPED.
WELL, MAYBE.

# Where it does not work

- Fails when randomness prevails
- Need a lot more data to come to the correct conclusions

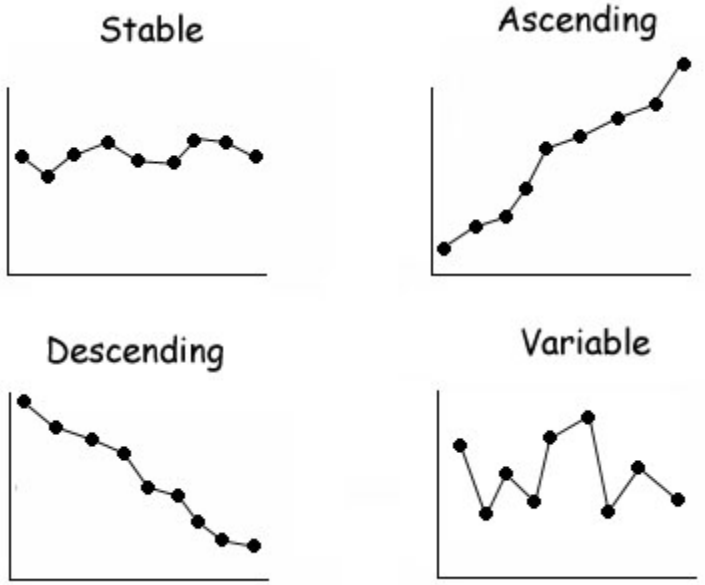
# Where does it work



# Where data is not an issue

# Data science

$$
\begin{aligned}
v_q &= -r_s i_q + \frac{\omega_r}{\omega_b}\Psi_d + \frac{p}{\omega_b}\Psi_q, \\
v_d &= -r_s i_d - \frac{\omega_r}{\omega_b}\Psi_q + \frac{p}{\omega_b}\Psi_d, \\
v_o &= -r_s i_o + \frac{p}{\omega_b}\Psi_o, \\
0 &= r_{aq} i_{aq} + \frac{p}{\omega_b}\Psi_{aq}, \\
v_f &= r_f i_f + \frac{p}{\omega_b}\Psi_f, \\
0 &= r_{ad} i_{ad} + \frac{p}{\omega_b}\Psi_{ad}, \\
T_e &= \frac{3}{2}\frac{P}{2}\frac{1}{\omega_b}(\Psi_d i_q - \Psi_q i_d), \\
p\omega_r &= \frac{P}{2J}(T_a - T_e),
\end{aligned}
\qquad
\begin{aligned}
p\theta_r &= \omega_r, \\
p\theta_e &= \omega_e, \\
\delta &= \theta_r - \theta_e, \\
\omega_m &= \frac{2}{p}\omega_r,
\end{aligned}
$$



# Currently

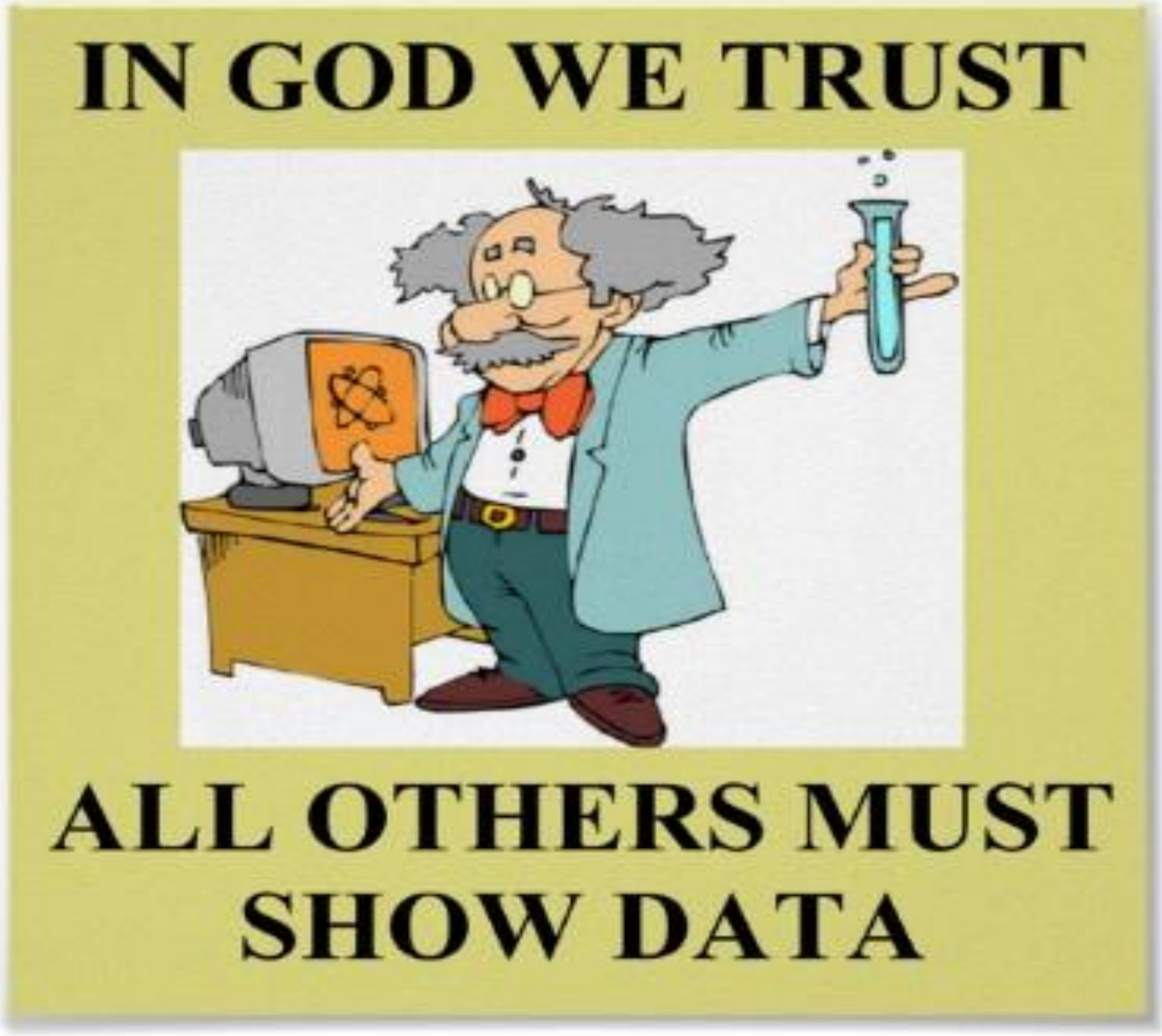
- A skill that employers can’t say no to
- Sexiest job of next decade

# IS INDUCTIVE LEARNING BETTER THAN INTUITION?

# Power of models

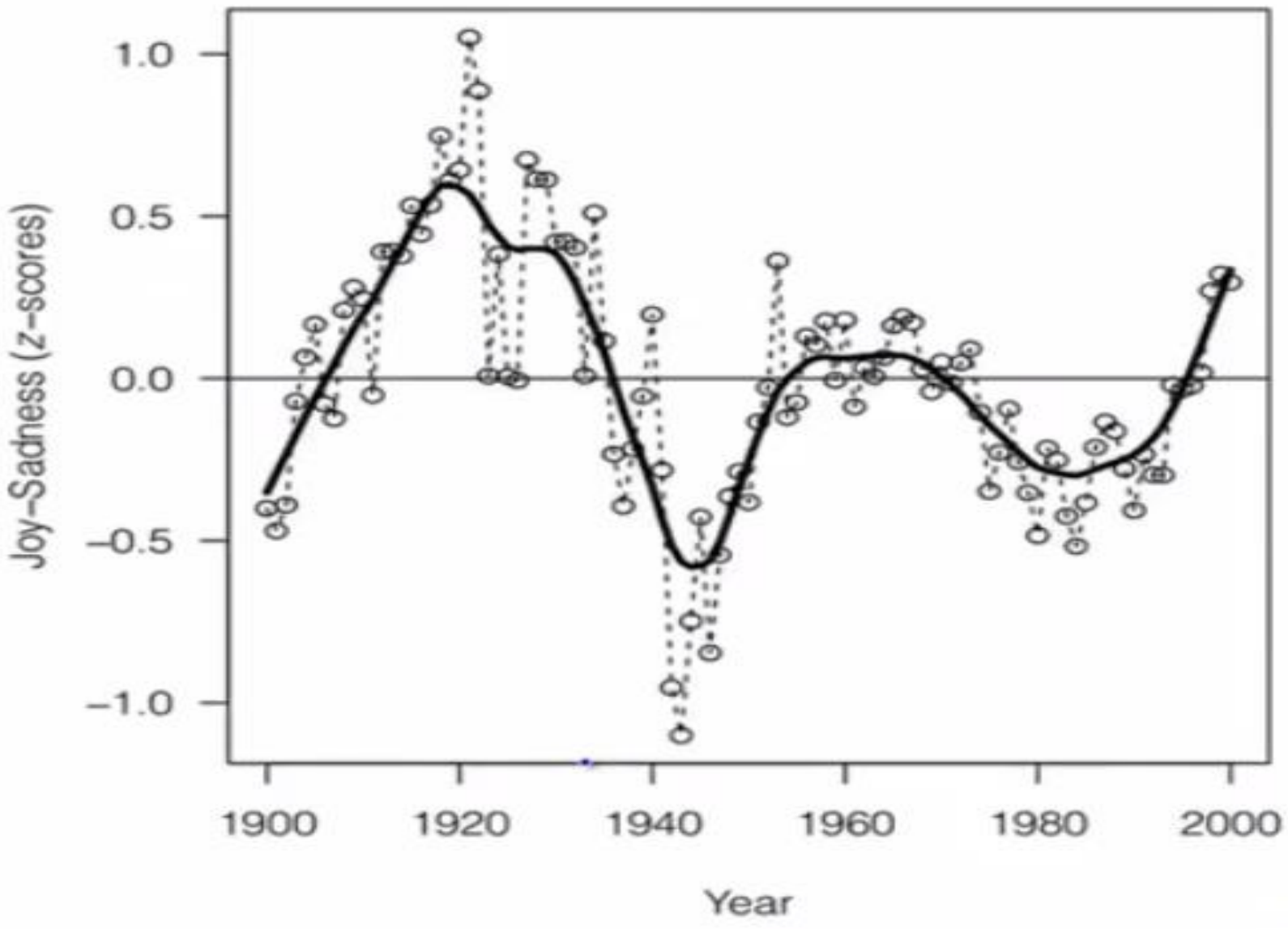
Robyn Dawes 1979: "The Robust Beauty of Improper Linear Models in Decision Making"

**Simple models do better than experts**

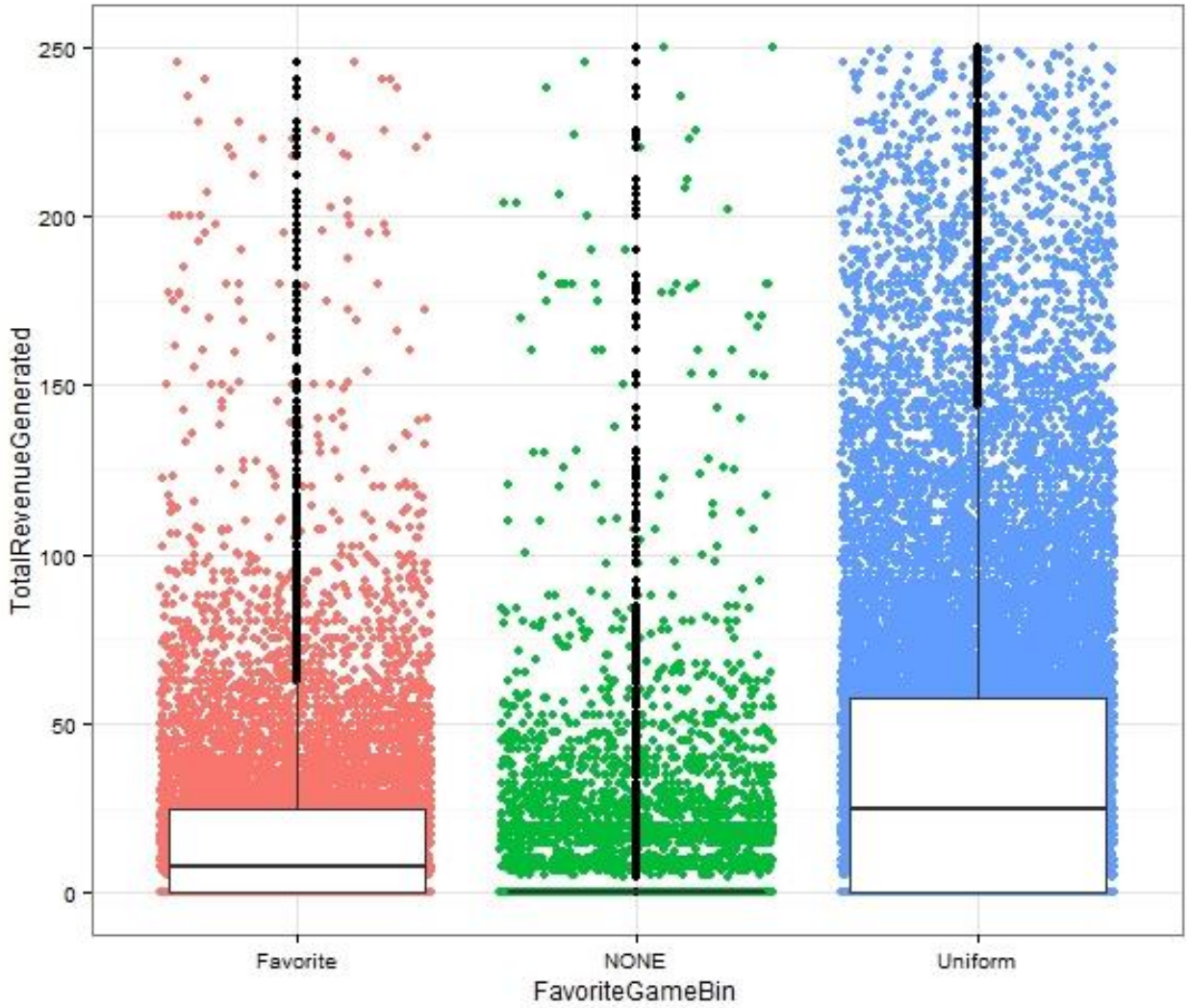

IN GOD WE TRUST
ALL OTHERS MUST
SHOW DATA

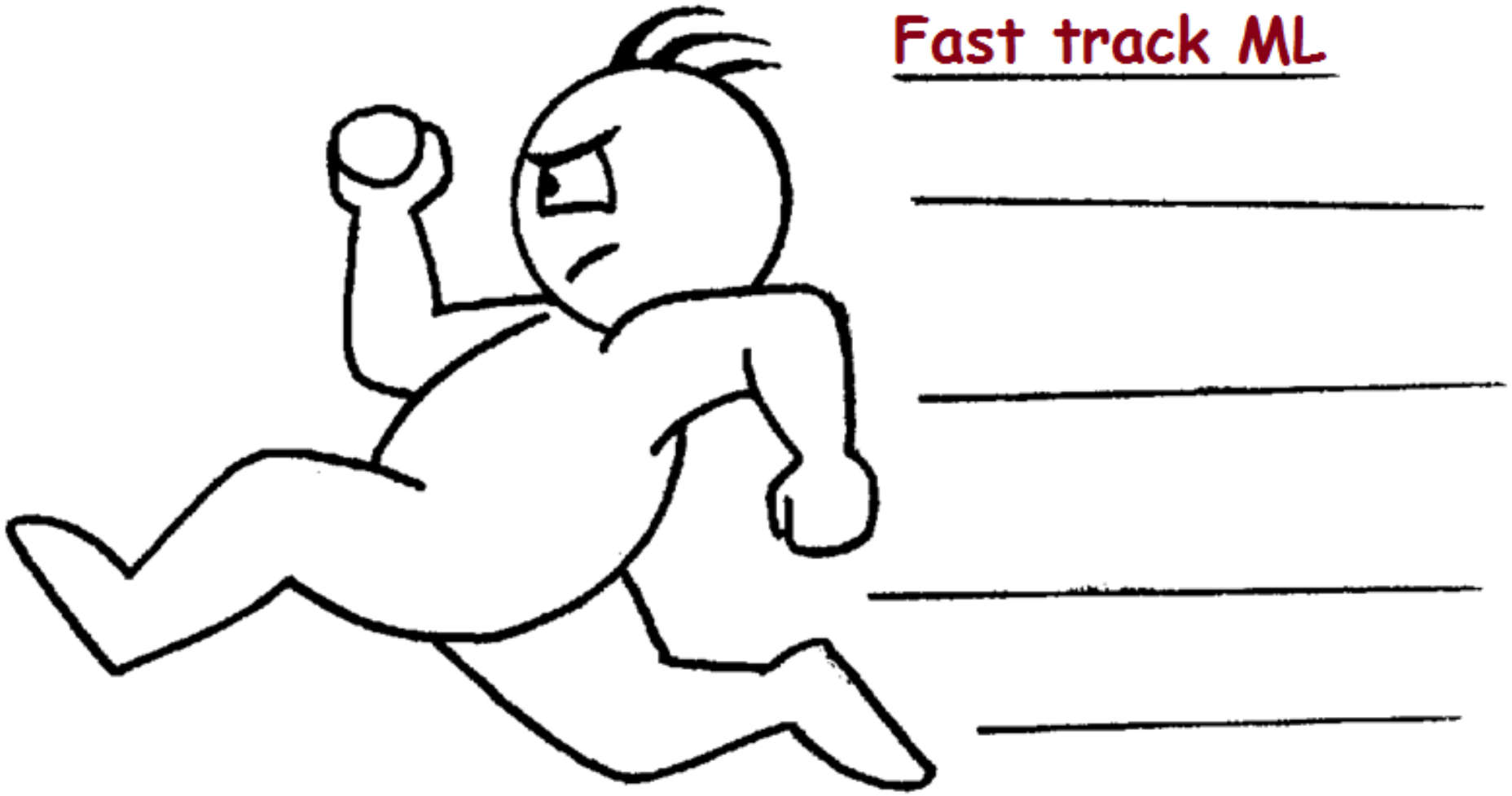
EXAMPLE

# Are Americans happy or unhappy

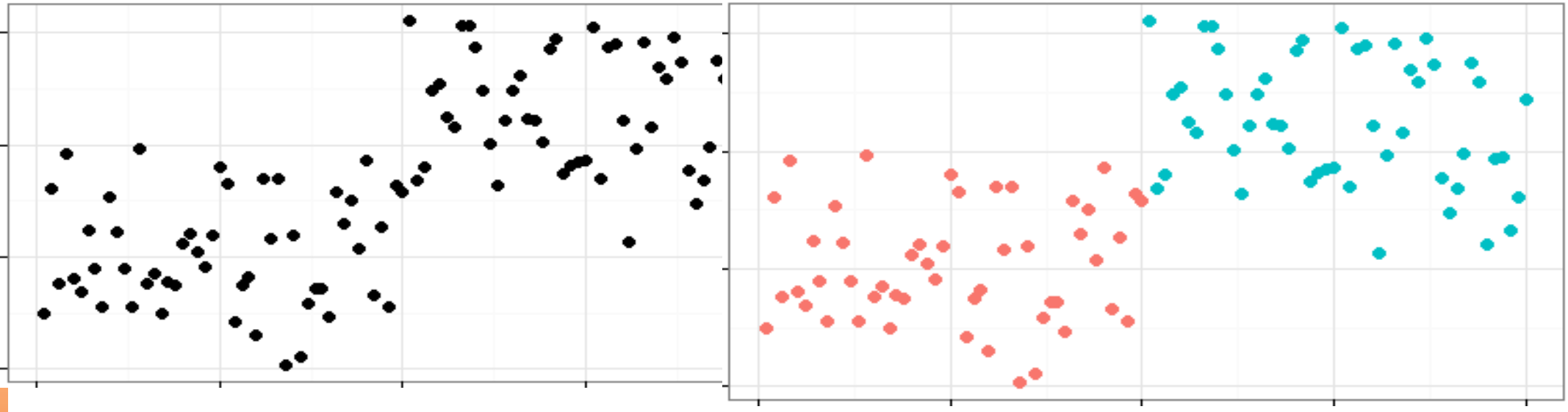


# Which customers are buying

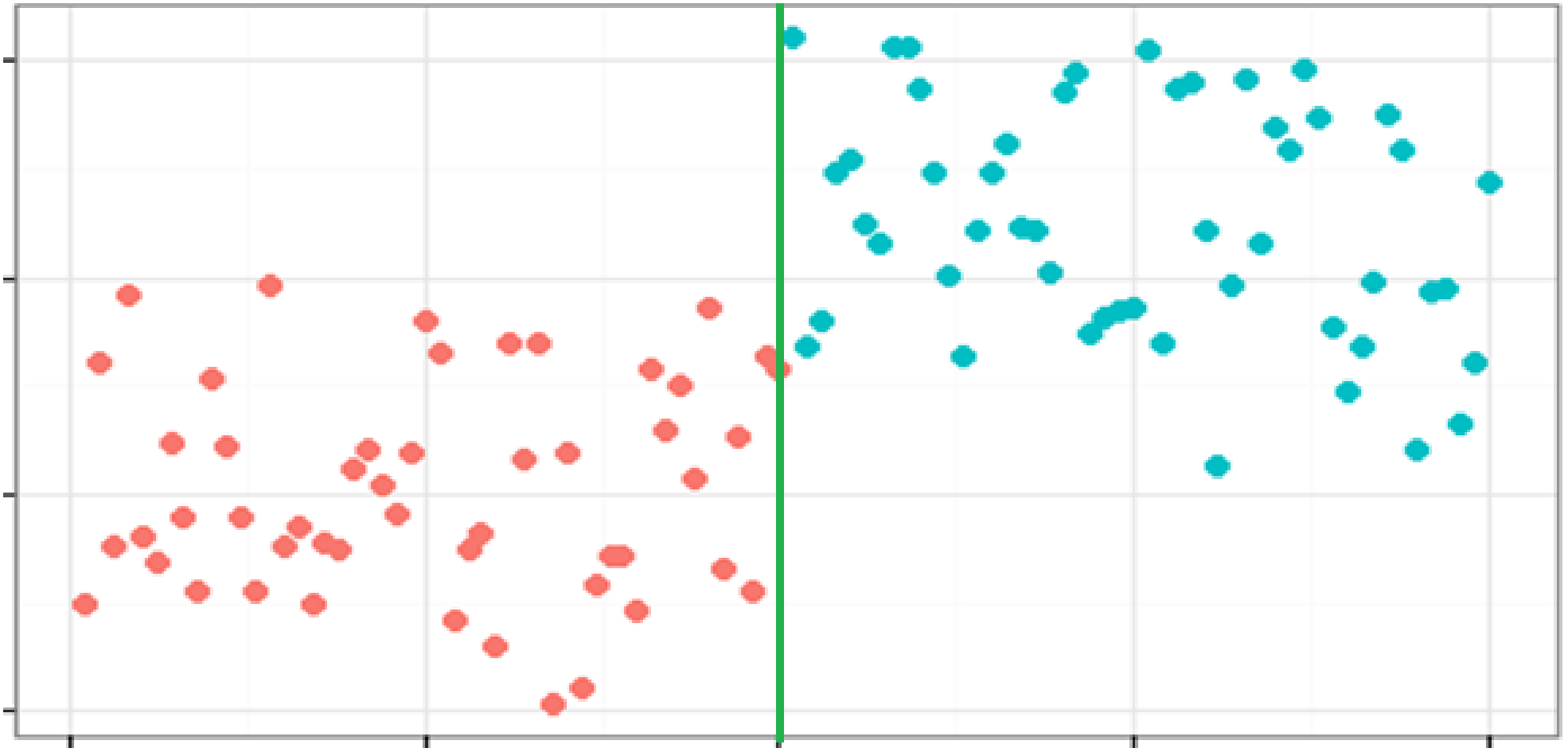



Fast track ML

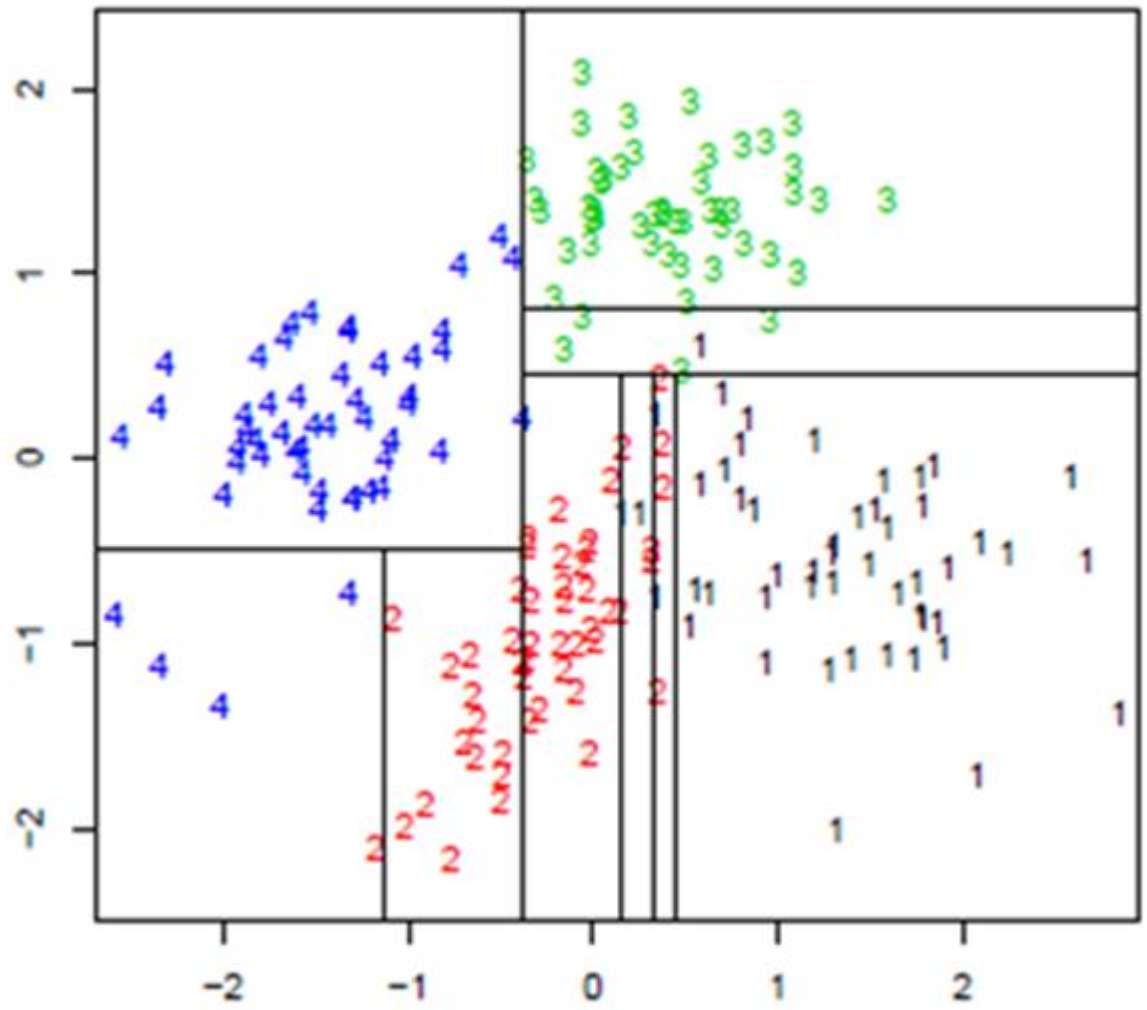
# Classification; Supervised and Unsupervised



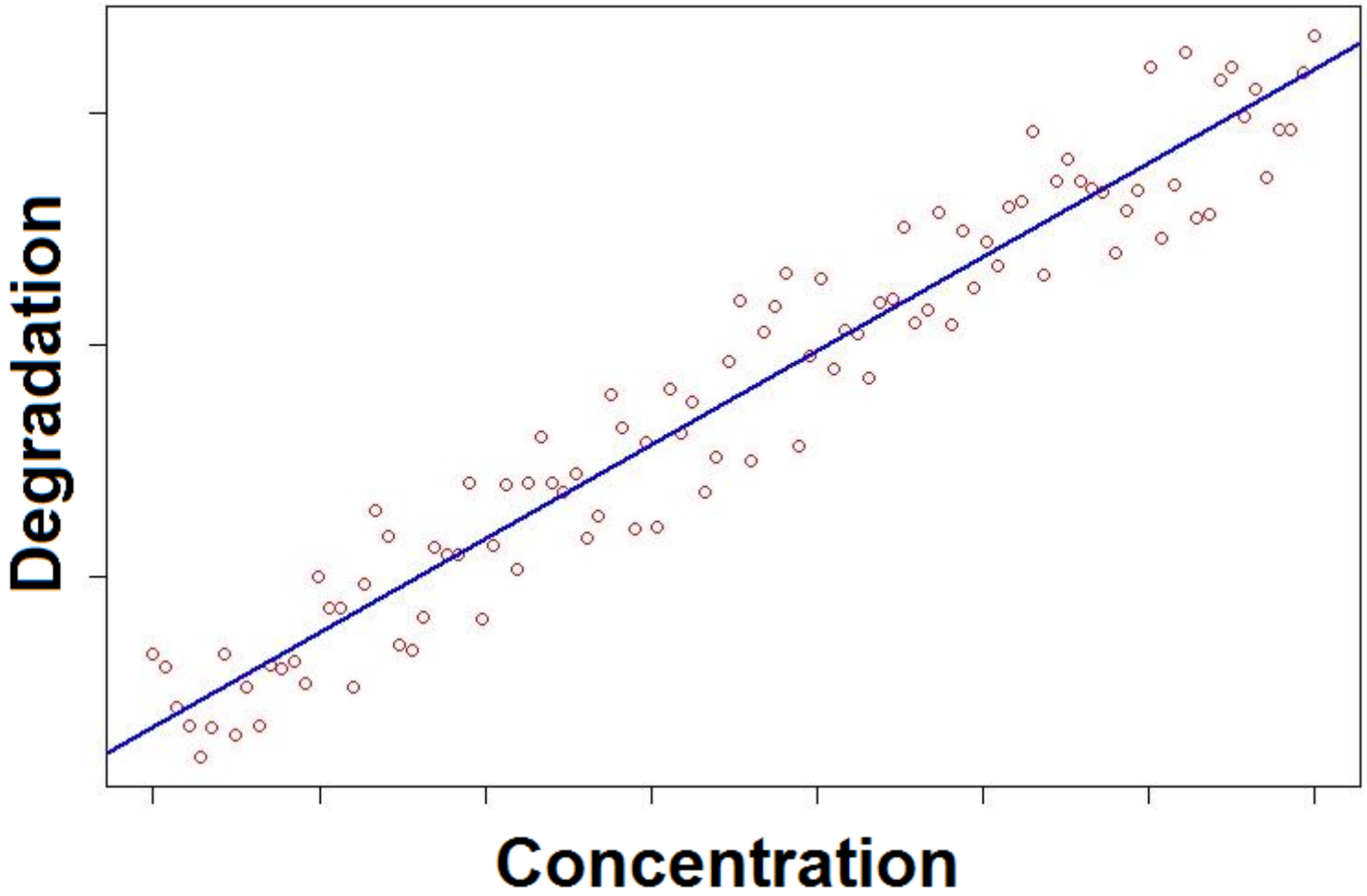
# Classification is partitioning the space



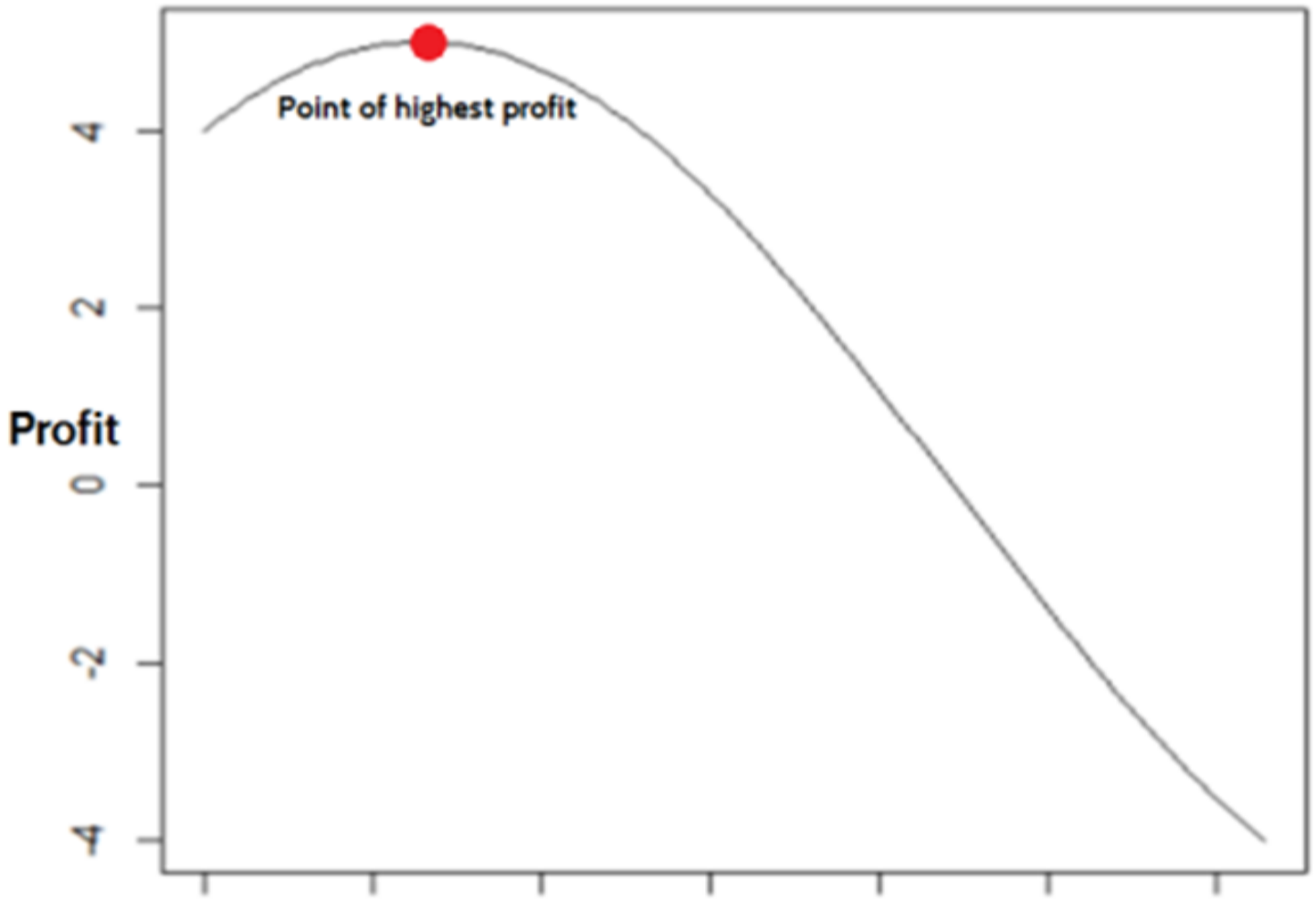
# Classification is partitioning…



# Forecasting is finding the line/plane closest to all points



# Optimization

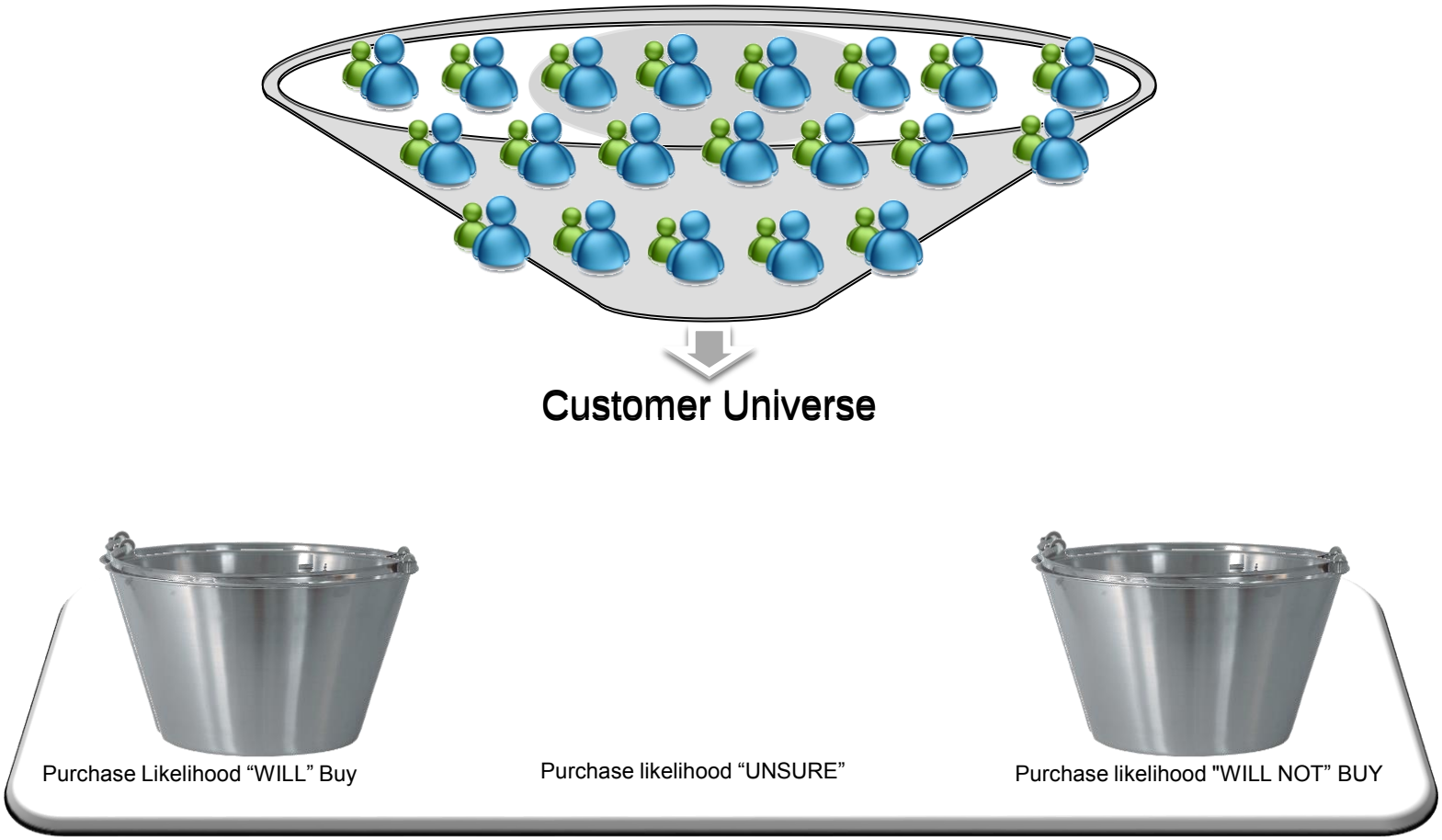


# Simulation

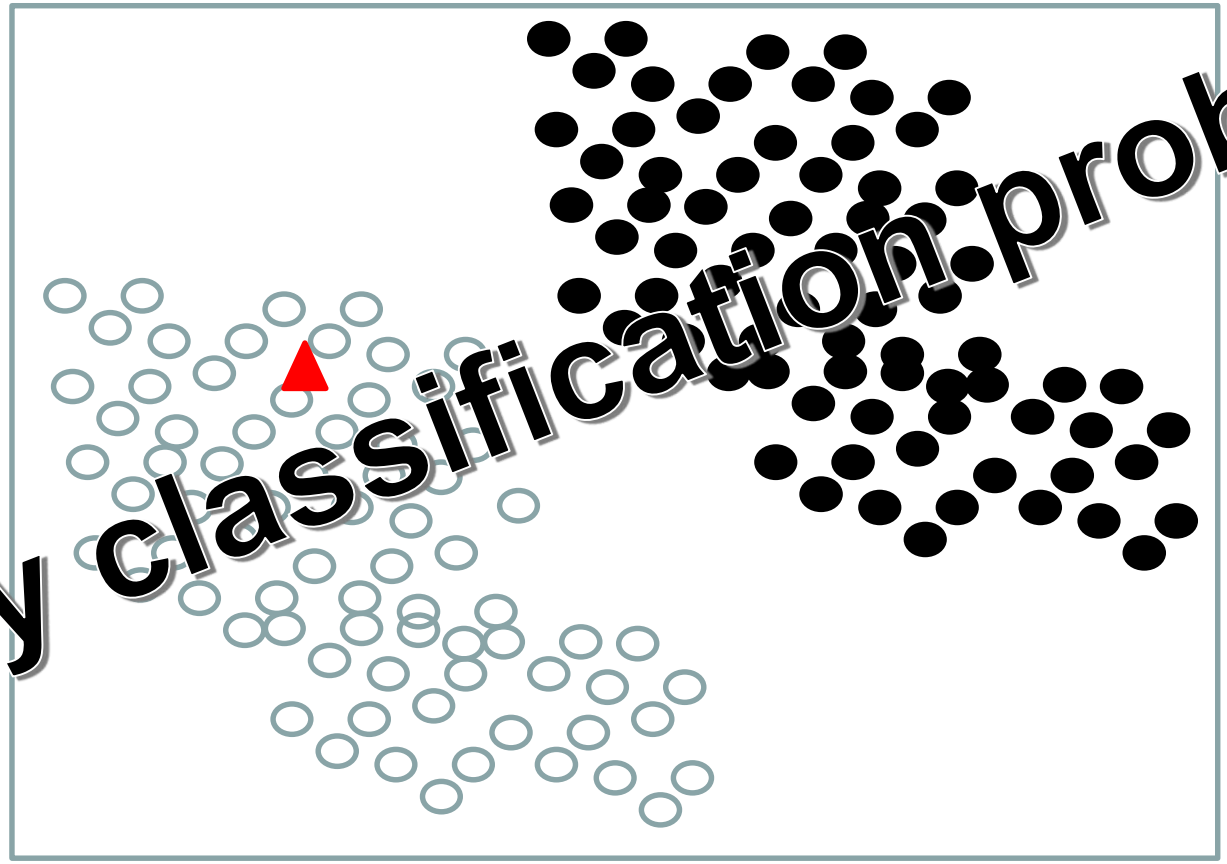
- Individuals are easy but groups and interactions are complex

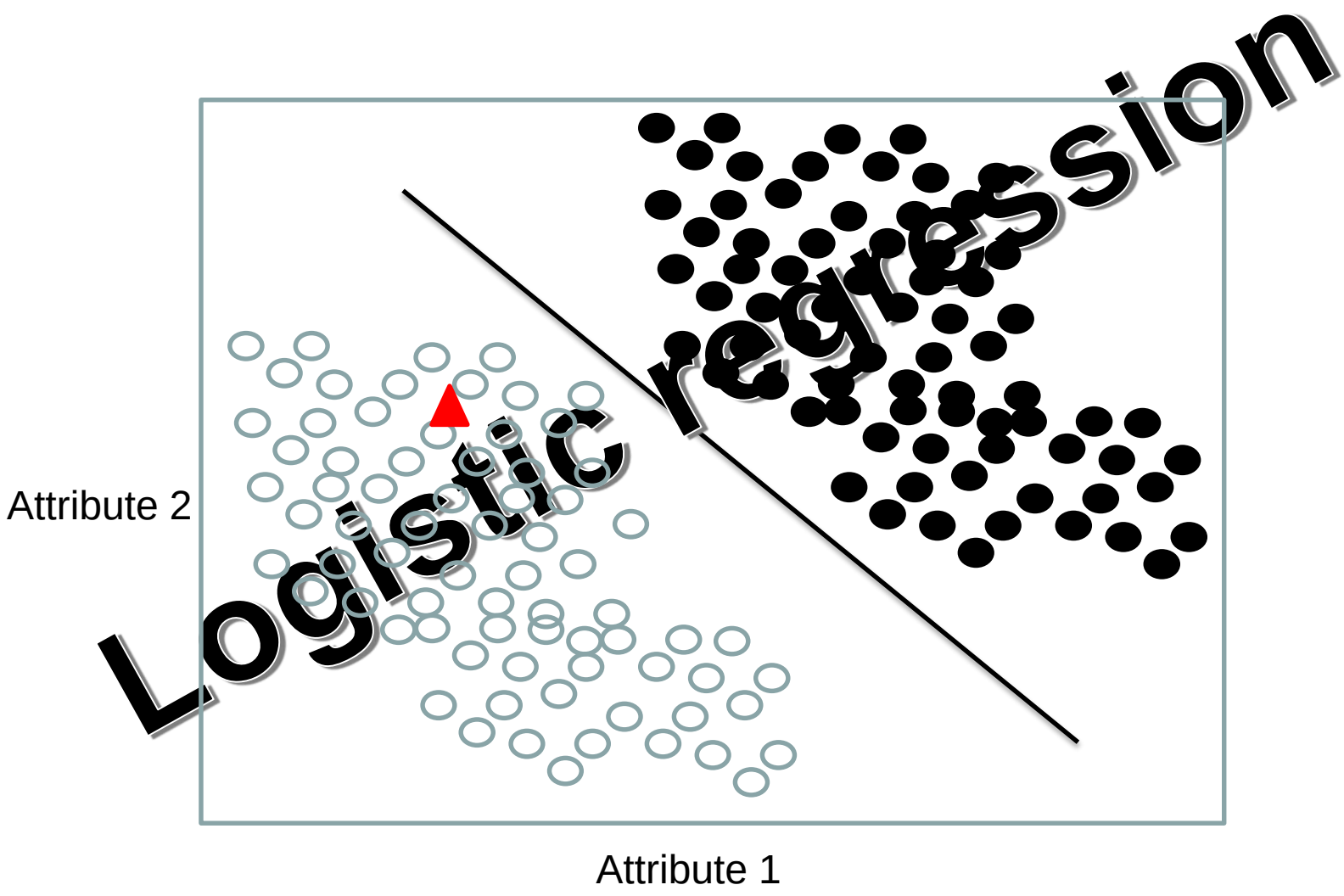
# FAST TRACK MODELS

# Data Science Models

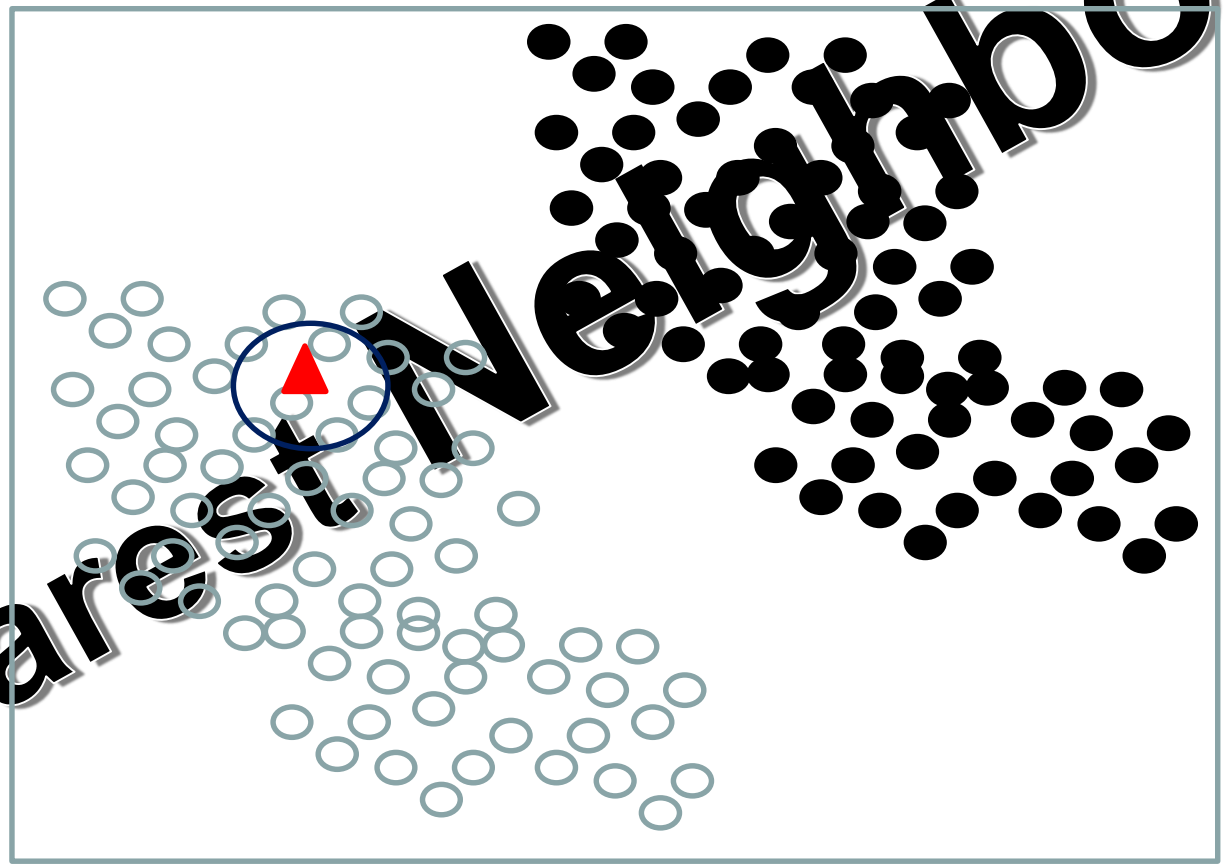


# Binary classification problem

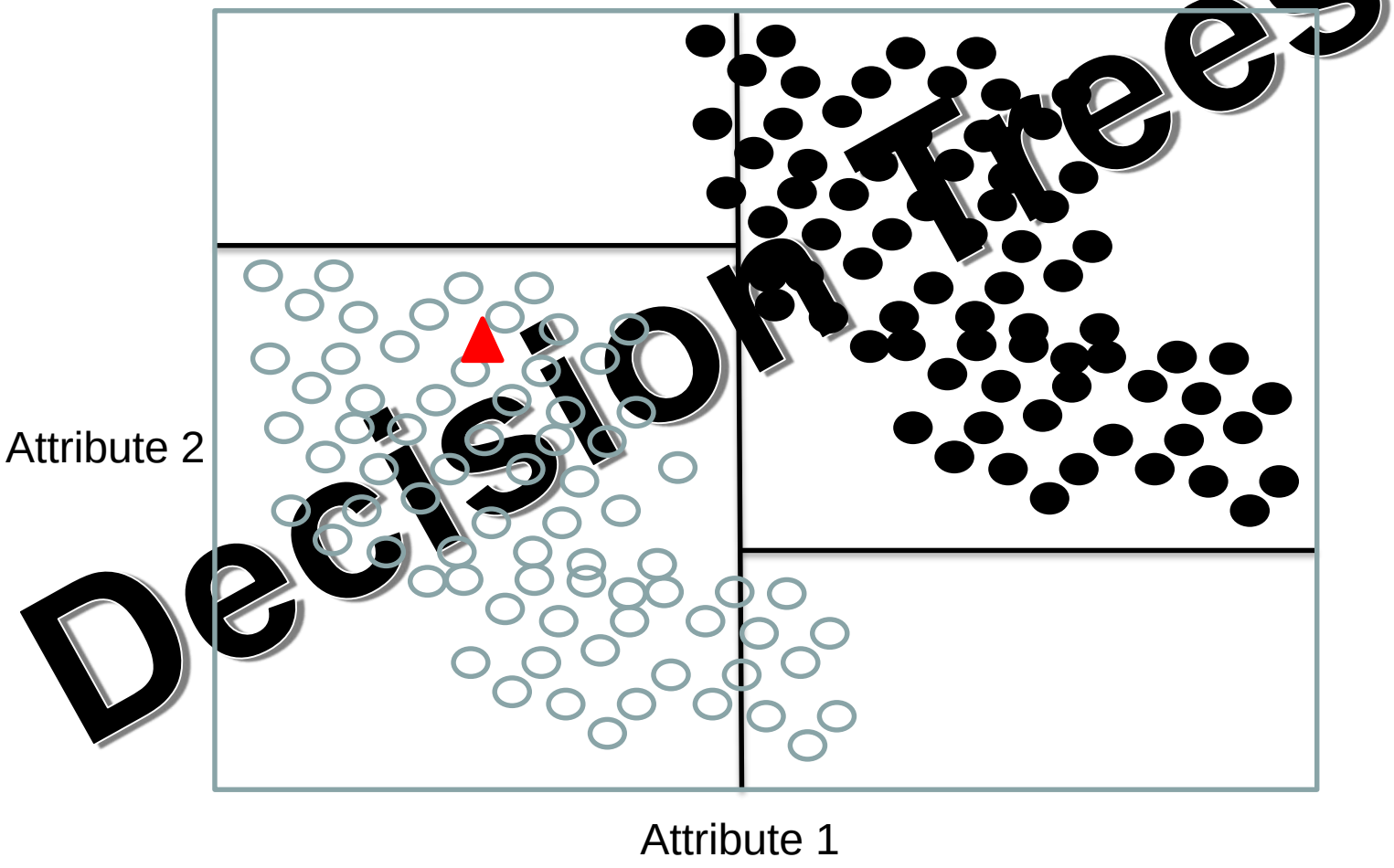



Logistic regression
Attribute 2
Attribute 1

# K-Nearest Neighbors



# Decision Trees



Non-linear solutions
Attribute 2
Attribute 1

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