VINI CARIDÁ

Human-Centered Data & AI

Vinicius Caridá, Ph.D.

Head of Digital Customer Service Platforms, PCP, WFM, Data and AI - Itaú Unibanco

MBA Professor - FIAP

Google Developer Expert – Machine Learning

Co-organizer TFUGSP and AWSUGSP

@vinicius caridá @vfcarida @vinicius caridá @vfcarida @vinicius caridá @vfcarida

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“

Introdução a Machine Learning

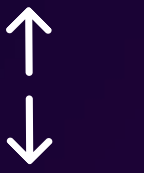
Vinicius F. Caridá

Dados

Técnica de ML

Técnica + Dados

Treinamento



Cientista de Dados

Modelo em produção

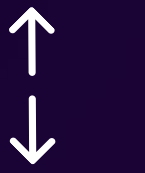
Modelo

Dados

Técnica de ML

Técnica + Dados

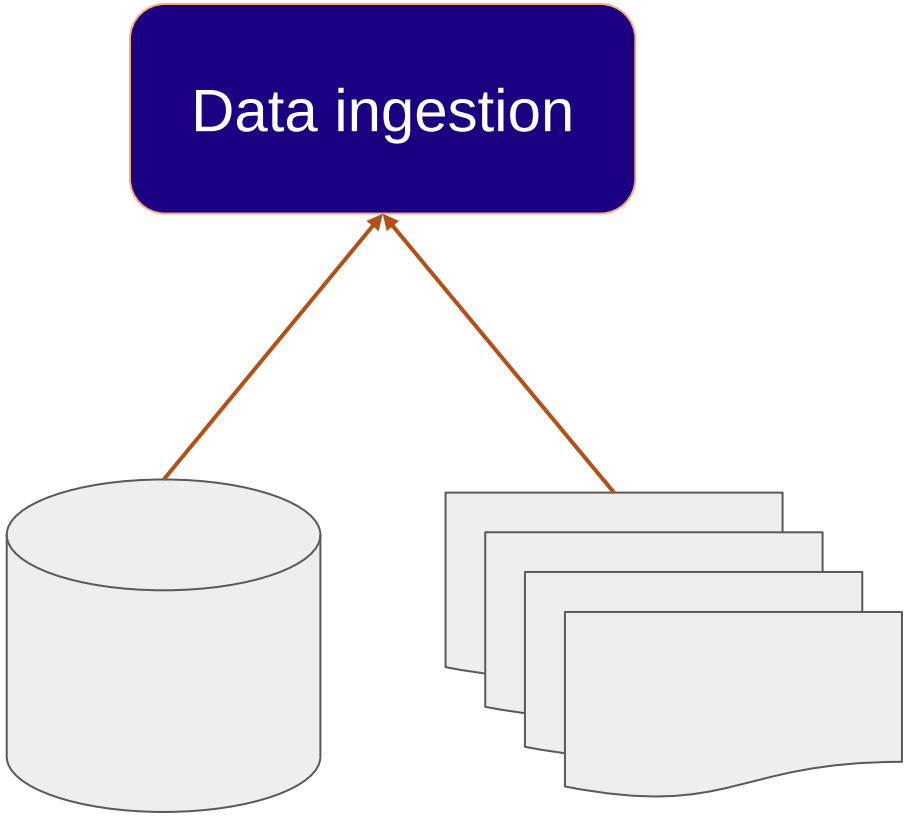
Treinamento

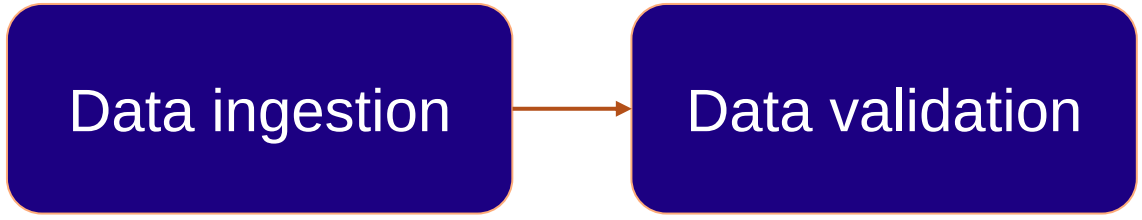


Cientista de Dados

Modelo em produção

Modelo


Data ingestion



`age` is missing

`country` not in:

- China
- India
- USA

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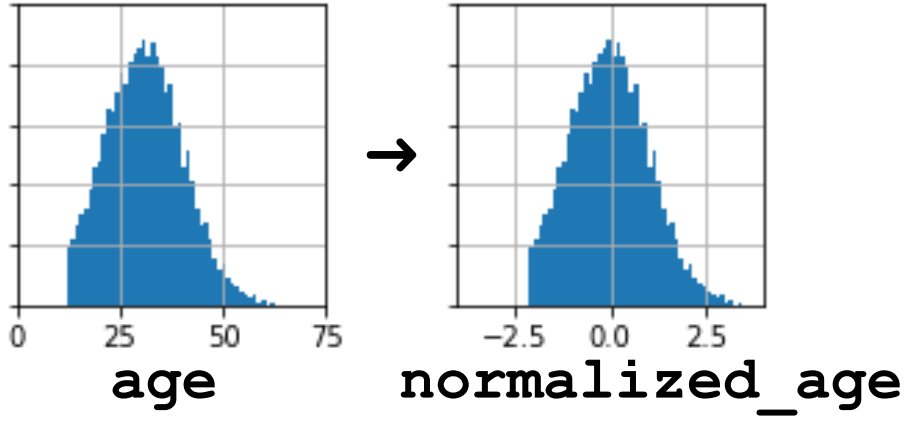
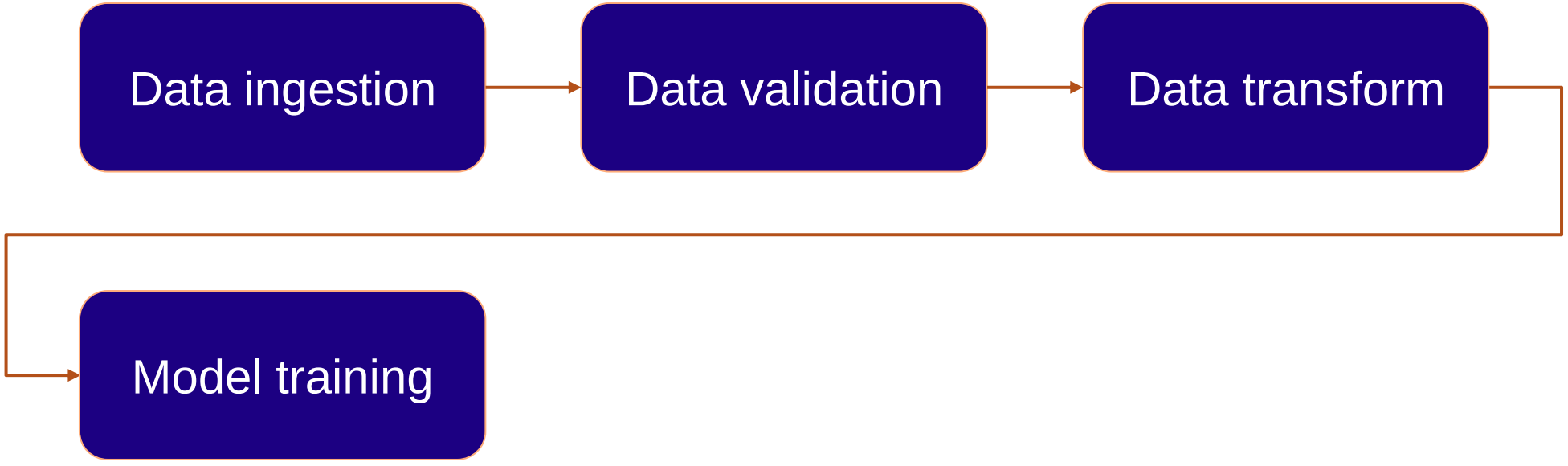
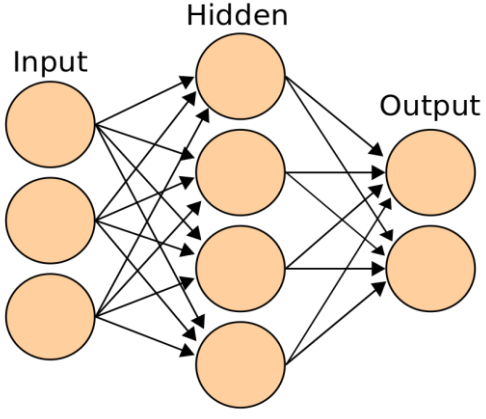
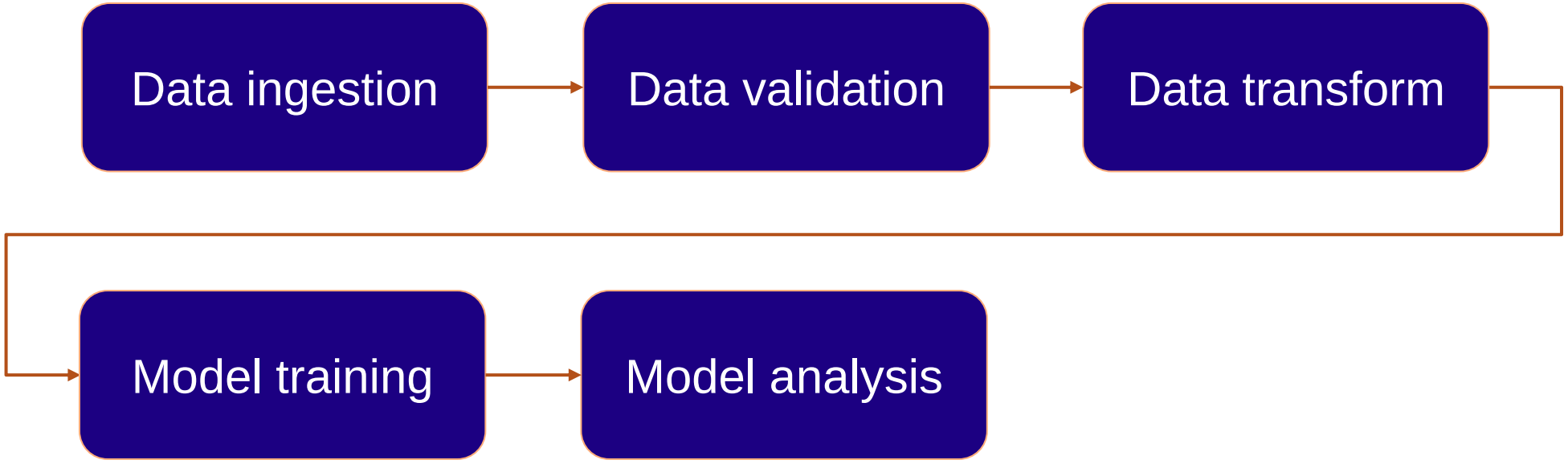
Data ingestion → Data validation → Data transform

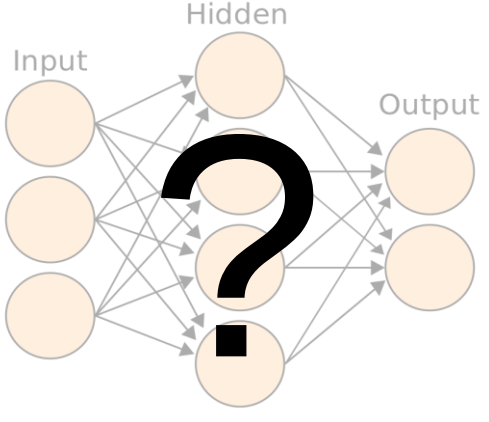


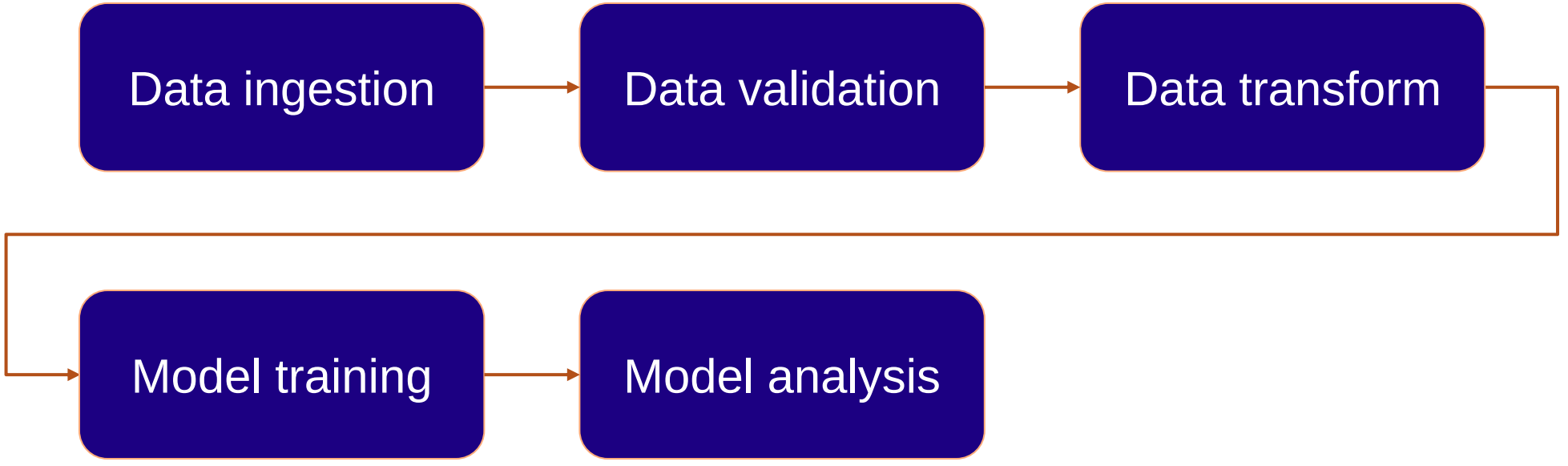
China → [1, 0, 0]
India → [0, 1, 0]
USA → [0, 0, 1]

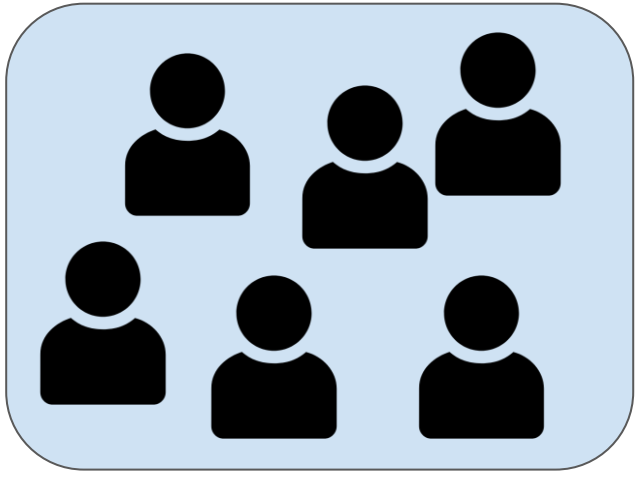

Data ingestion
Data validation
Data transform
Model training

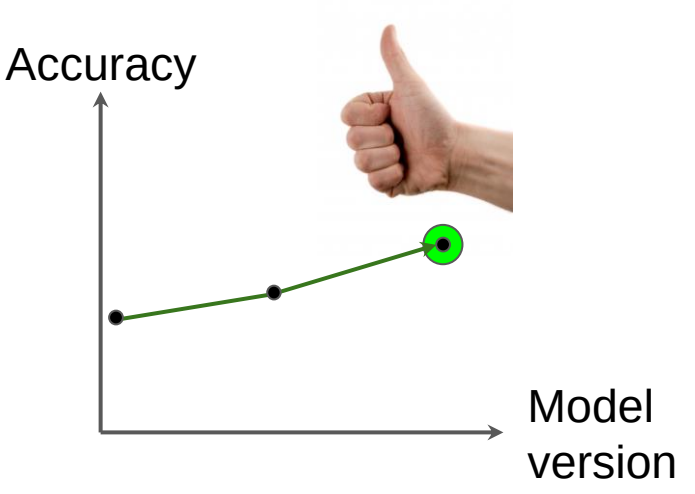

Input
Hidden
Output

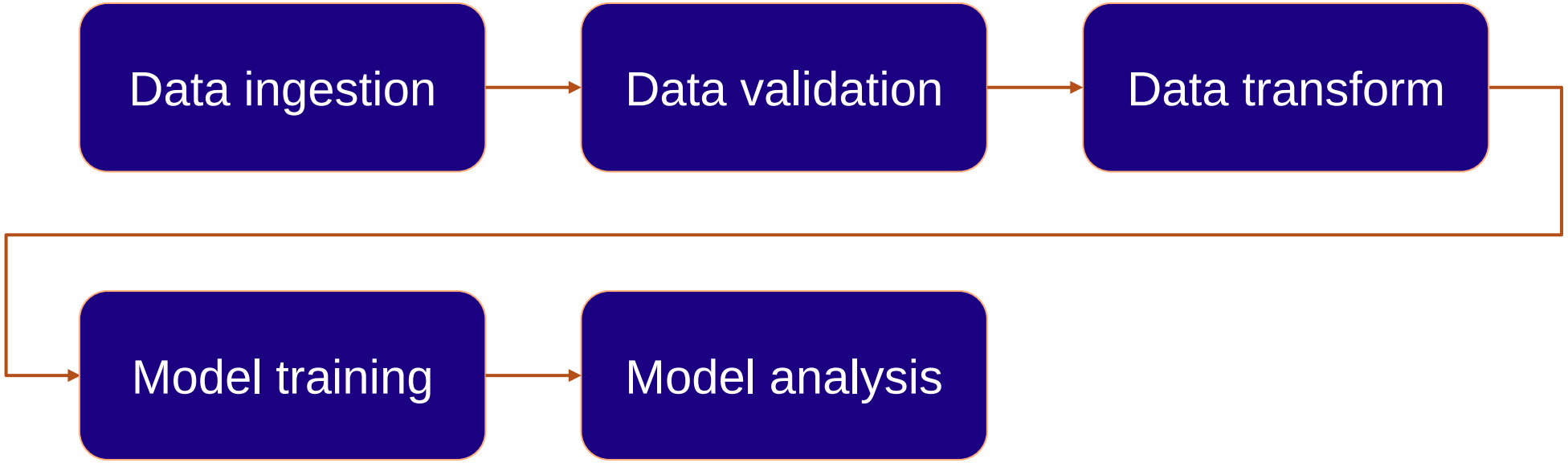

Data ingestion
Data validation
Data transform
Model training
Model analysis

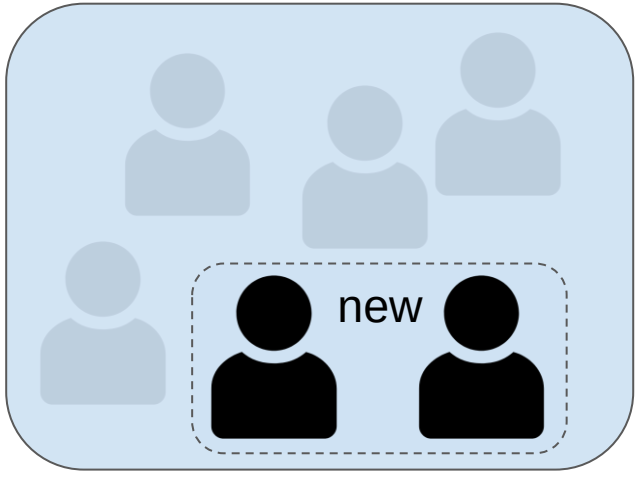

Hidden
Input
Output
?

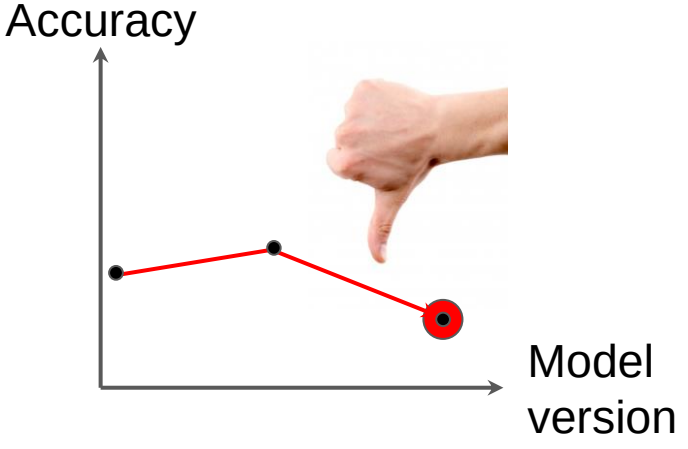

Data ingestion
Data validation
Data transform
Model training
Model analysis




Accuracy
Model
version


Data ingestion
Data validation
Data transform
Model training
Model analysis


new


Accuracy
Model
version

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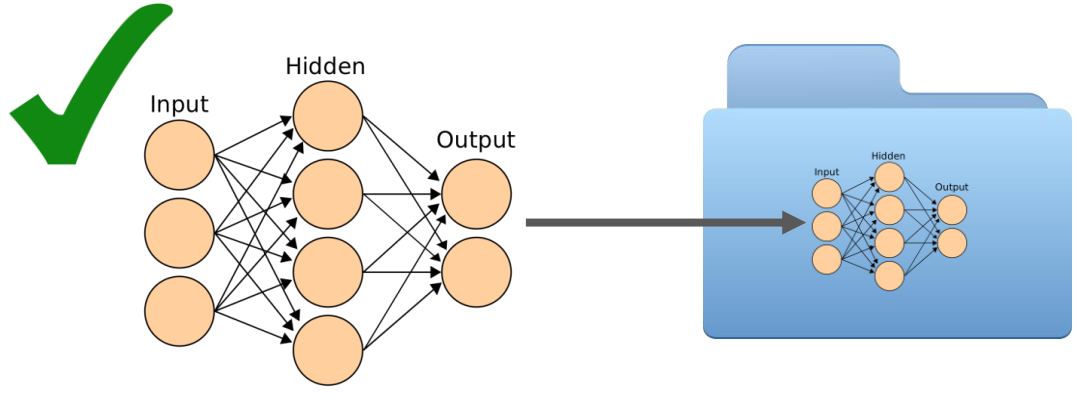
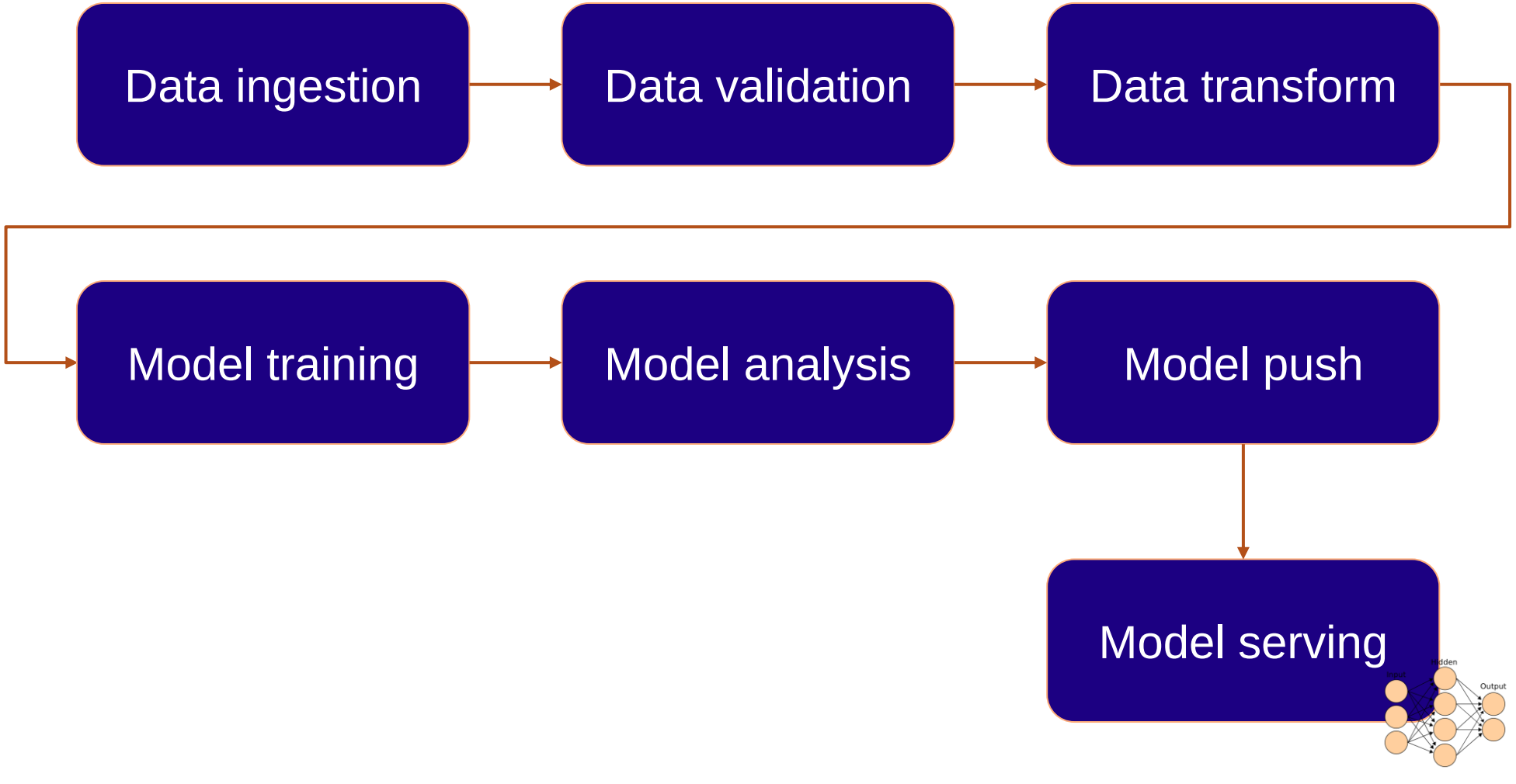
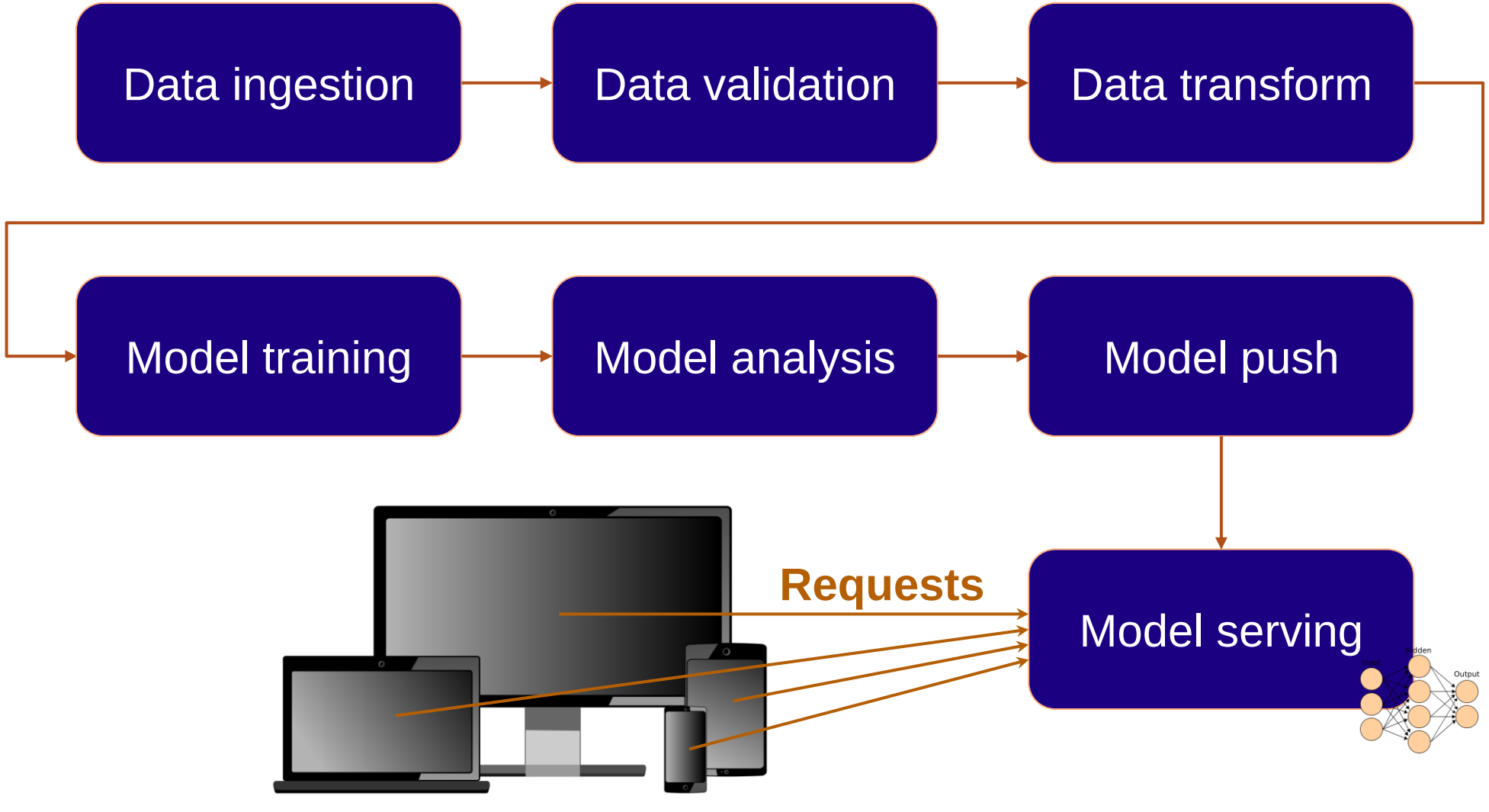
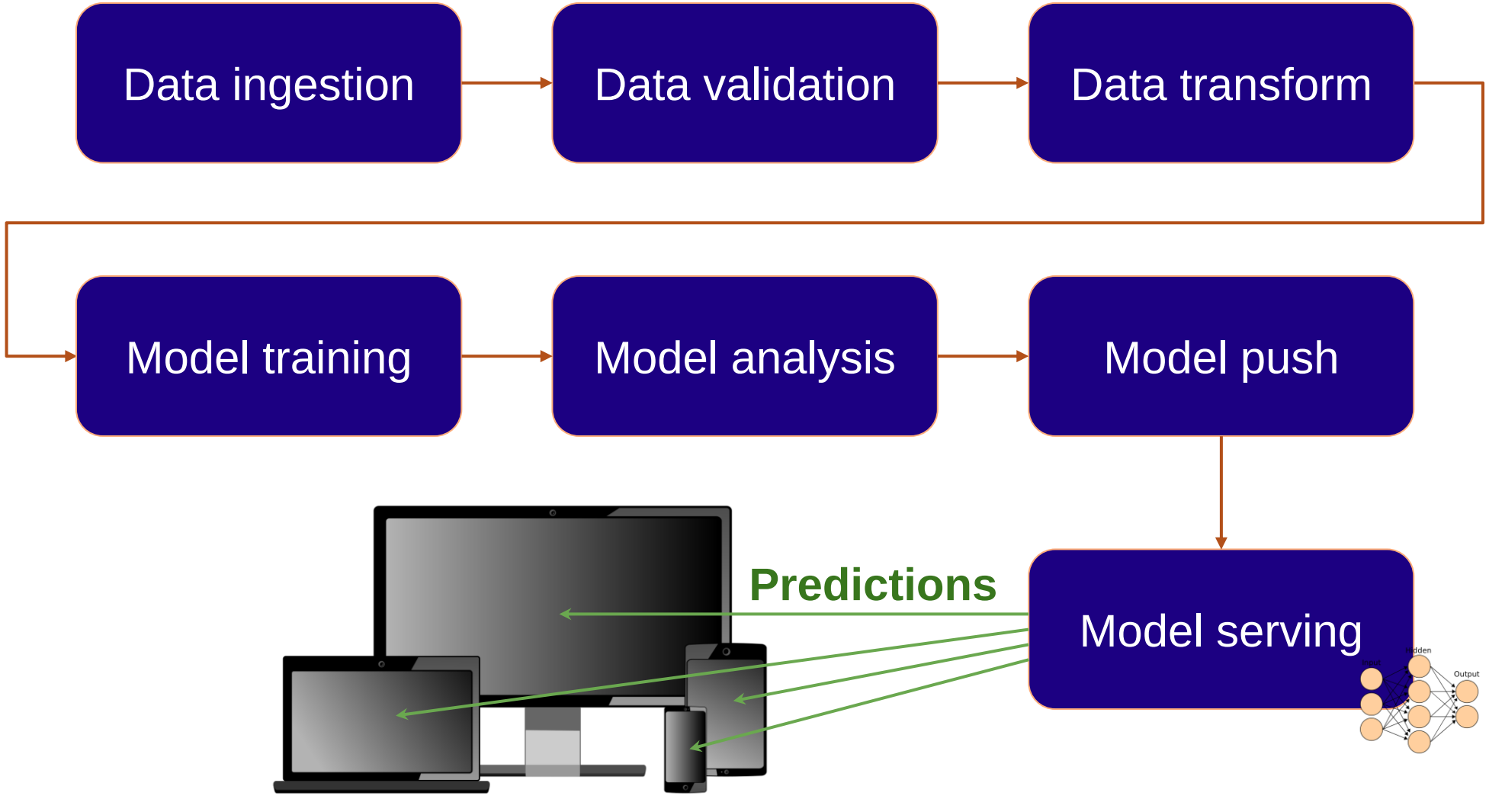
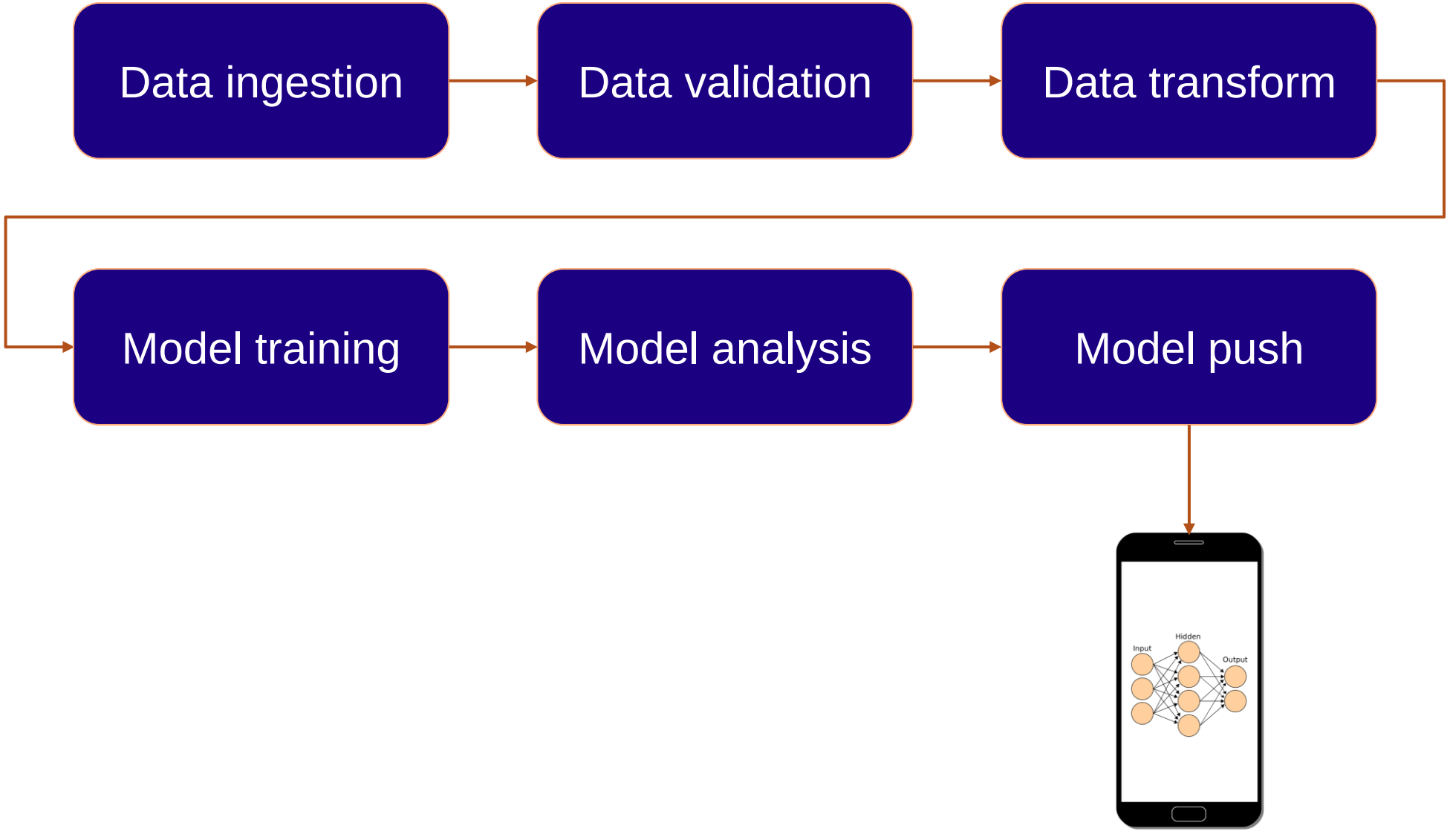
Data ingestion → Data validation → Data transform → Model training → Model analysis → Model push

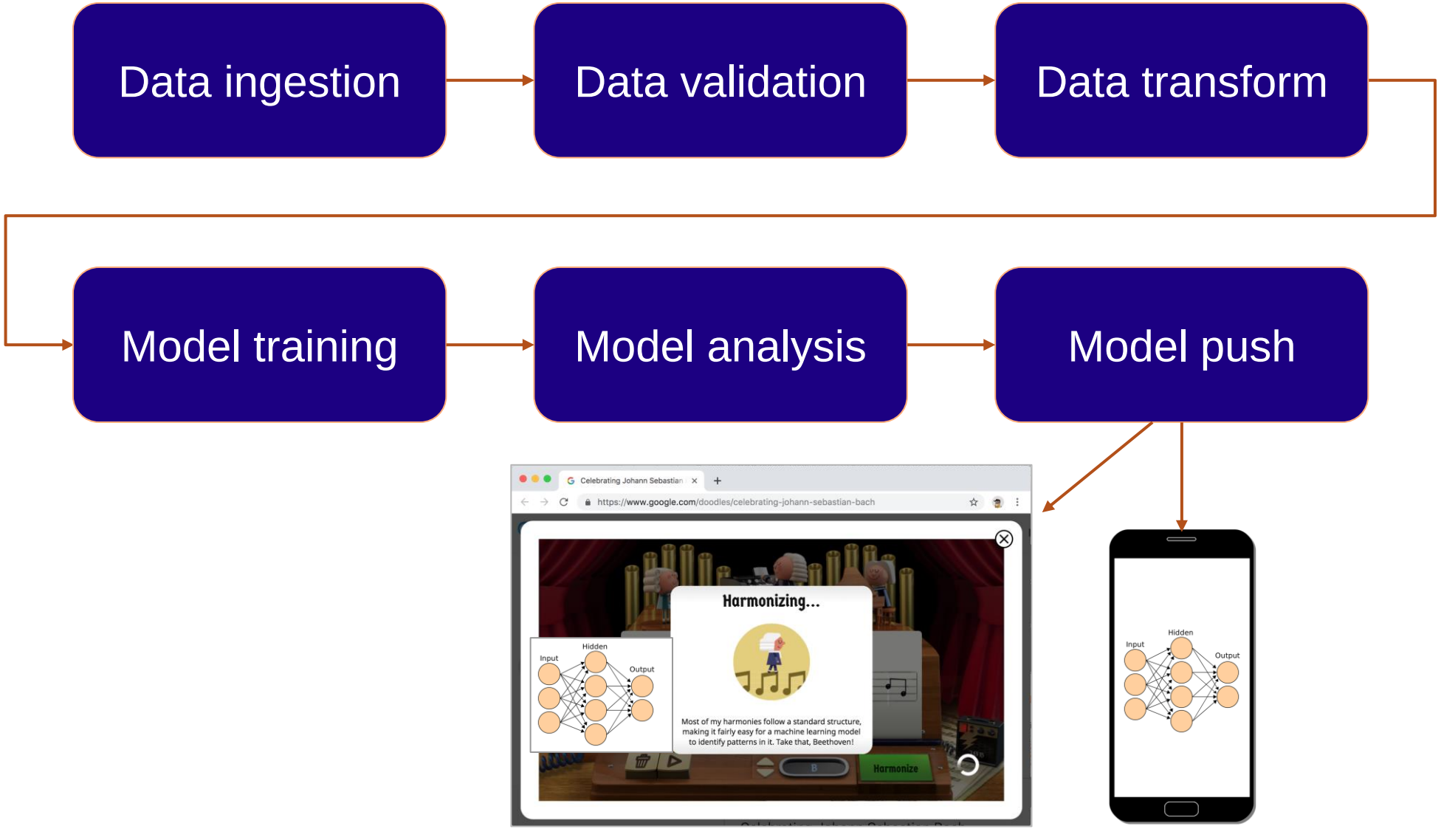


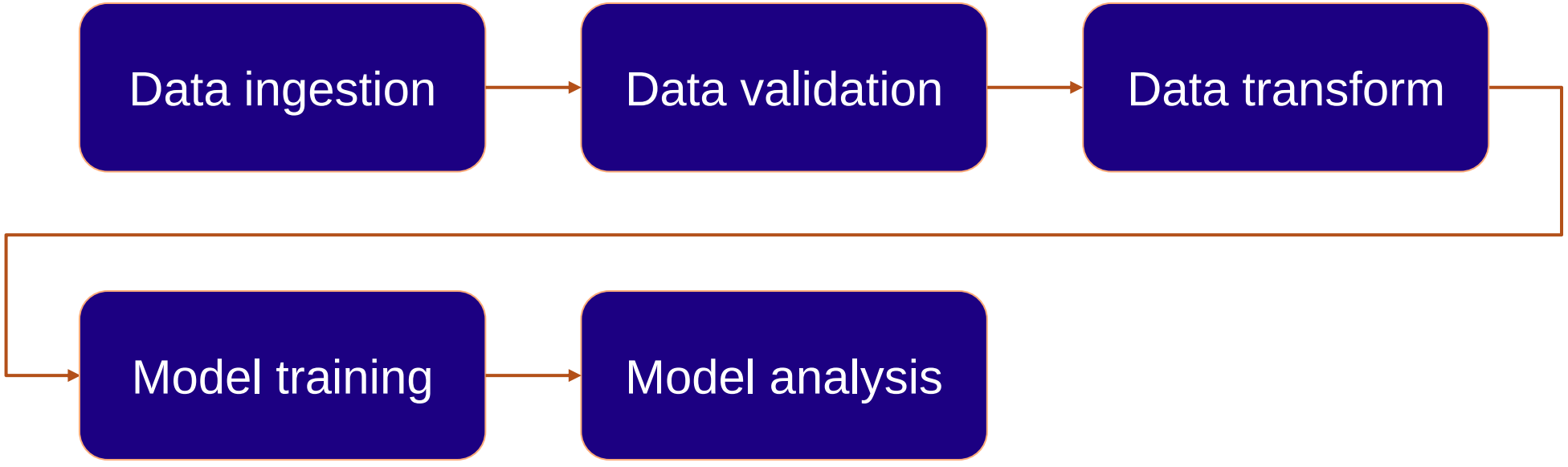

Data ingestion
Data validation
Data transform
Model training
Model analysis
Model push
Model serving
Input
Hidden
Output

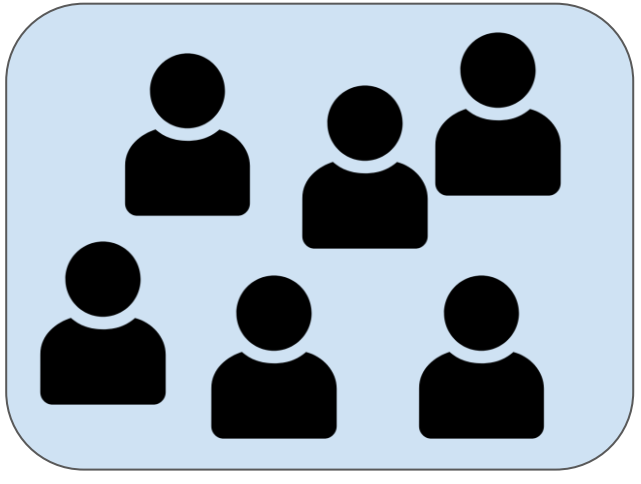

Data ingestion
Data validation
Data transform
Model training
Model analysis
Model push
Requests
Model serving
Input
Hidden
Output

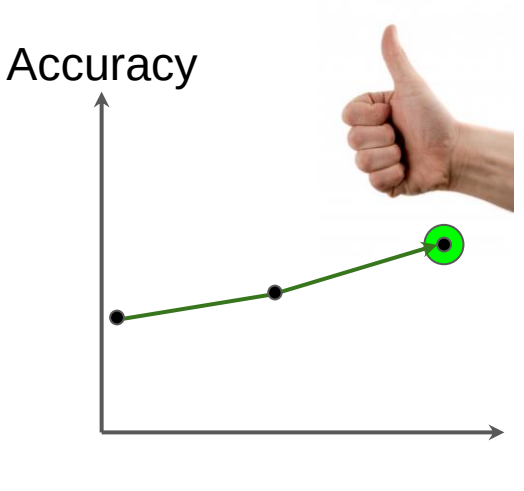

Data ingestion
Data validation
Data transform
Model training
Model analysis
Model push
Predictions
Model serving
Input
Hidden
Output


Data ingestion
Data validation
Data transform
Model training
Model analysis
Model push
Input
Hidden
Output


Data ingestion
Data validation
Data transform
Model training
Model analysis
Model push
Celebrating Johann Sebastian
https://www.google.com/doodles/celebrating-johann-sebastian-bach
Harmonizing...
Input
Hidden
Output
Most of my harmonies follow a standard structure, making it fairly easy for a machine learning model to identify patterns in it. Take that, Beethoven!
Harmonize
Input
Hidden
Output


Data ingestion
Data validation
Data transform
Model training
Model analysis




Accuracy
Model
version

Remediation:
Smile Detection on CelebA using TF Constrained Optimization

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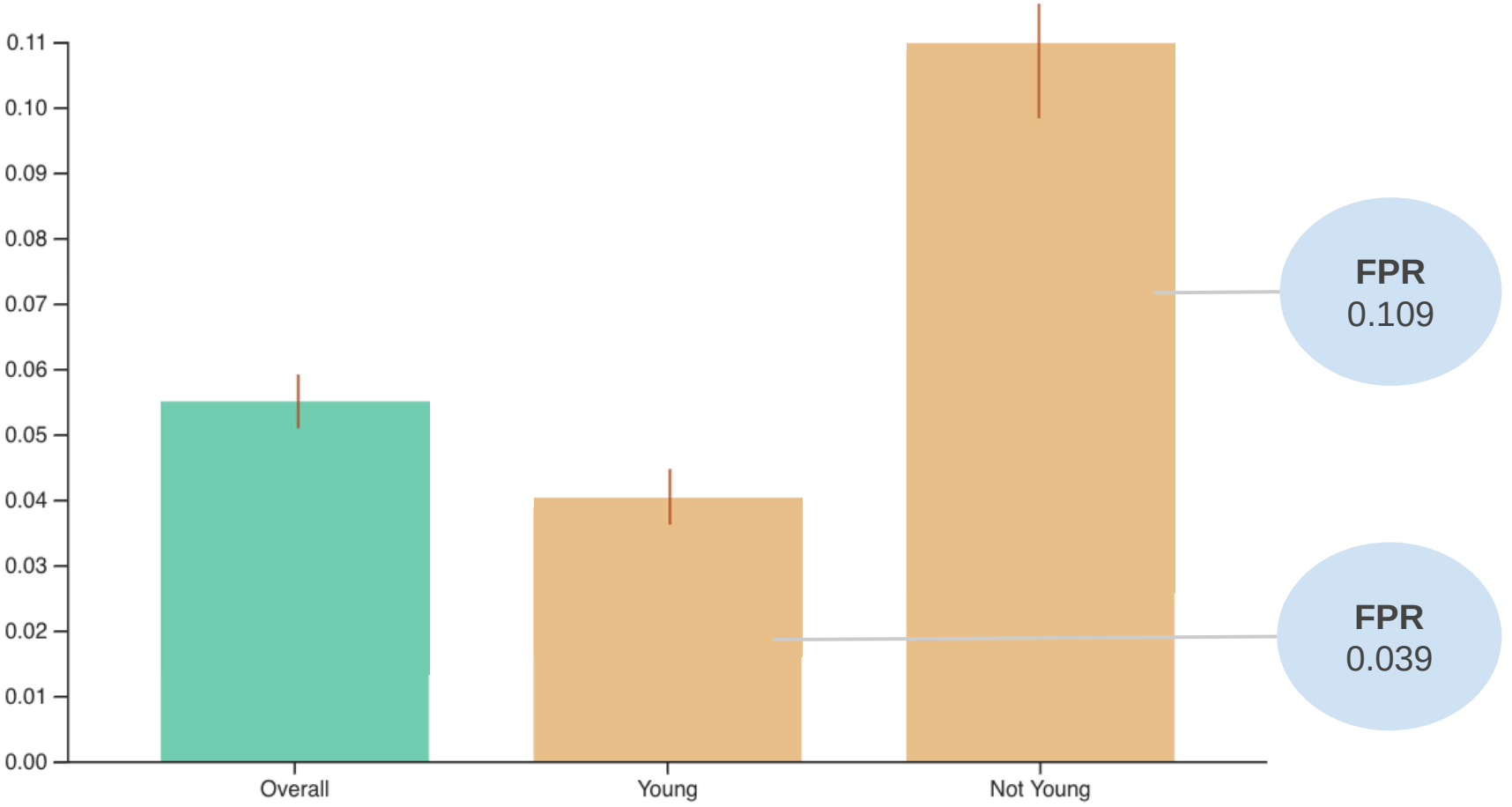
Results: Unconstrained tf.keras.Sequential model



Remediation: CelebA example using TFCO

1. Define subsets of interest

```
context = tfco.rate_context(predictions, labels=lambda:labels_tensor)
context_subset = context.subset(lambda:groups_tensor < 1)
```

https://github.com/google-research/tensorflow_constrained_optimization

Remediation: CelebA example using TFCO

1. Define subsets of interest

```
context = tfco.rate_context(predictions, labels=lambda:labels_tensor)
context_subset = context.subset(lambda:groups_tensor < 1)
```

2. Set constraints on subset using rate helpers

```
constraints = [tfco.false_positive_rate(context_subset) <= 0.05]
```

https://github.com/google-research/tensorflow_constrained_optimization

Remediation: CelebA example using TFCO*

1. Define subsets of interest

```
context = tfco.rate_context(predictions, labels=lambda:labels_tensor)
context_subset = context.subset(lambda:groups_tensor < 1)
```

2. Set constraints on subset using rate helpers

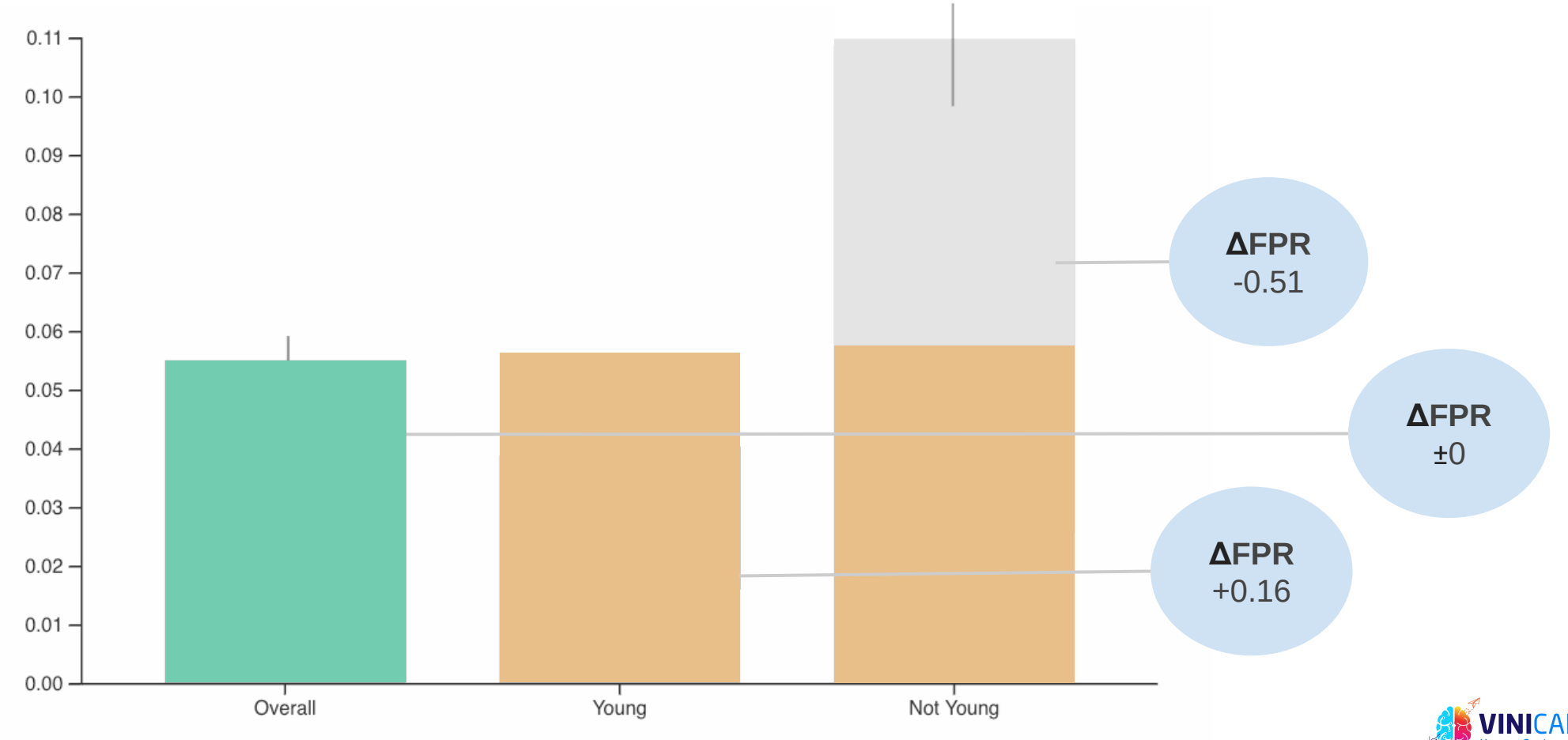
```
constraints = [tfco.false_positive_rate(context_subset) <= 0.05]
```

3. Define optimizer and train

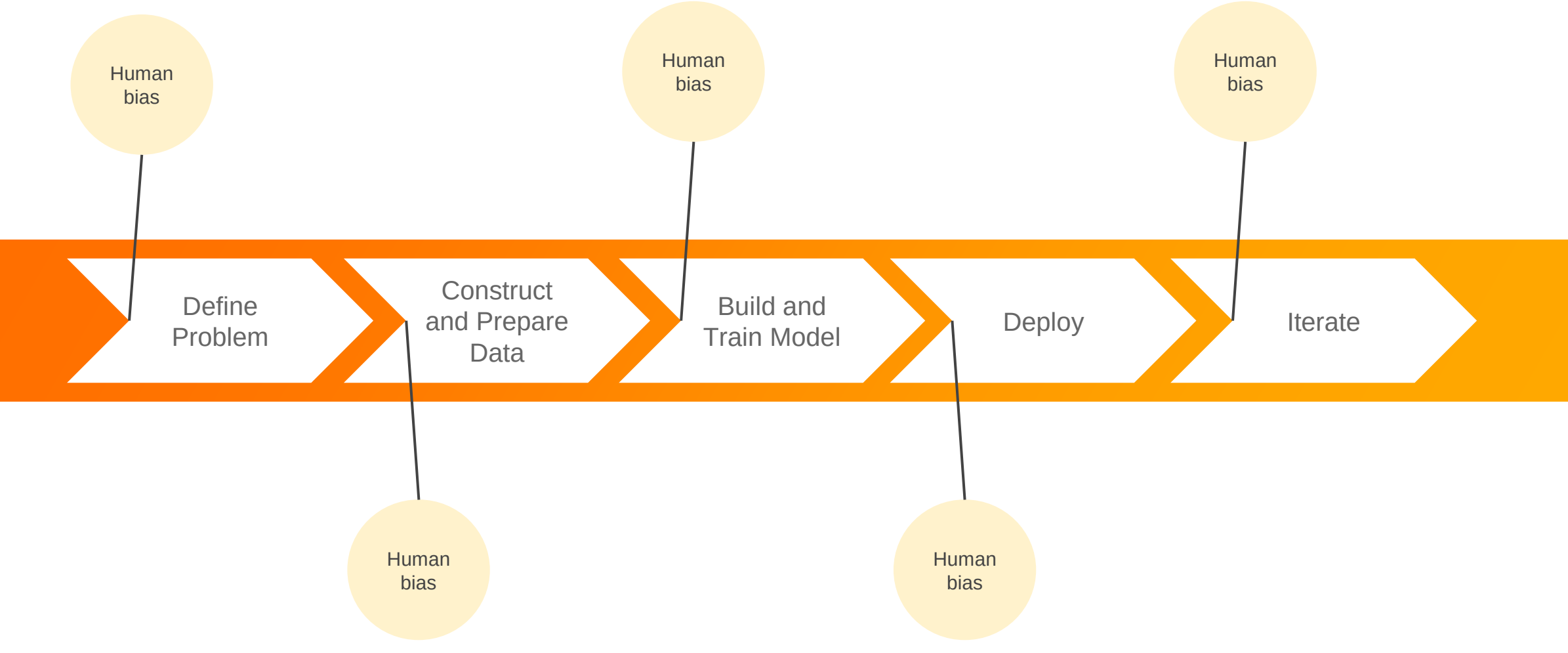
```
problem = tfco.RateMinimizationProblem(tfco.error_rate(context), constraints)
optimizer = tfco.ProxyLagrangianOptimizerV2(
      optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
      constraint_optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
      num_constraints=problem.num_constraints)
```

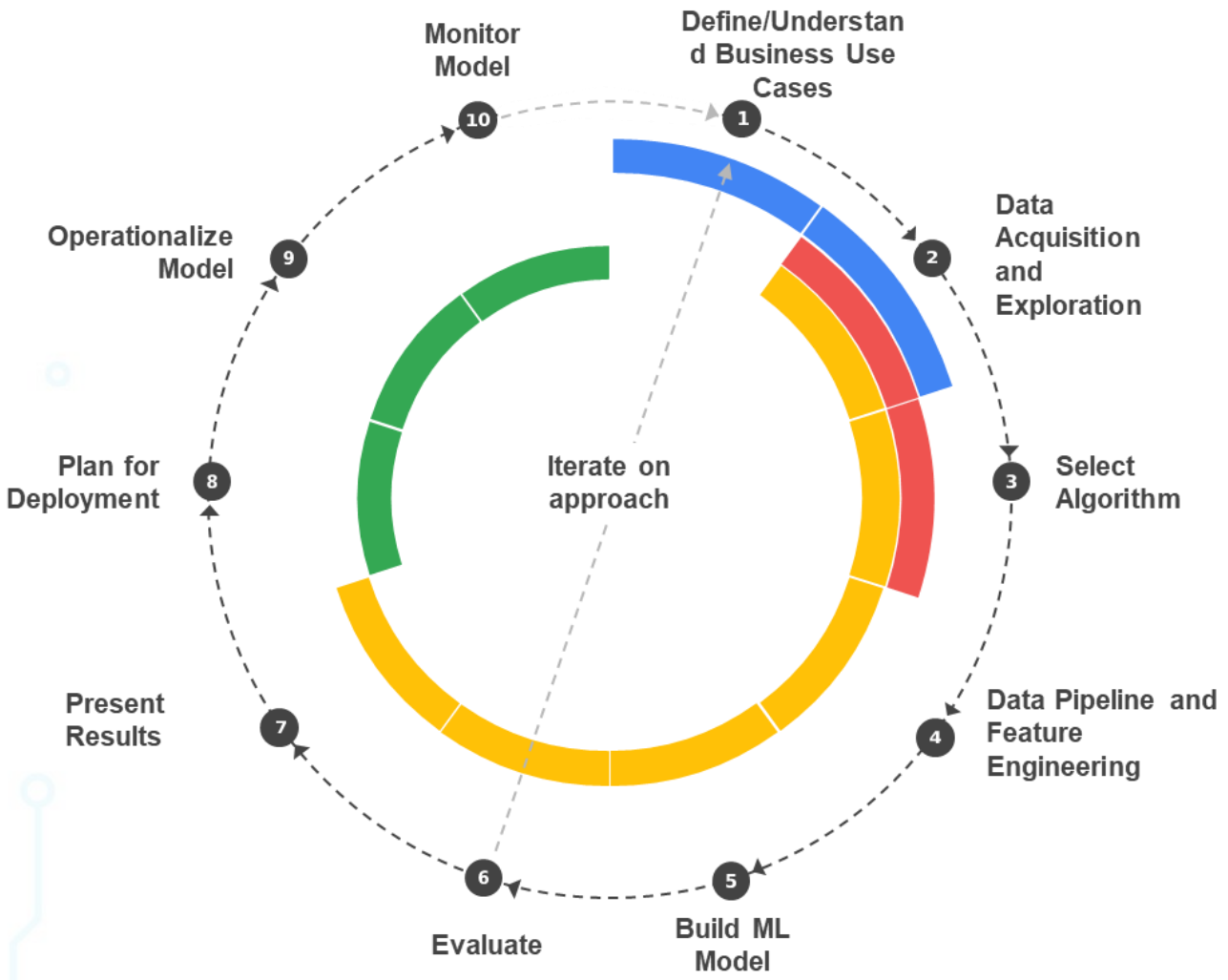
https://github.com/google-research/tensorflow_constrained_optimization

Results: Constrained tf.keras.Sequential model

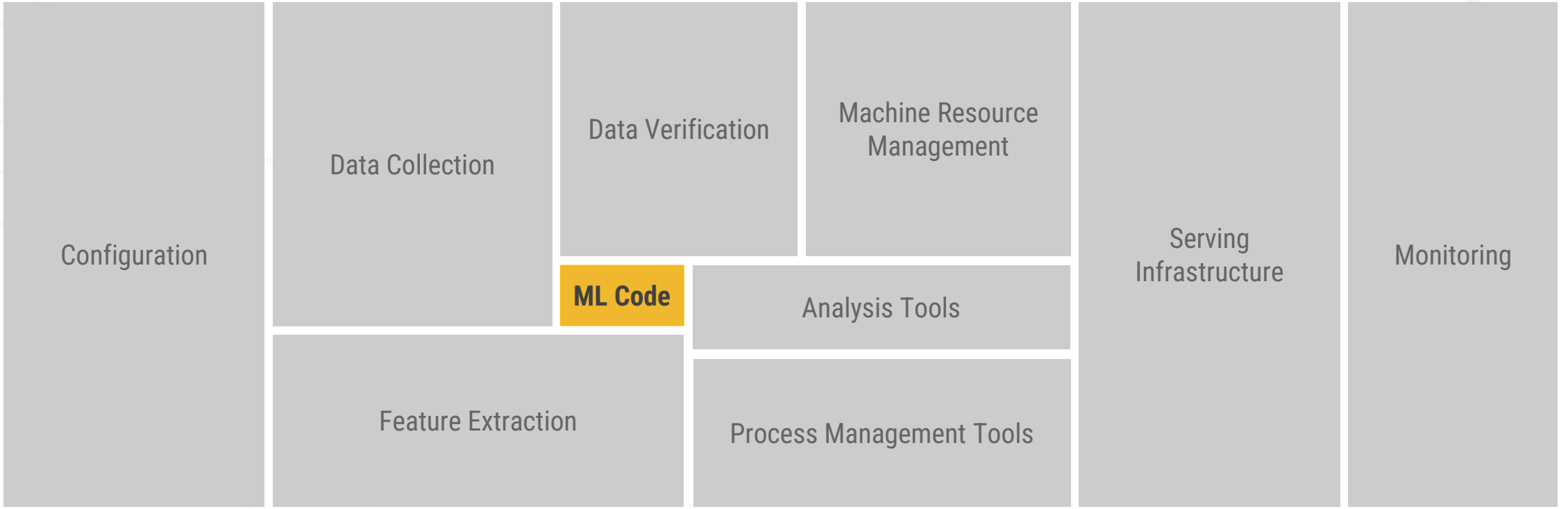


Humans have a history of making product design decisions that are *not* in line with the needs of everyone.


Human bias
Human bias
Human bias
Define Problem
Construct and Prepare Data
Build and Train Model
Deploy
Iterate
Human bias
Human bias


Define/Understand Business Use Cases
1
Data Acquisition and Exploration
2
Select Algorithm
3
Data Pipeline and Feature Engineering
4
Build ML Model
5
Evaluate
6
Present Results
7
Plan for Deployment
8
Operationalize Model
9
Monitor Model
10
Iterate on approach

… a production solution requires so much more



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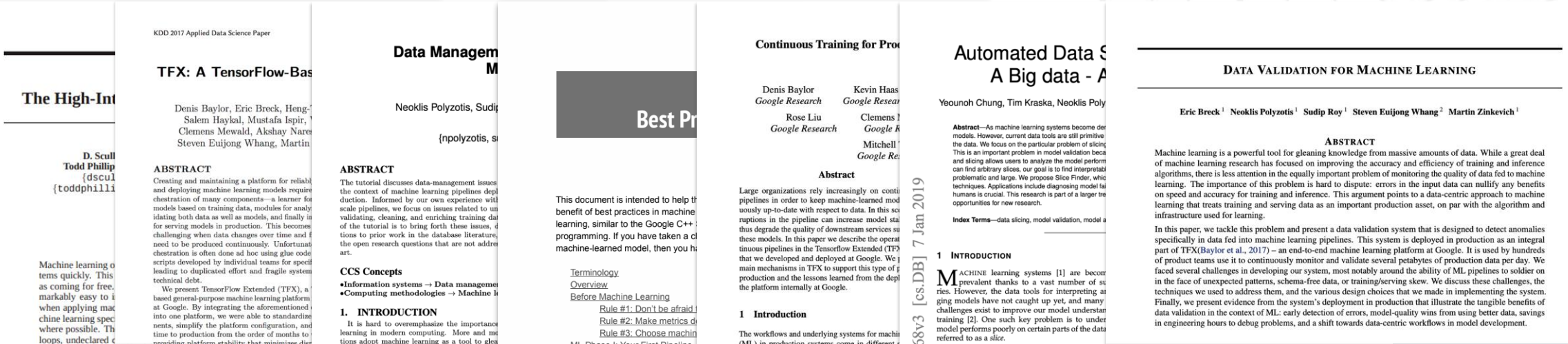
Leading ML | Best Practices

Continuous Training for Production ML in the TFX Platform. OpML (2019).
Slice Finder: Automated Data Slicing for Model Validation. ICDE (2019).
Data Validation for Machine Learning. SysML (2019).
TFX: A TensorFlow-Based Production-Scale Machine Learning Platform. KDD (2017).
Data Management Challenges in Production Machine Learning. SIGMOD (2017).
Rules of Machine Learning: Best Practices for ML Engineering. Google AI Web (2017).
Machine Learning: The High Interest Credit Card of Technical Debt. NeurIPS (2015).



Afinal,

Como funciona inteligência artificial?

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Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim
	Luiz	R$1.500,00	Não
	Maria	R$5.000,00	Sim

Base de dados inicial

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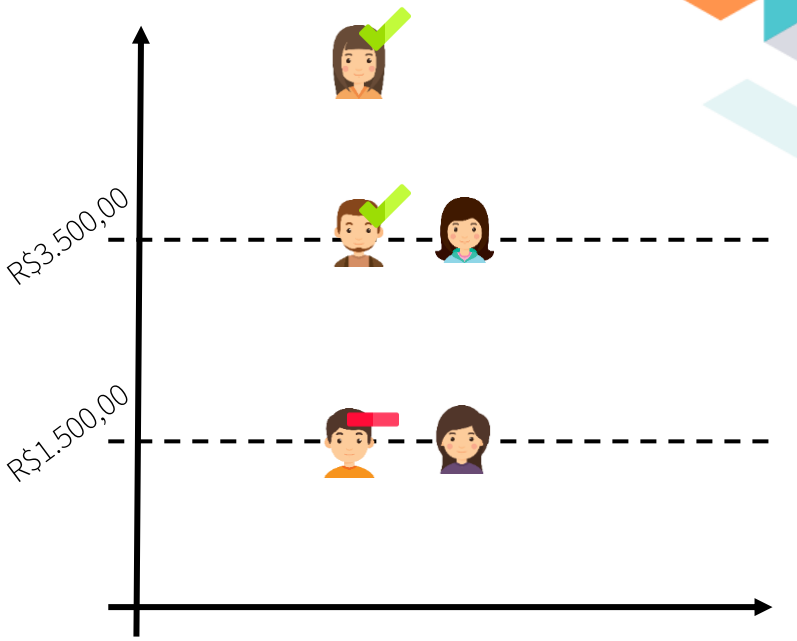
Nome
Renda
Investidor?
João
R$3.500,00
Sim
Luiz
R$1.500,00
Não
Maria
R$5.000,00
Sim
Instâncias
Atributos
Classe

Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim ✔
	Luiz	R$1.500,00	Não ▬
	Maria	R$5.000,00	Sim ✔
	Rosa	R$1.500,00	???
	Ana	R$3.500,00	???



Novas entradas desconhecidas

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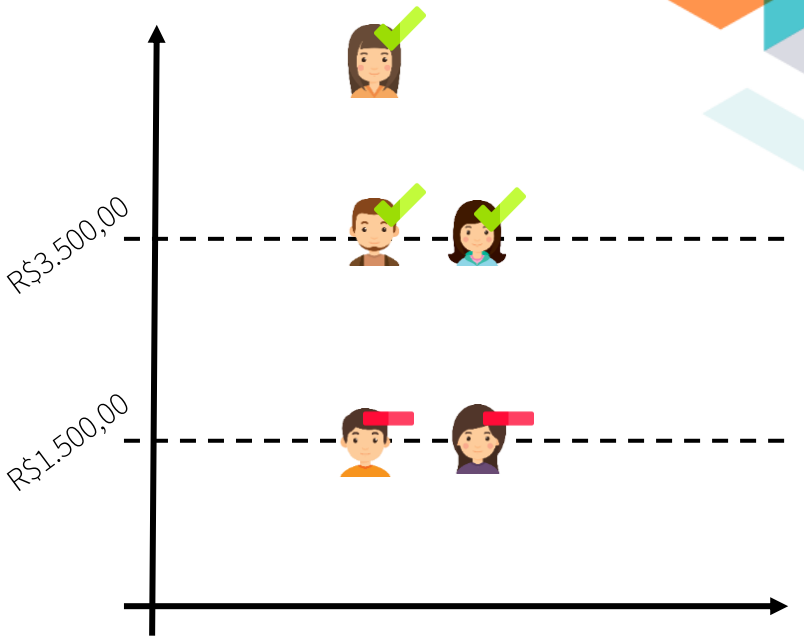
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim ✔
	Luiz	R$1.500,00	Não ▬
	Maria	R$5.000,00	Sim ✔
	Rosa	R$1.500,00	Não ▬
	Ana	R$3.500,00	Sim ✔



✔ É possível classificar.

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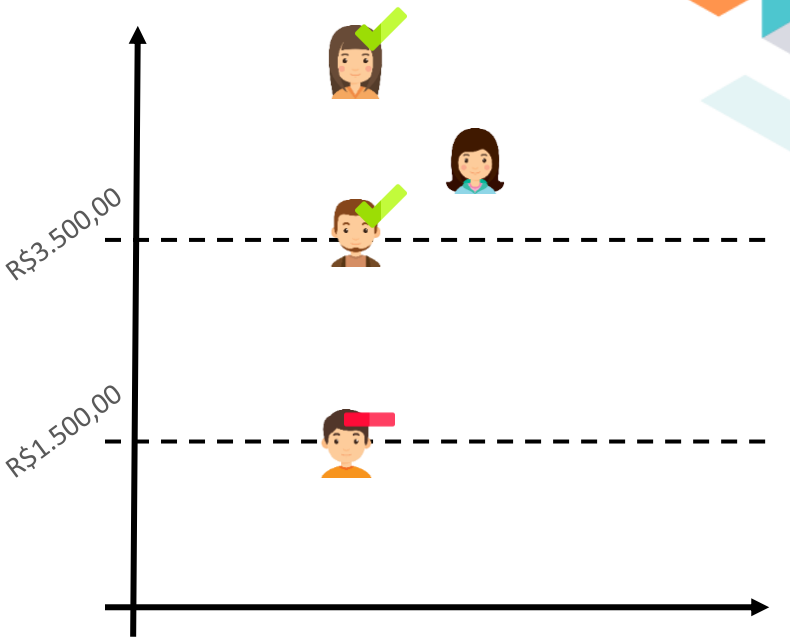
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim
	Luiz	R$1.500,00	Não
	Maria	R$5.000,00	Sim
	Ana	R$3.659,00	???



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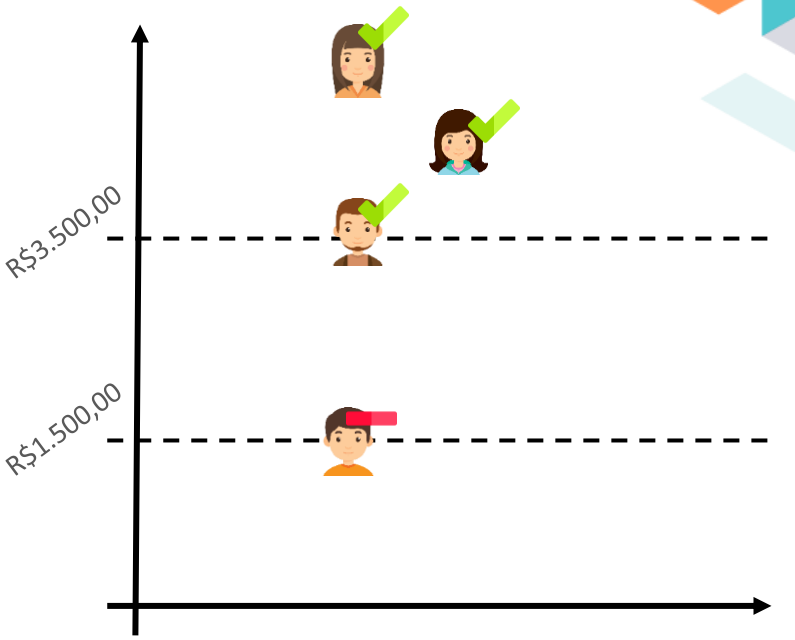
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim ✔
	Luiz	R$1.500,00	Não ▬
	Maria	R$5.000,00	Sim ✔
	Ana	R$3.659,00	Sim ✔



✔ É possível classificar.

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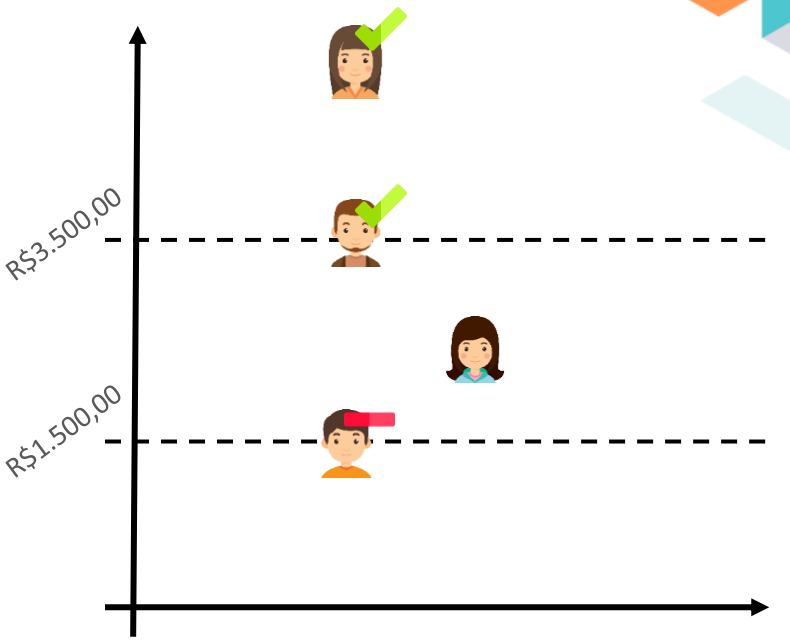
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim
	Luiz	R$1.500,00	Não
	Maria	R$5.000,00	Sim
	Ana	R$2.000,00	???



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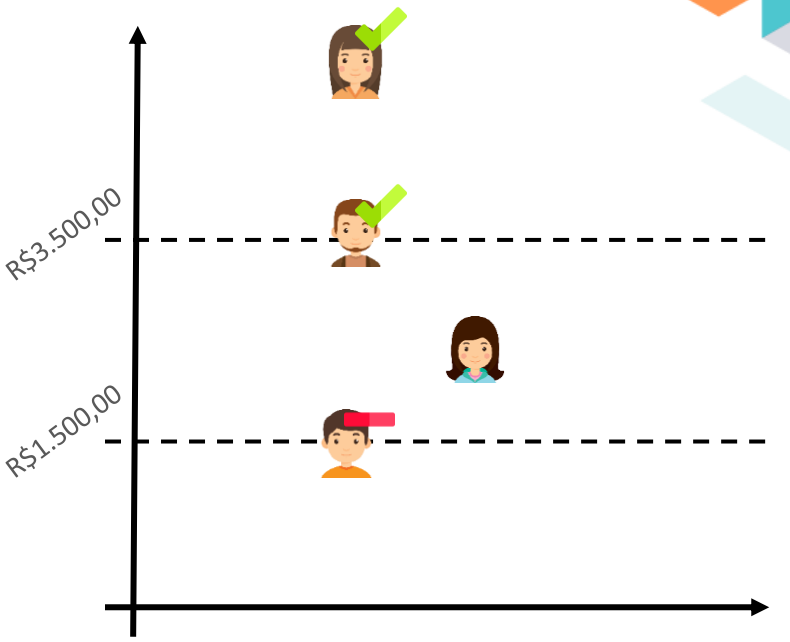
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim
	Luiz	R$1.500,00	Não
	Maria	R$5.000,00	Sim
	Ana	R$2.000,00	???



Não é possível classificar

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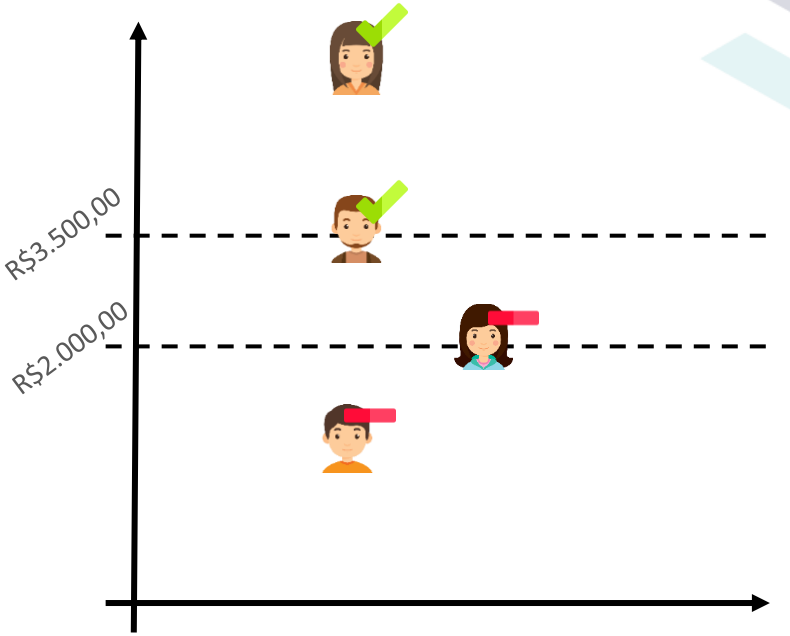
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim ✔
	Luiz	R$1.500,00	Não ▬
	Maria	R$5.000,00	Sim ✔
	Ana	R$2.000,00	Não ▬



Podemos inserir novos exemplos

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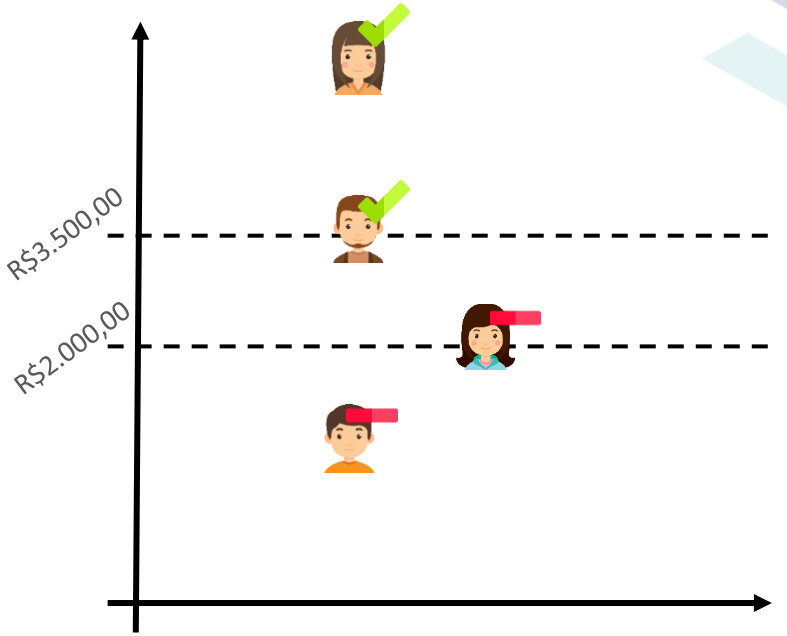
Inteligência Artificial

	Nome	Renda	Investidor?
	João	R$3.500,00	Sim ✔
	Luiz	R$1.500,00	Não ▬
	Maria	R$5.000,00	Sim ✔
	Ana	R$2.000,00	Não ▬
	José	R$1.735,00	???



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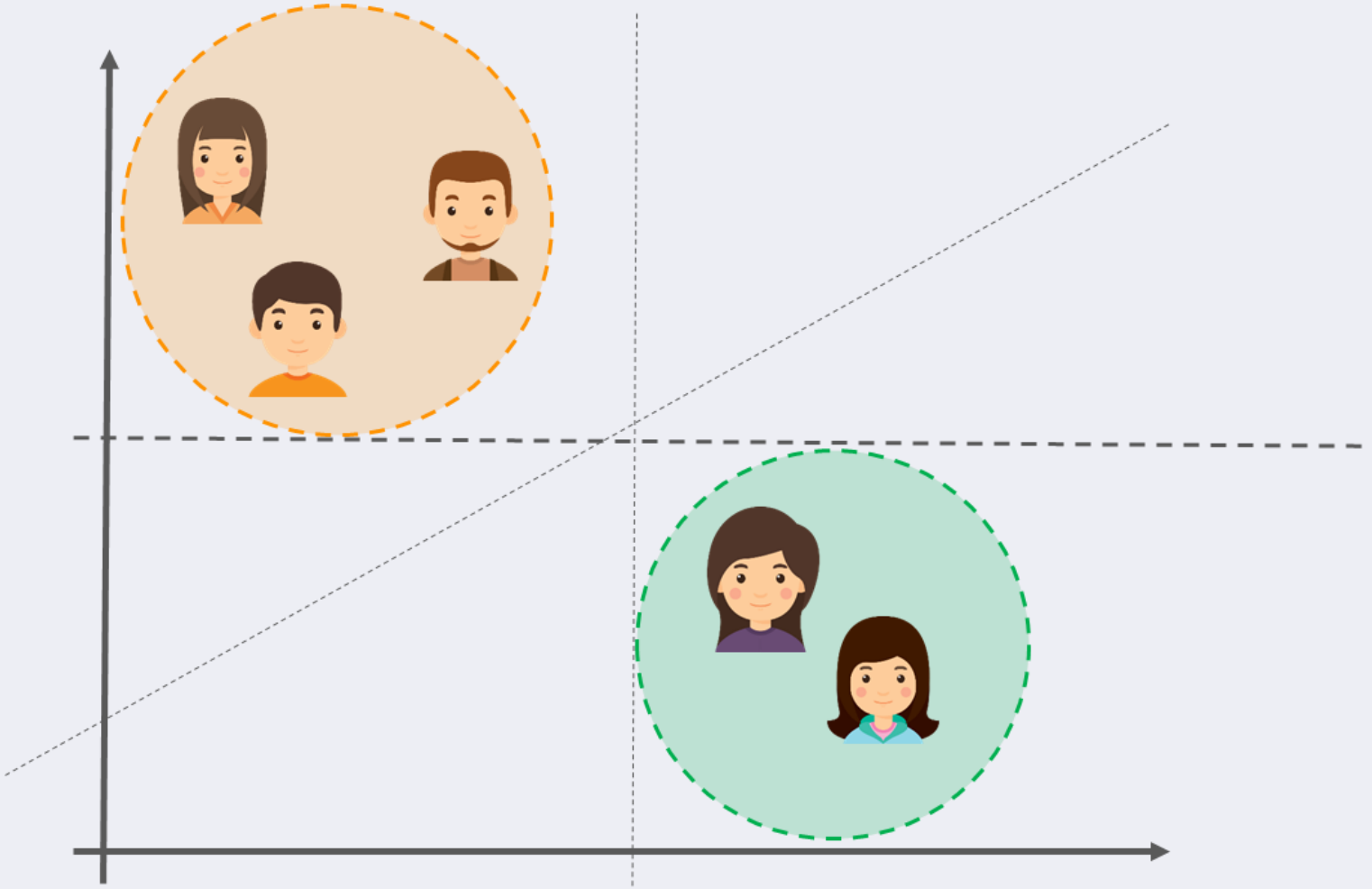

Afinal, como funciona a Inteligência Artificial?

	Nome	Renda	Patrimônio	Residência	Já teve investimento	Cliente a quanto tempo	Escolaridade		Investidor?
	João	R$4.500,00	R$ 1 M	Vl. Mariana	Sim	2 anos	Médio	...	Não
	Luiz	R$2.500,00	R$ 250 Mil	Jabaquara	Não	5 anos	Superior	...	Não
	Maria	R$6.000,00	R$ 1.5 M	Morumbi	Não	6 anos	Médio	...	Sim
	Ana	R$7.000,00	R$ 800 Mil	Jardins	Sim	3 anos	Superior	...	Sim
	José	R$5.000,00	R$ 1.2 M	Conceição	Não	2 anos	Superior	...	???

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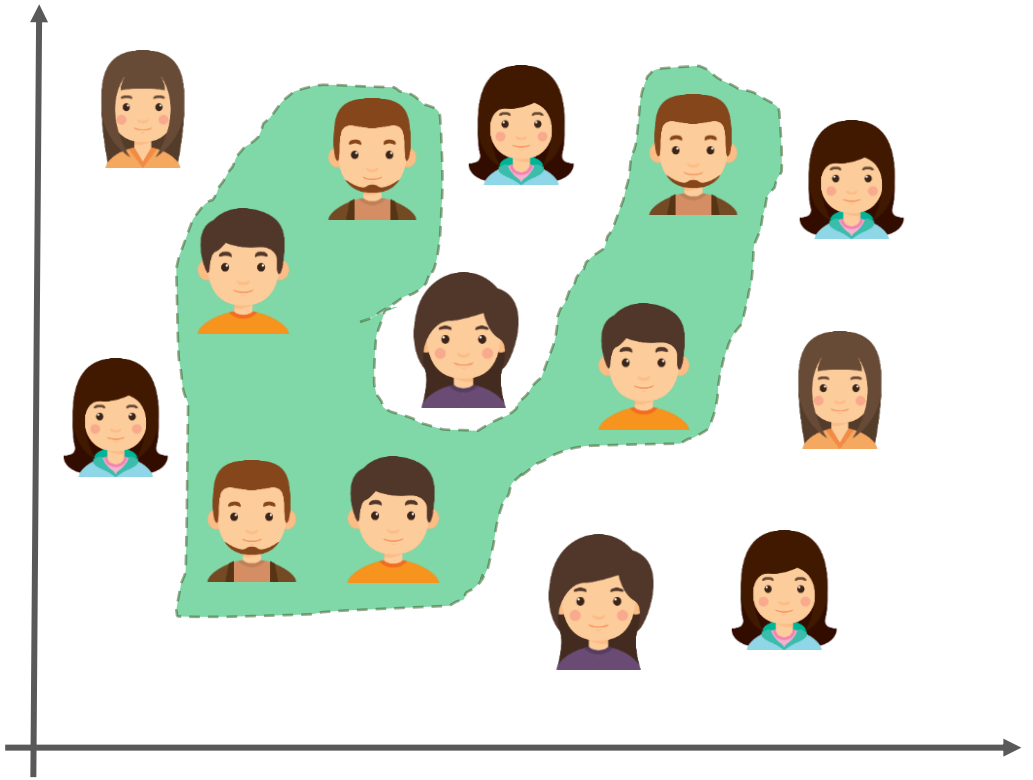
Afinal, como funciona a Inteligência Artificial?

Mas os problemas do mundo real são mais complexos...



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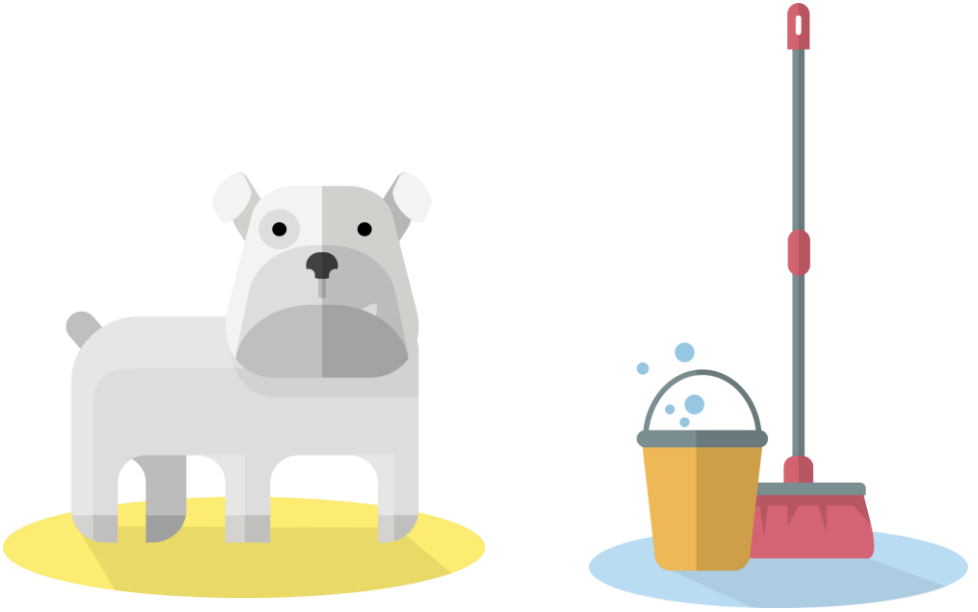
What about a dog and a mop? Easy, right?



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Not so fast...





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Not so fast...

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CC-BY-2.0 Wikimedia Commons https://commons.wikimedia.org/wiki/File:2014_Westminster_Kennel_Club_Dog_Show_(12487315865).jpg

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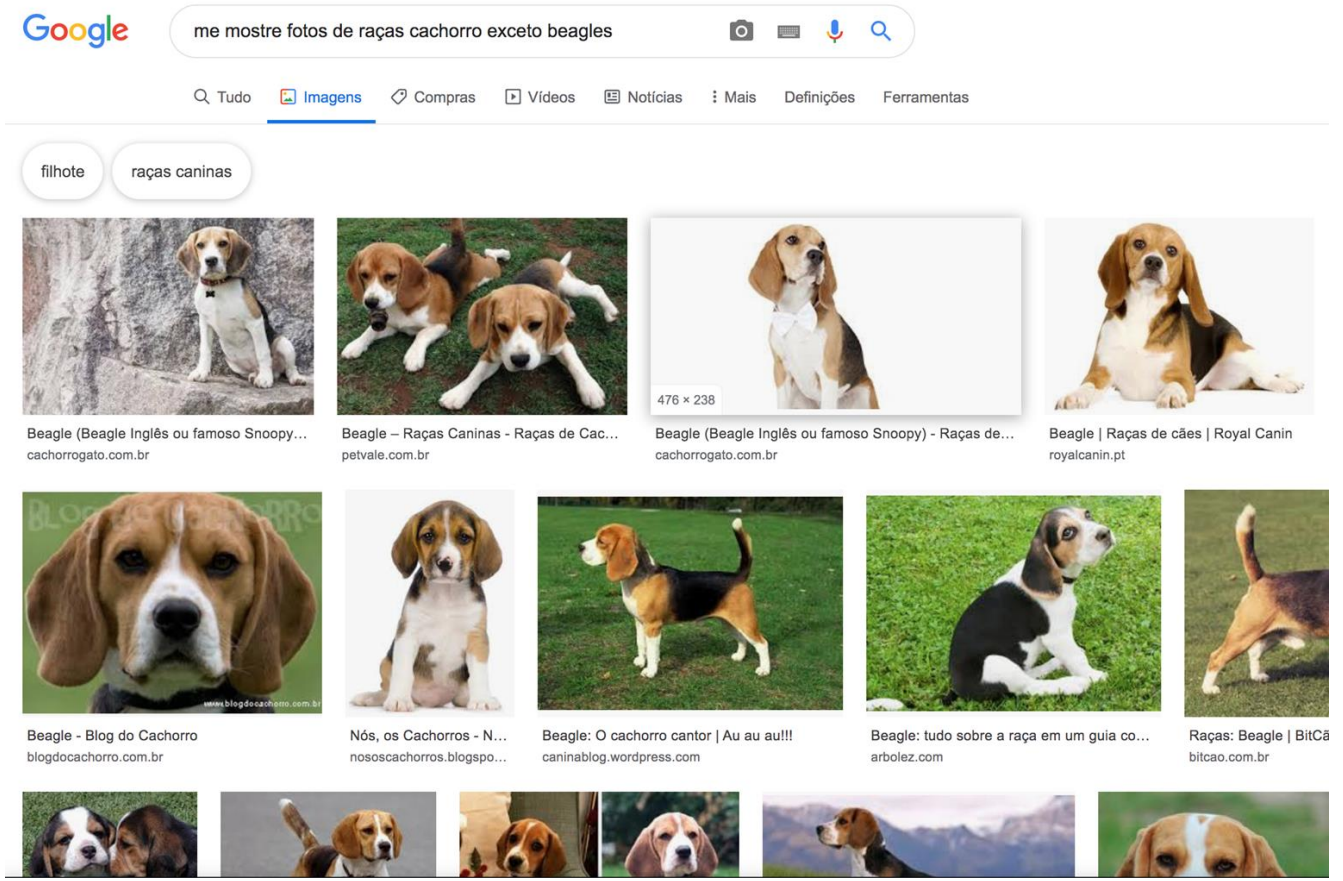
Entender não é tão simples



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Introdução à Machine Learning

		Peso	Altura
	Pessoa 1	80 kg	163
	Pessoa 2	85 kg	168
	Pessoa 3	90 kg	175
	Pessoa 4	95 kg	188

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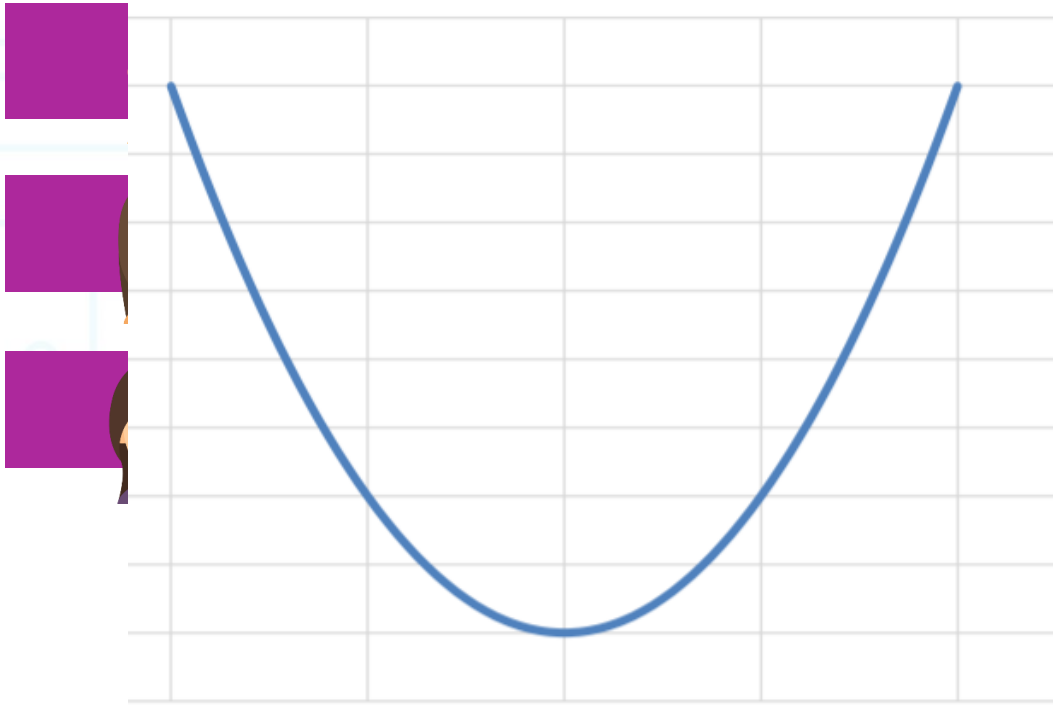

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$$\hat{y} = 258{,}5$$

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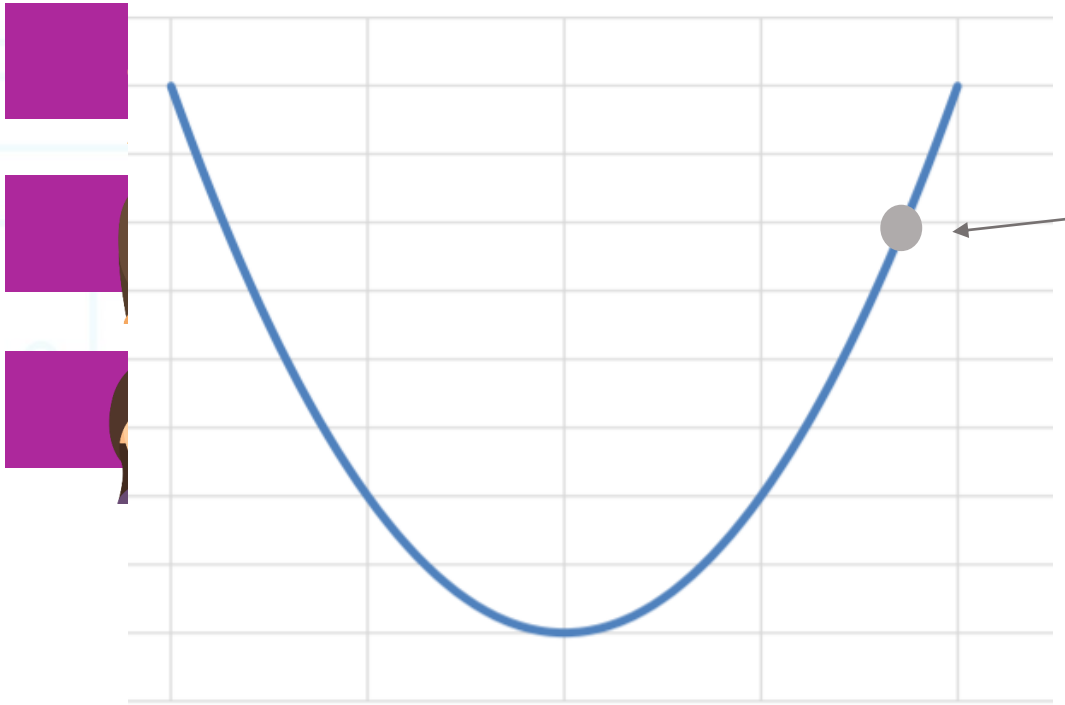

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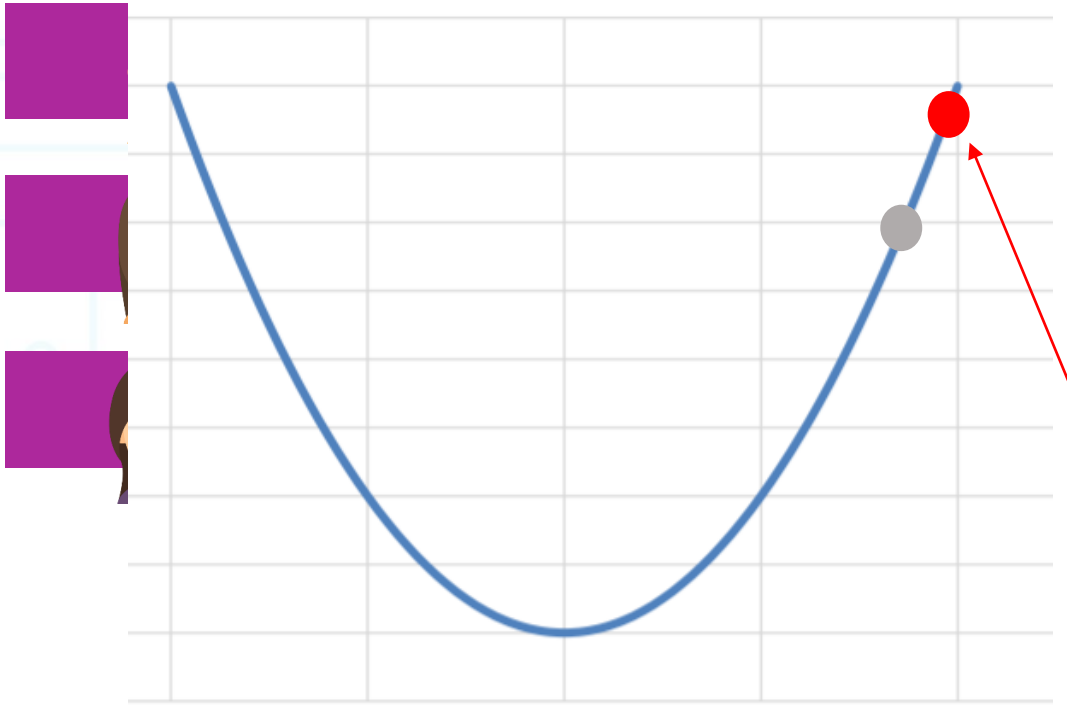

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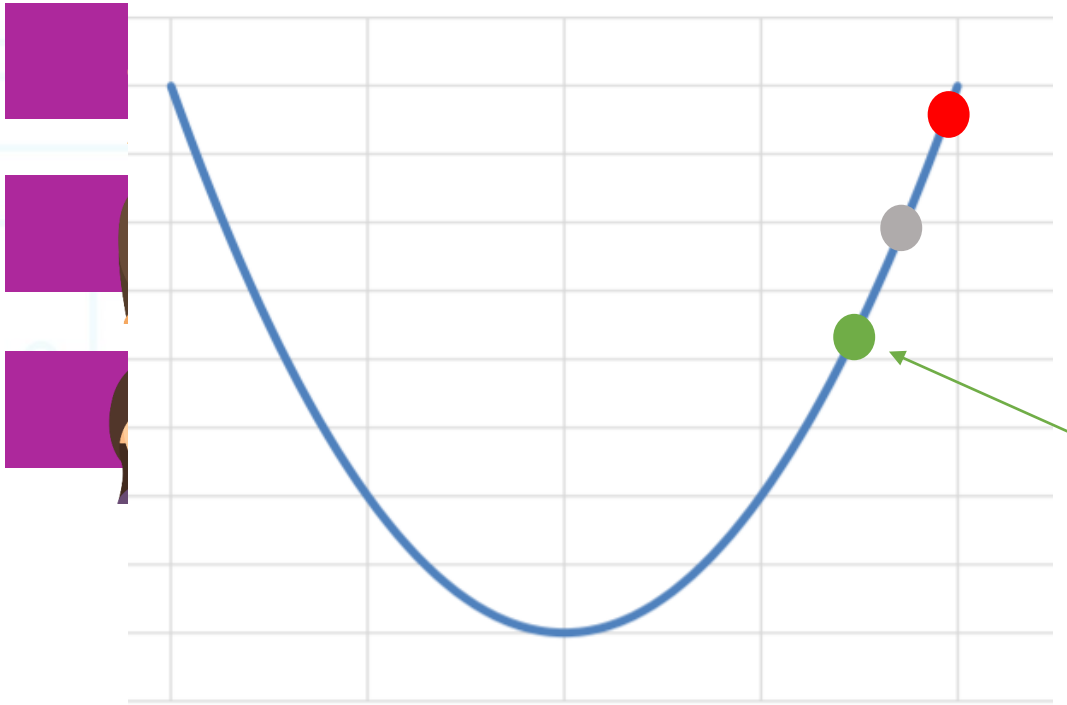

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$$\hat{y} = 258{,}5$$

$$\hat{y} = 10 + 1{,}1\ x\ 168$$

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$$MSE = (90 - 147)^2$$

MSE = 3.249

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MSE = 3.249

$$\hat{y} = 3 + 0{,}5\ x\ 188$$

$$\text{MSE} = (95 - 97)^2$$

$$\hat{y} = 97$$

MSE = 4

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$$\text{MSE} = (95 - 97)^2$$

$$\hat{y} = 97$$

MSE = 4

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Introdução à Machine Learning

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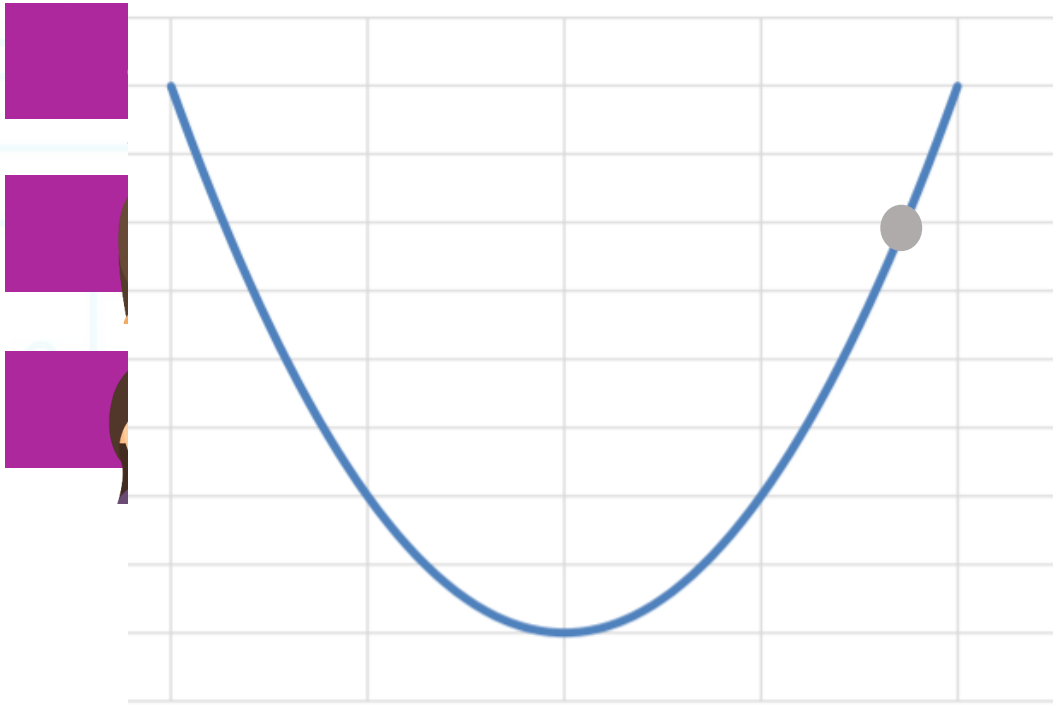

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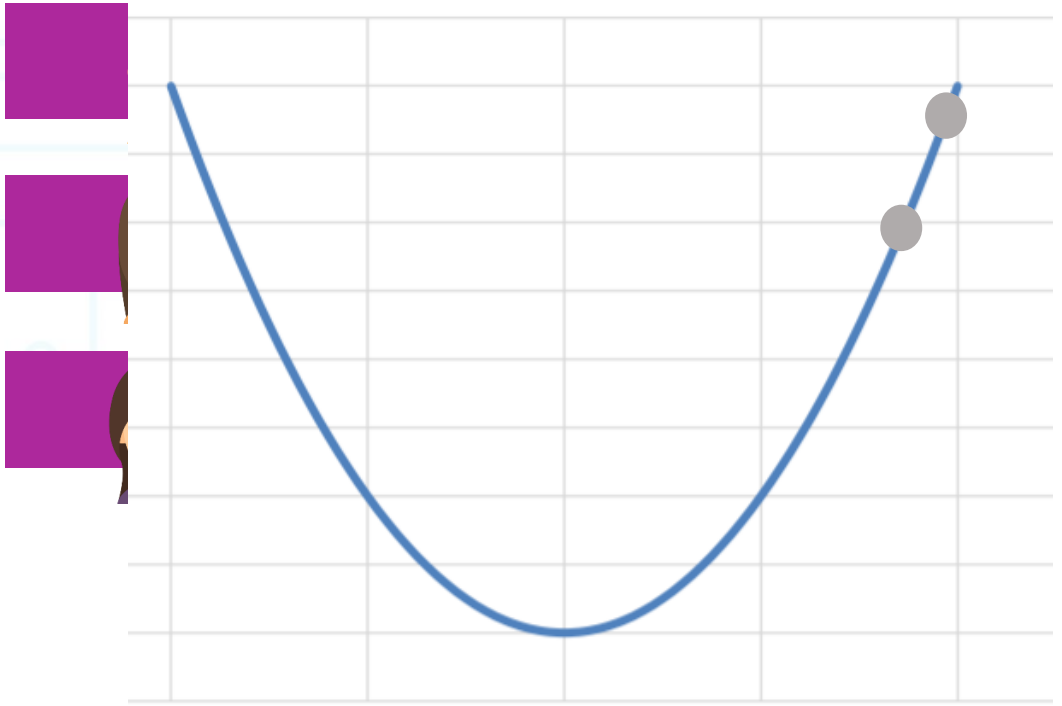

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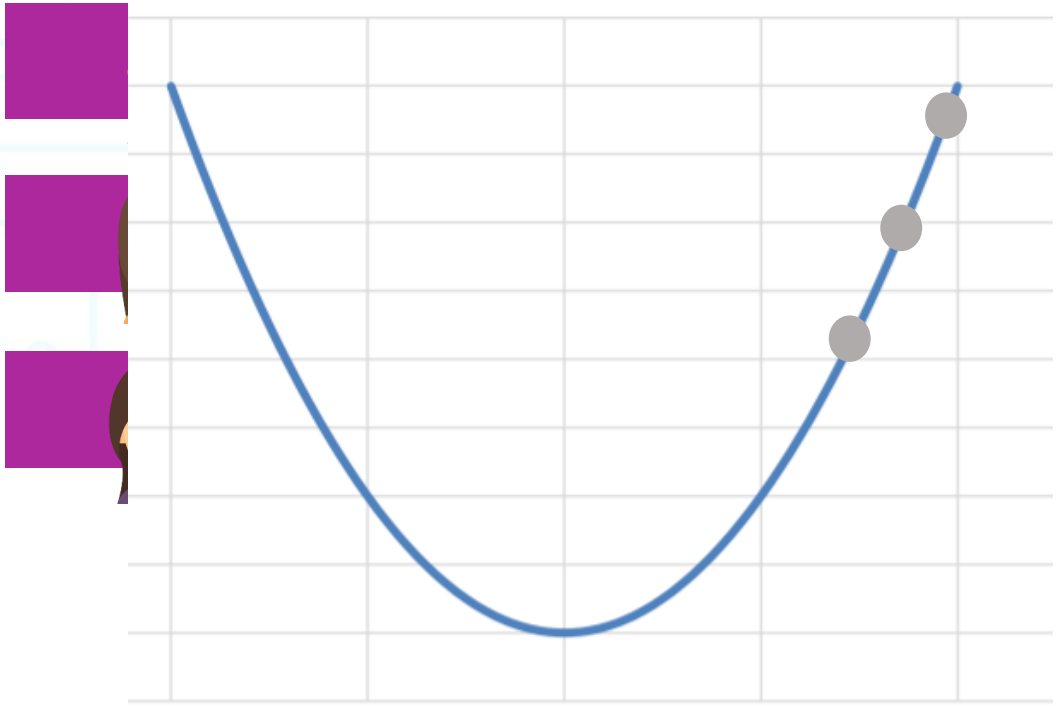

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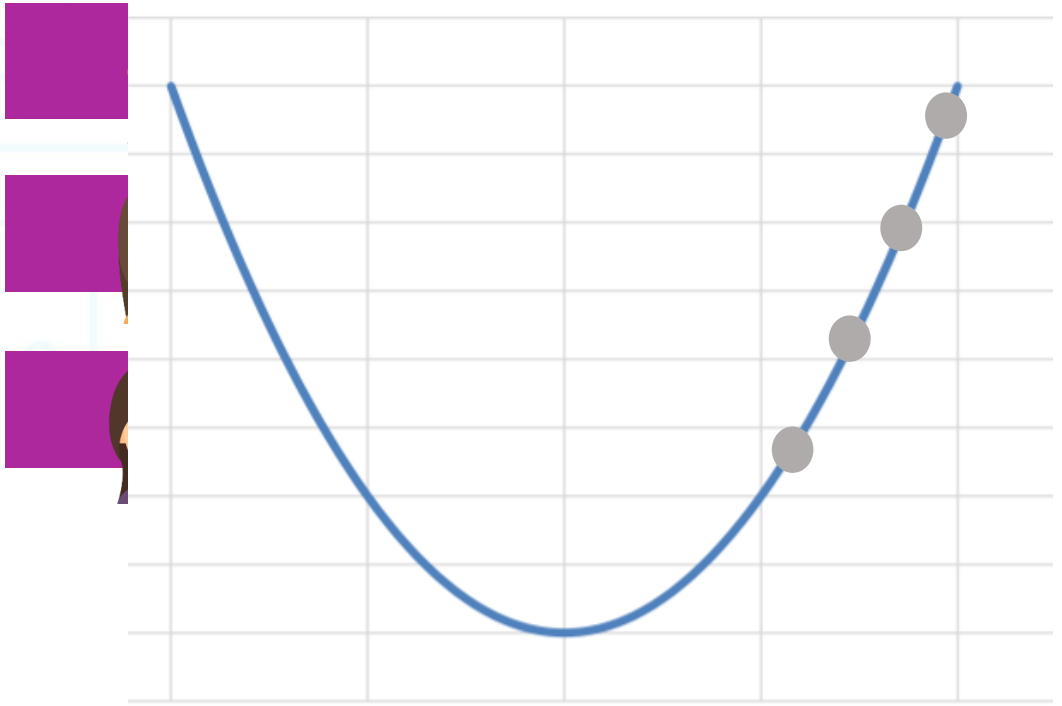

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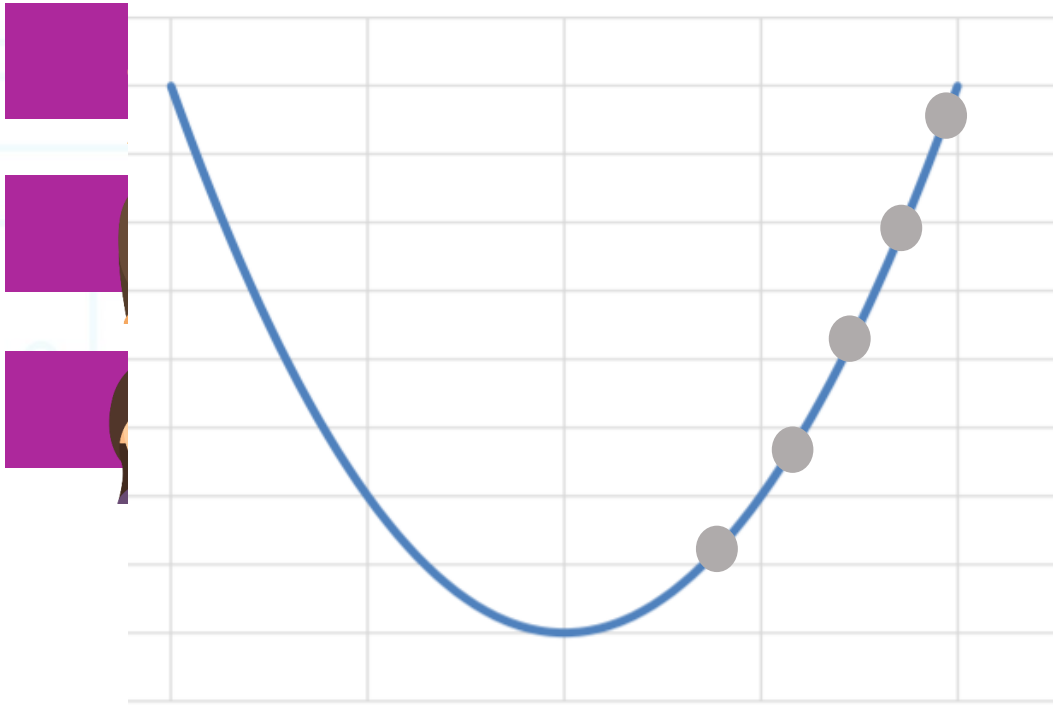

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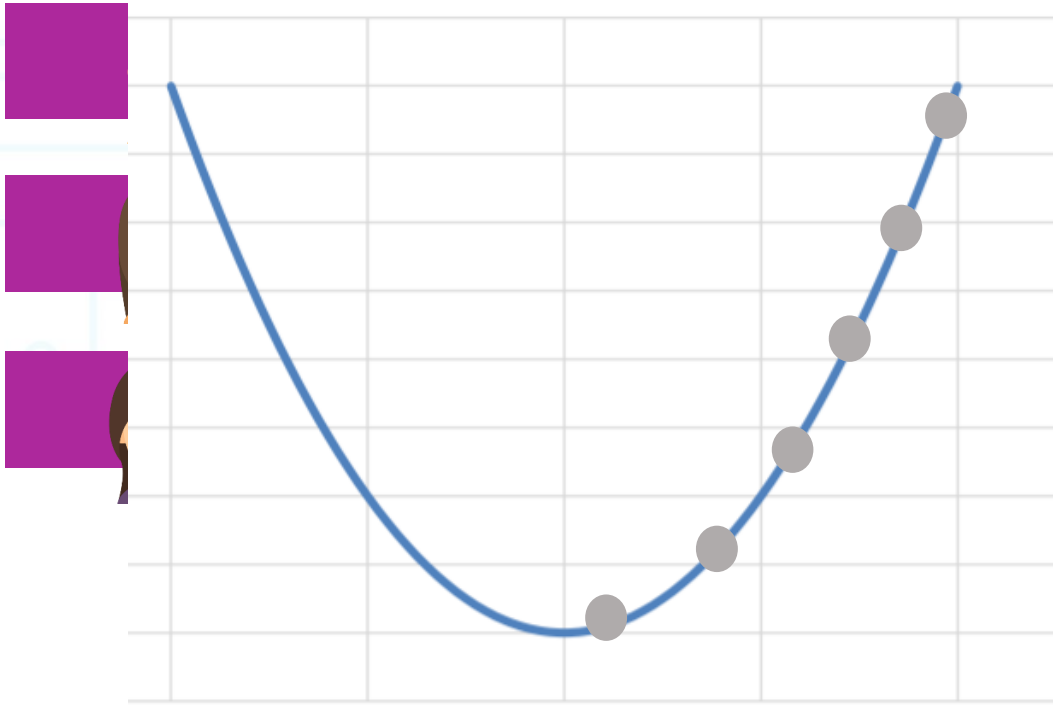

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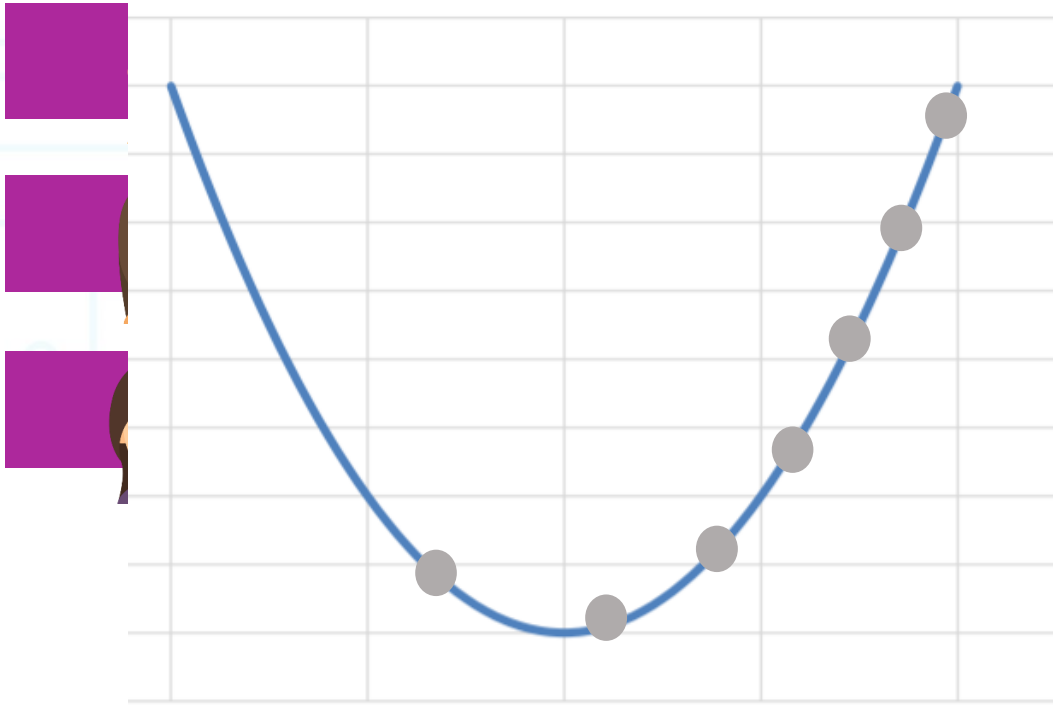

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$$\hat{y} = 97$$

$$\text{MSE} = 4$$

$$\hat{y} = 84{,}5$$

$$\text{MSE} = 20{,}25$$

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MSE = 4

$$\hat{y} = 84{,}5$$

MSE = 20,25

$$\hat{y} = 87$$

MSE = 4

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$$\hat{y} = 90{,}5$$ MSE = 0,25

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MSE = 7,125

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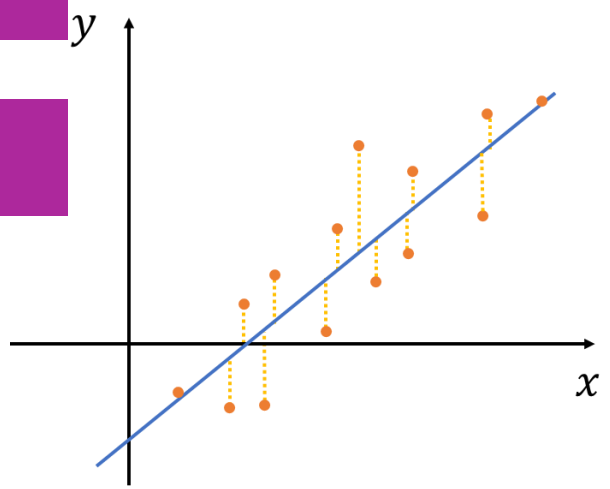

$$\hat{y} = 84{,}5 \quad \text{MSE} = 20{,}25$$

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MSE = 7,125

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$\beta_0 = 3$

$\beta_1 = 0{,}5$

MSE = 7,125

$$\hat{y} = 3 + 0{,}5\, X_1$$

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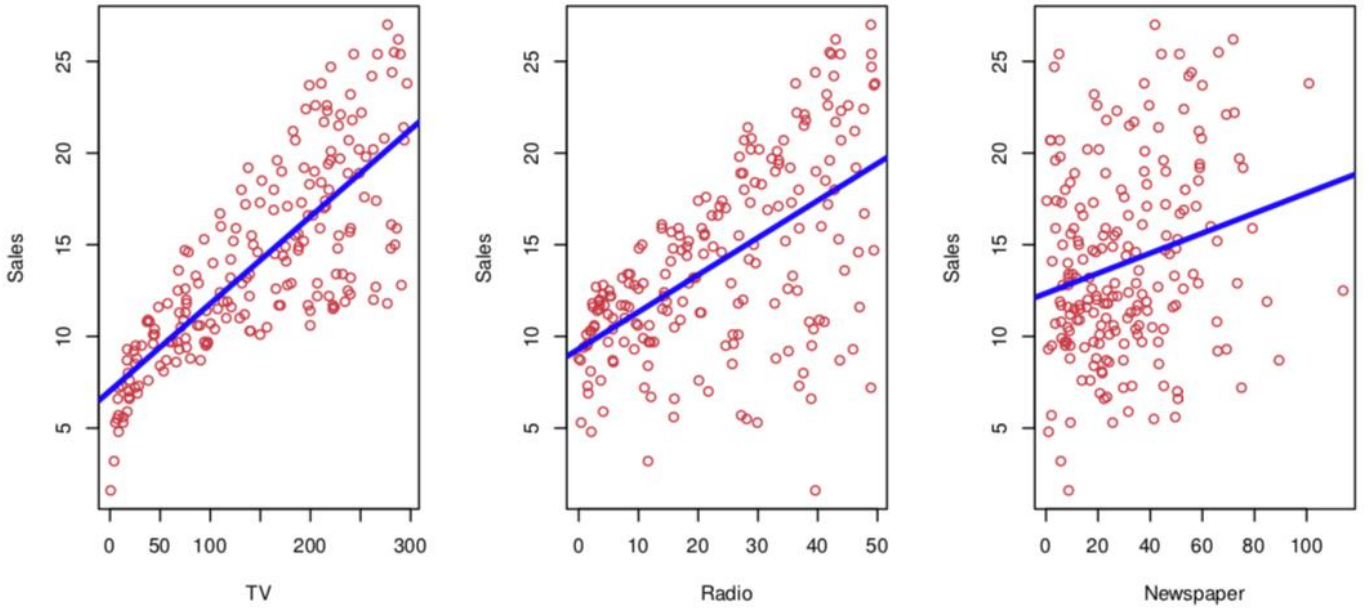
Regressão Linear

- Há alguma relação entre aumento de vendas e propaganda?
- Qual mídia contribui mais para as vendas?



Regressão Linear

- Abordagem supervisionada simples
- Assume uma dependência linear entre a variável resposta Y e os valores $X_1, X_2, \ldots, X_p$
- Assume-se o modelo:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p$$

Sendo β_0, β_1, ..., β_p coeficientes aprendidos pelo modelo

Regressão Linear

- Para o exemplo do slide 5, foi obtida a seguinte equação do hiperplano:

$$Vendas = 2{,}939 + 0{,}046 \times TV + 0{,}189 \times radio + 0.01 \times Jornal$$

Regressão Linear

- Para o exemplo do slide 5, foi obtida a seguinte equação do hiperplano:

$$Vendas = 2{,}939 + 0{,}046 \times TV + 0{,}189 \times radio + 0.01 \times Jornal$$

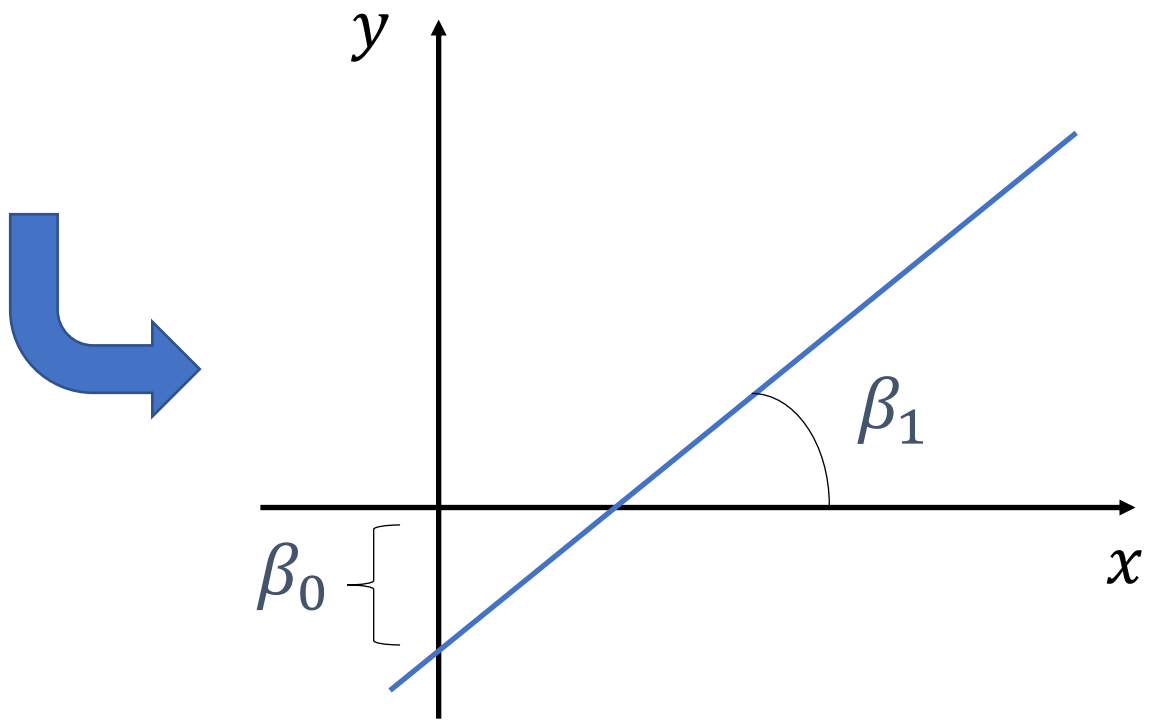
- caso nenhuma ação de propaganda seja feita as vendas serão de 2,939
- Mantendo todos os outros valores constantes, a cada uma unidade aumentada nas ações por TV, as vendas aumentam 0,046
- A influência da utilização de jornal é quase nula

Regressão Linear

Reta

$$y = \beta_0 + \beta_1 x$$

- β_0: deslocamento
- β_1: inclinação

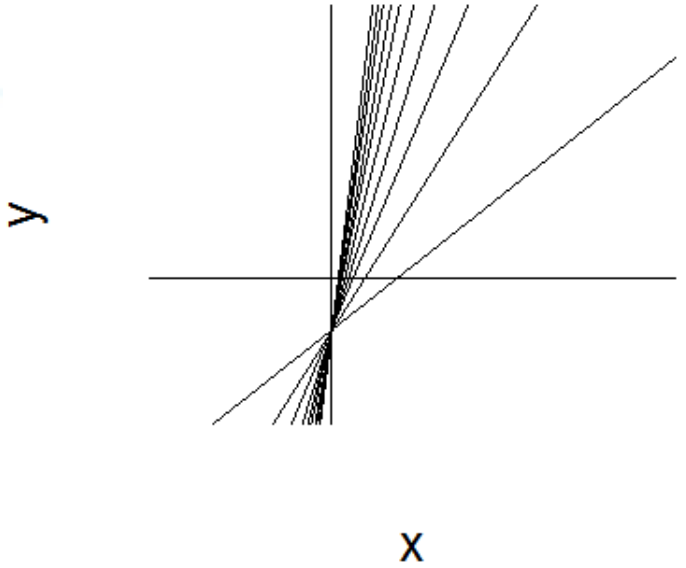


Regressão Linear

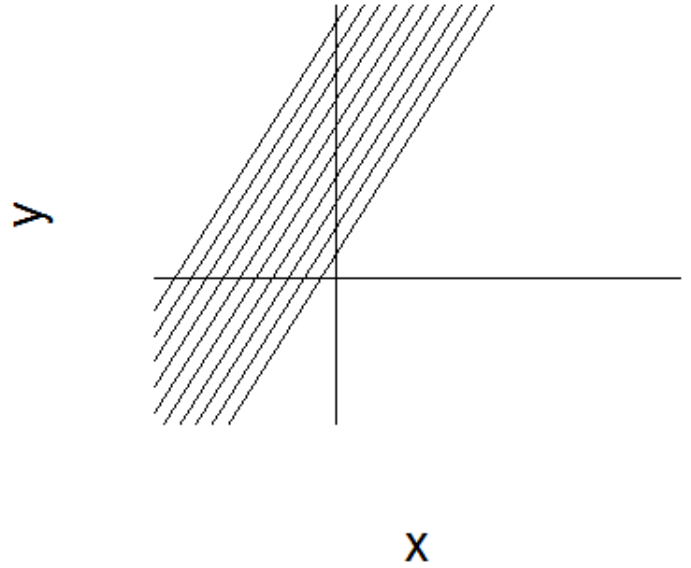
Reta

$$y = \beta_0 + \beta_1 x$$

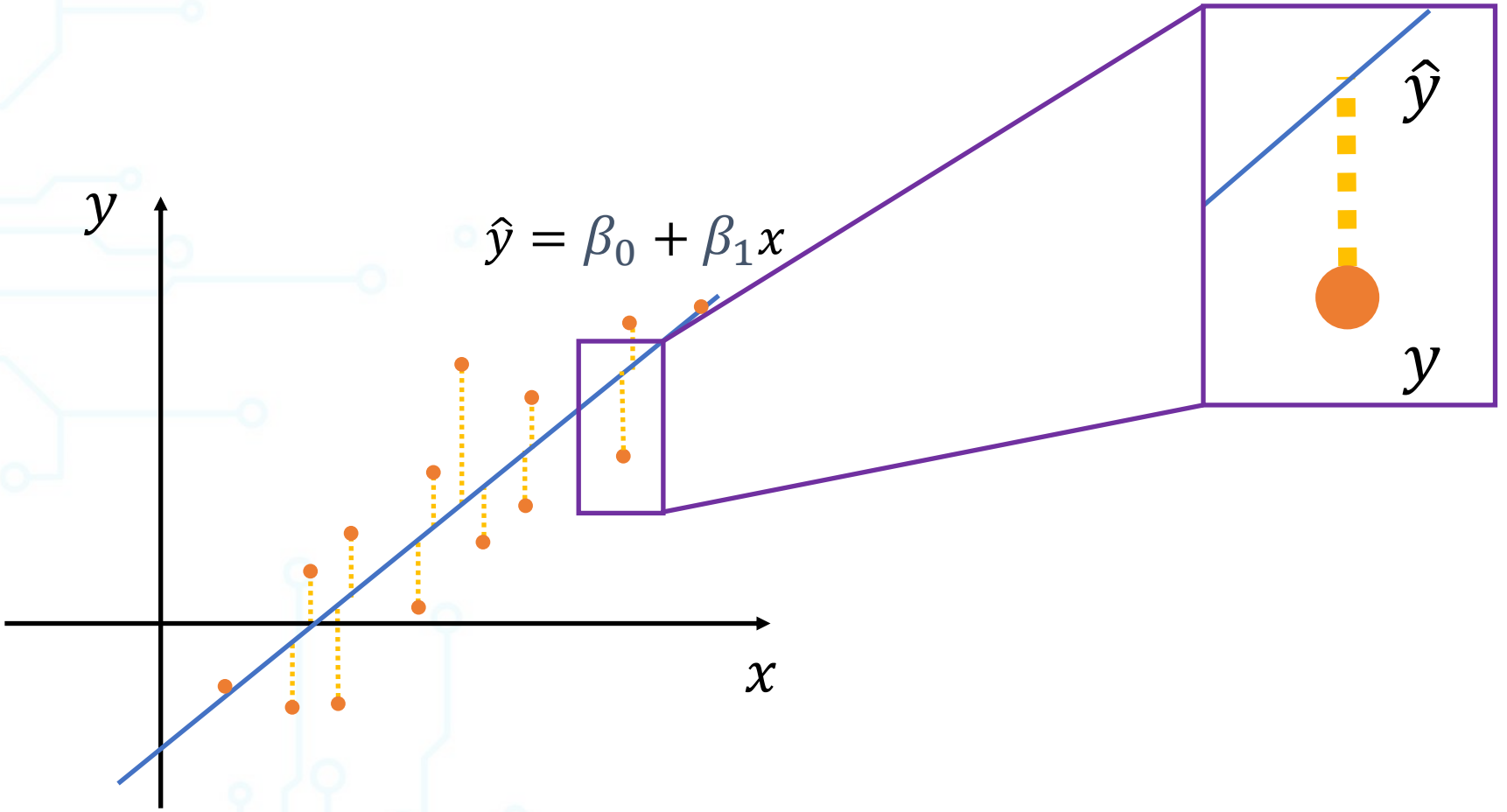
β_0 fixo; β_1 variável



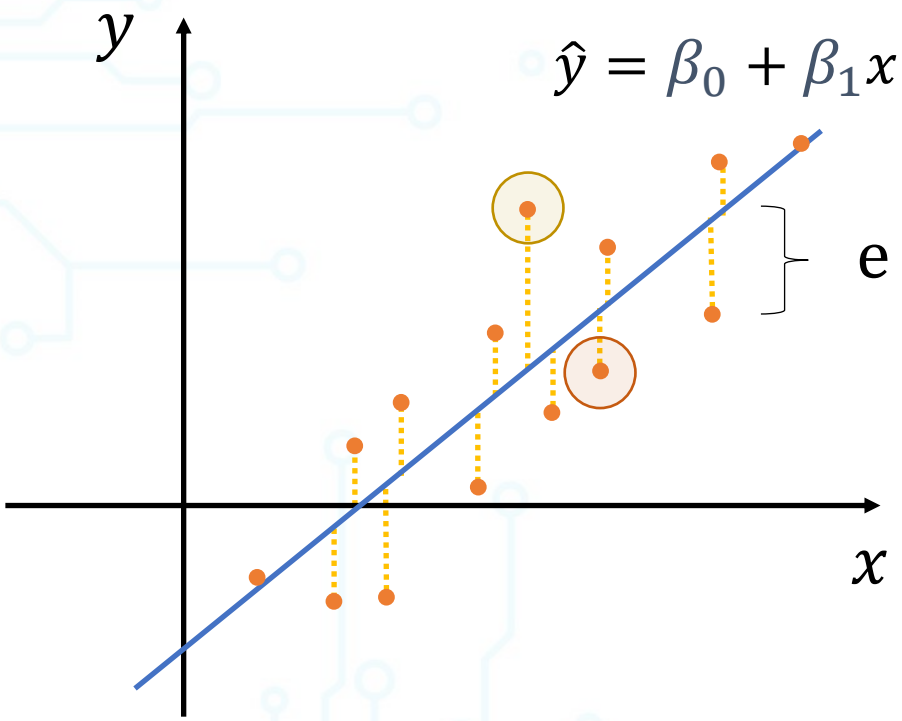
β_0 variável; β_1 fixo



Regressão Linear



Regressão Linear



$$e = y - \hat{y}$$

$$e = y - (\beta_0 + \beta_1 x)$$

Positivo

$y - \hat{y} > 0$

Negativo

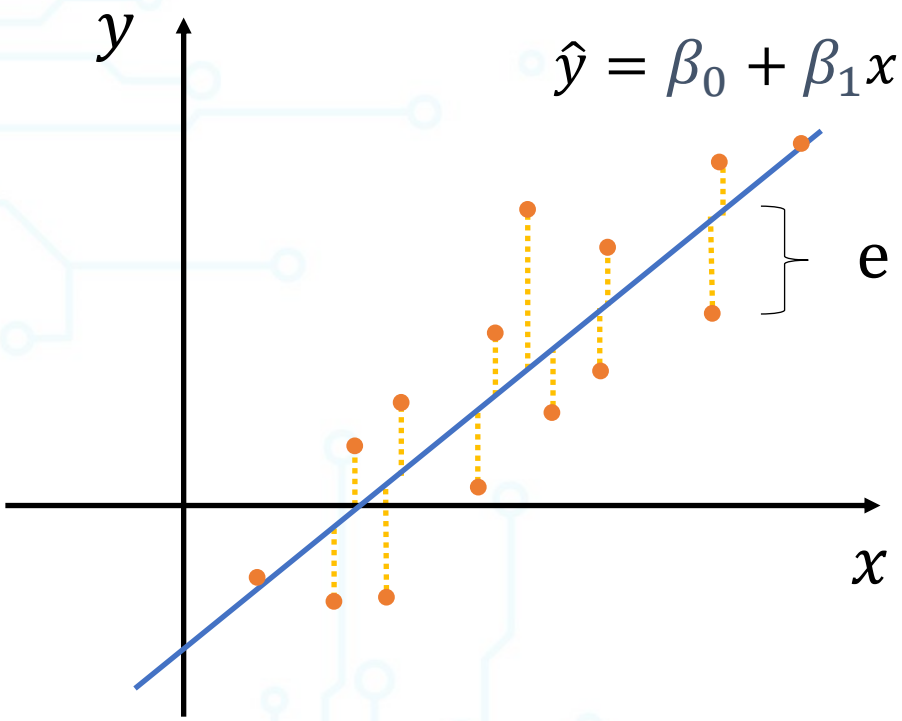
$y - \hat{y} < 0$

Solução?

$(y - \hat{y})^2$

$|y - \hat{y}|$

Regressão Linear



Como avaliar o erro total?

Erro quadrático médio (MSE)

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}$$

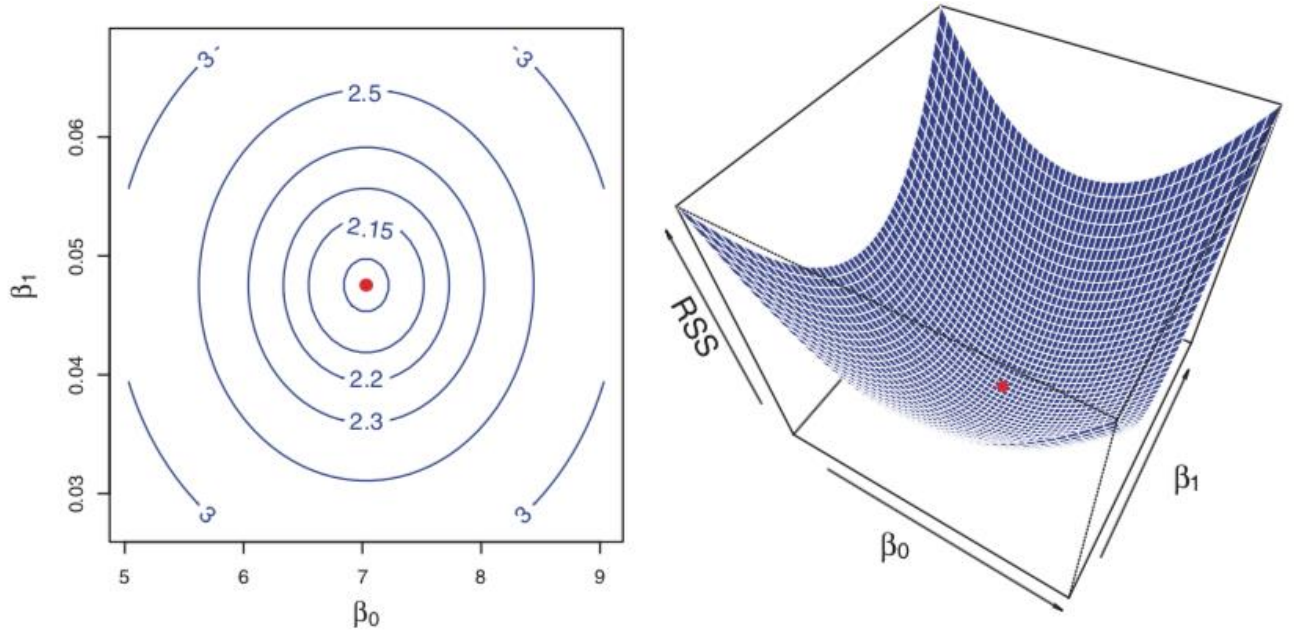
R

Erro absoluto médio (MAE)

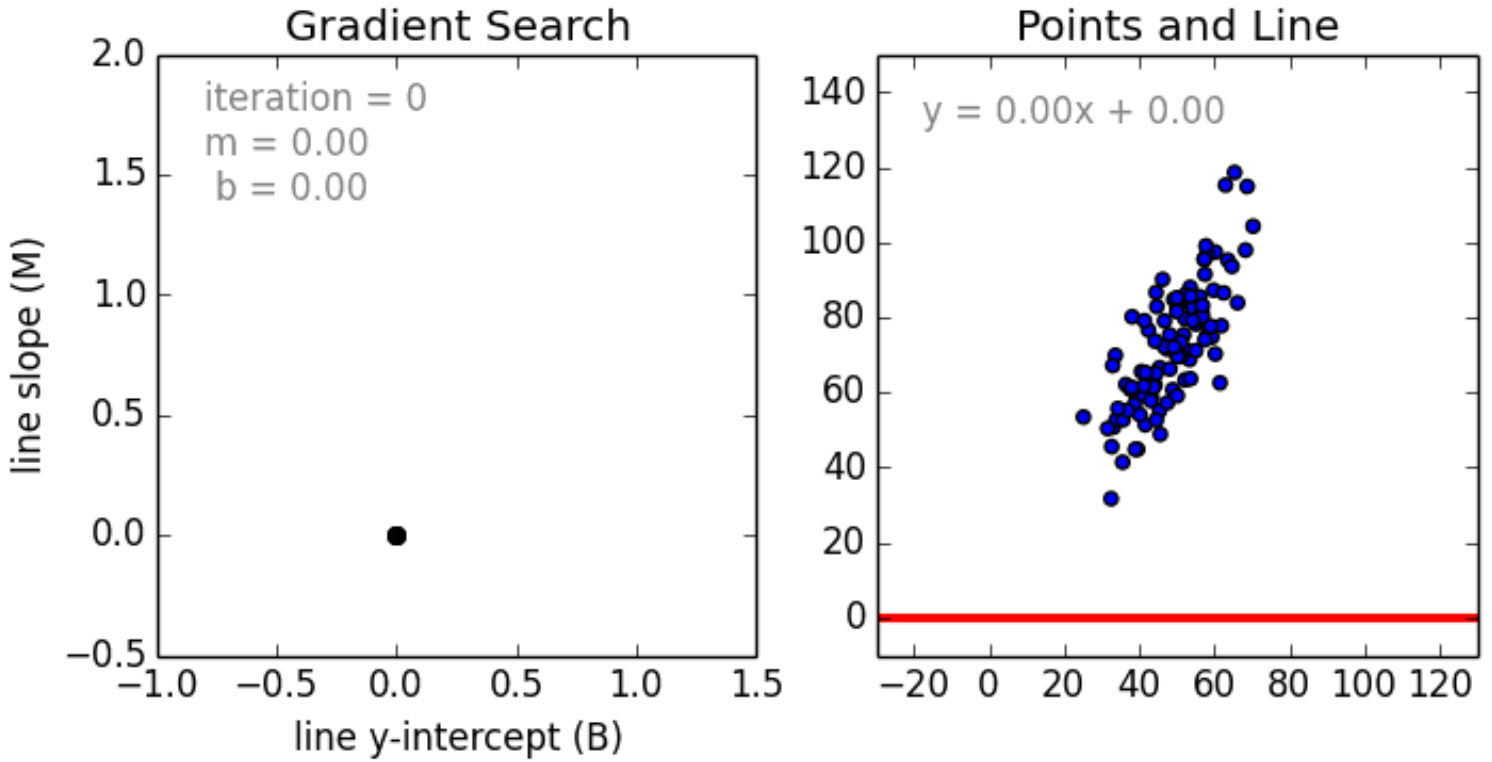
$$\frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i|$$

Regressão Linear

- Como a função RMSE é convexa, é possível encontrar o valor mínimo por meio de algoritmos de otimização



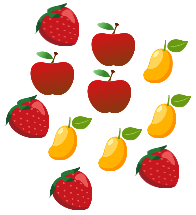
Regressão Linear



Types of machine learning algorithms | Supervised learning

Training

Labeled inputs | **Training** | **Trained model as output**



+

Labels

Apple

Mango

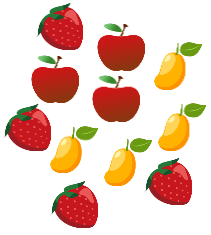
Strawberry

Supervised machine learning algorithm

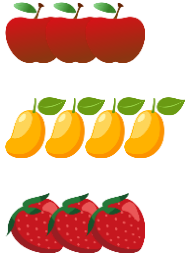
f(x)
A trained ML model that maps inputs to outputs

Prediction

Inputs | **Processing** | **Prediction**



f(x) trained model



Labels

Apple

Mango

Strawberry

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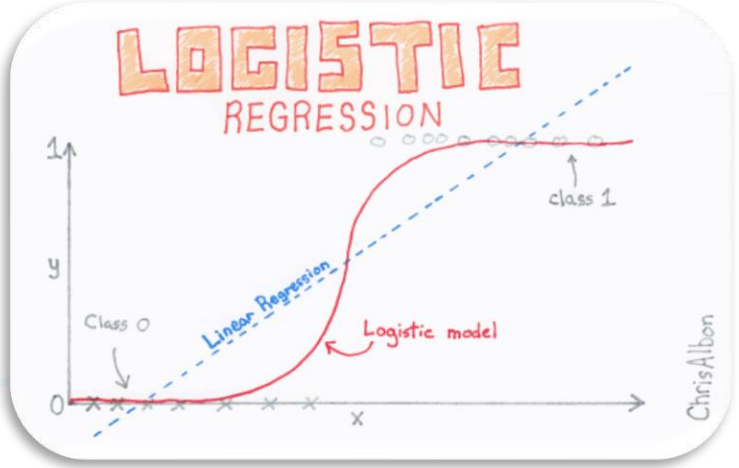
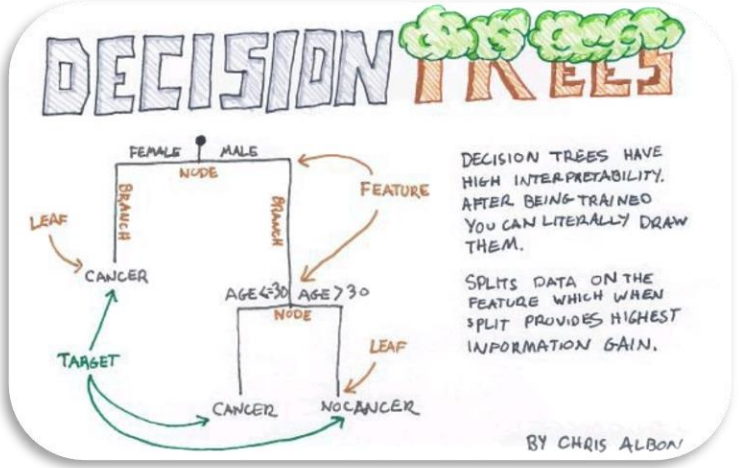
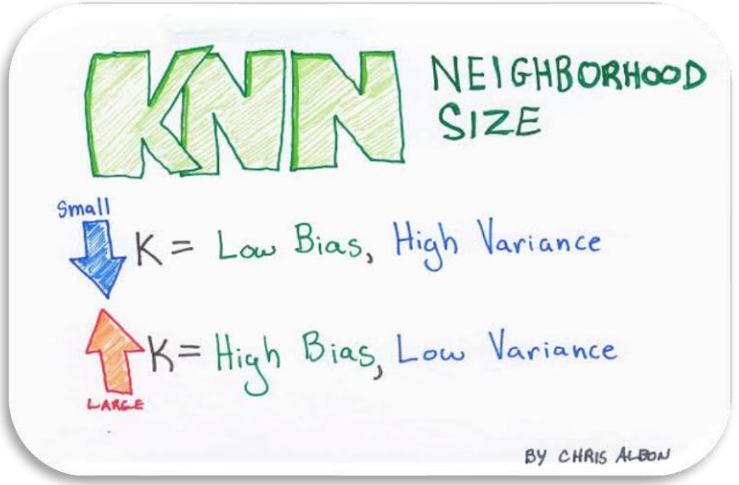
Classificação



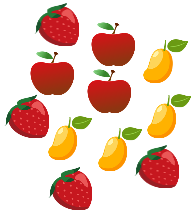




Types of machine learning algorithms | Unsupervised learning

Training

Labeled inputs

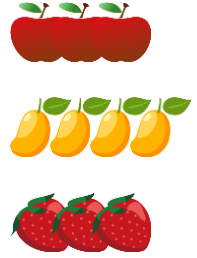


Training

Unsupervised machine learning algorithm

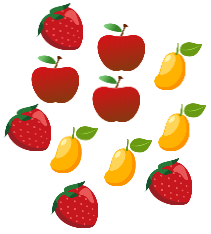
Trained model as output

f(x)
Model: Learns clusters or patterns in data to detect anomalies



Prediction

Inputs

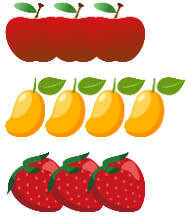


Processing

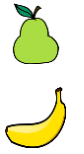
f(x) trained model

Prediction

Known clusters



Anomalies



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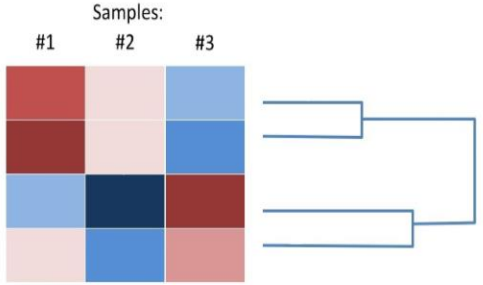
Agrupamento

Hierarchical Clustering, Clearly Explained!!!!



AGGLOMERATIVE CLUSTERING

All observations start as their own cluster. Clusters meeting some criteria are merged. This process is repeated, growing clusters until some end point is reached.

ChrisAlbon

K-MEANS CLUSTERING

1. k centerpoints are randomly initialized.
2. Observations are assigned to the closest centerpoint.
3. Centerpoints are moved to the center of their members.
4. Repeat steps 2 and 3 until no observation changes membership in step 2.

Chris Albon

DBSCAN

DBSCAN looks for densely packed observations and makes no assumptions about the number or shape of clusters.

1. A random observation, x_i, is selected
2. If x_i has a minimum of close neighbors, we consider it part of a cluster.
3. Step 2 is repeated recursively for all of x_i's neighbors, then neighbors' neighbors etc... These are the cluster's core members.
4. Once Step 3 runs out of observations, a new random point is chosen

Afterwards, observations not part of a core are assigned to a nearby cluster or marked as outliers.

ChrisAlbon

Types of machine learning algorithms | Reinforcement learning

Training

Agent interacting with environment

Intelligent Policy

π(x)
Intelligent policy that understands environment

Policy in action

Trained agent / policy intelligently interacting with the environment

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Thanks !

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