Projeto de Data Science

Resolvendo problemas de dados reais do começo ao fim

TÉO ME WHY

07 a 28 de Abril de 2022

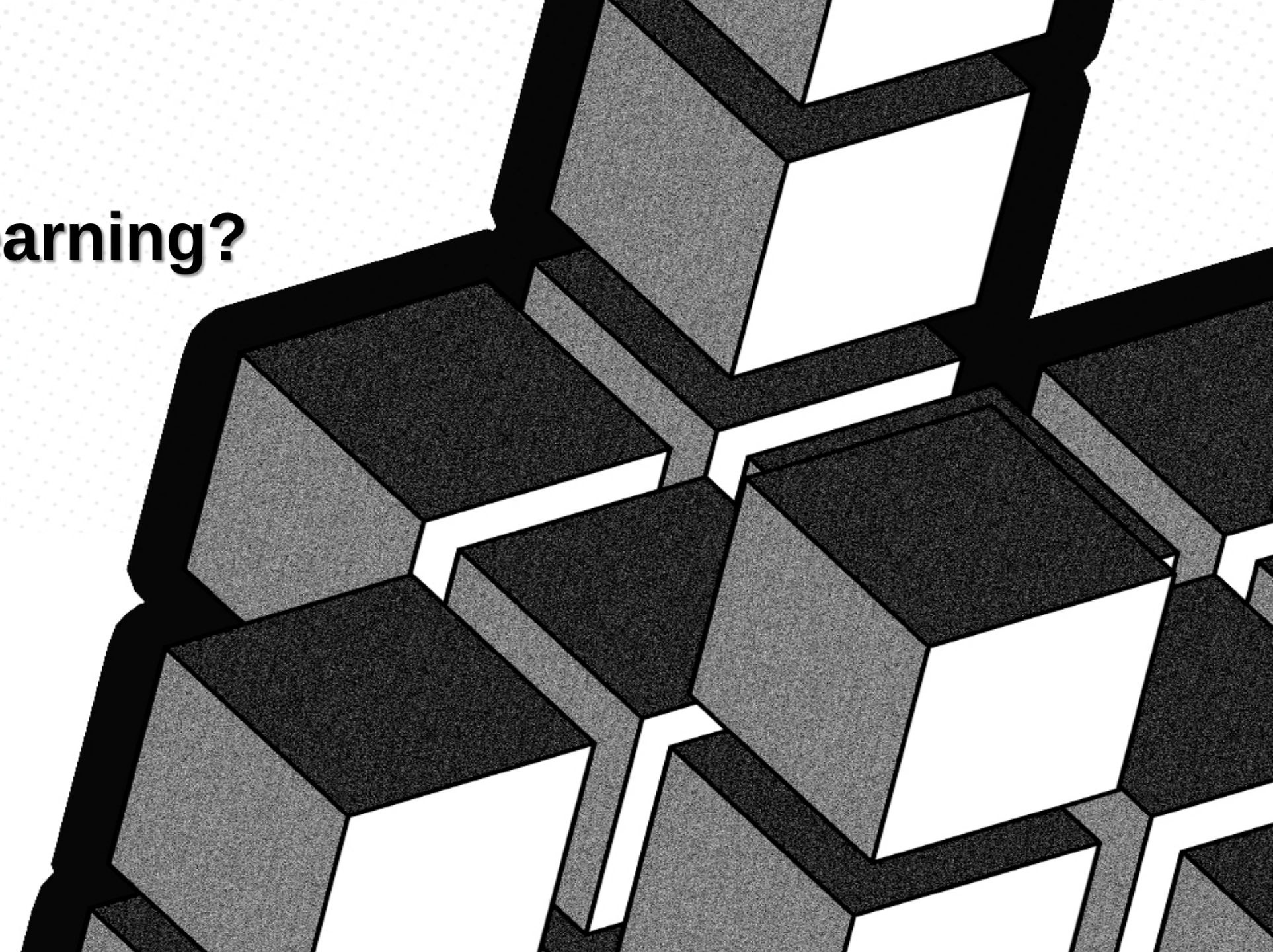
Agenda

- O que é Machine Learning
- Tipos de Aprendizado
- Pré processamento
- Metricas de Ajuste

Um pouco da minha história

O que é

Machine Learning?



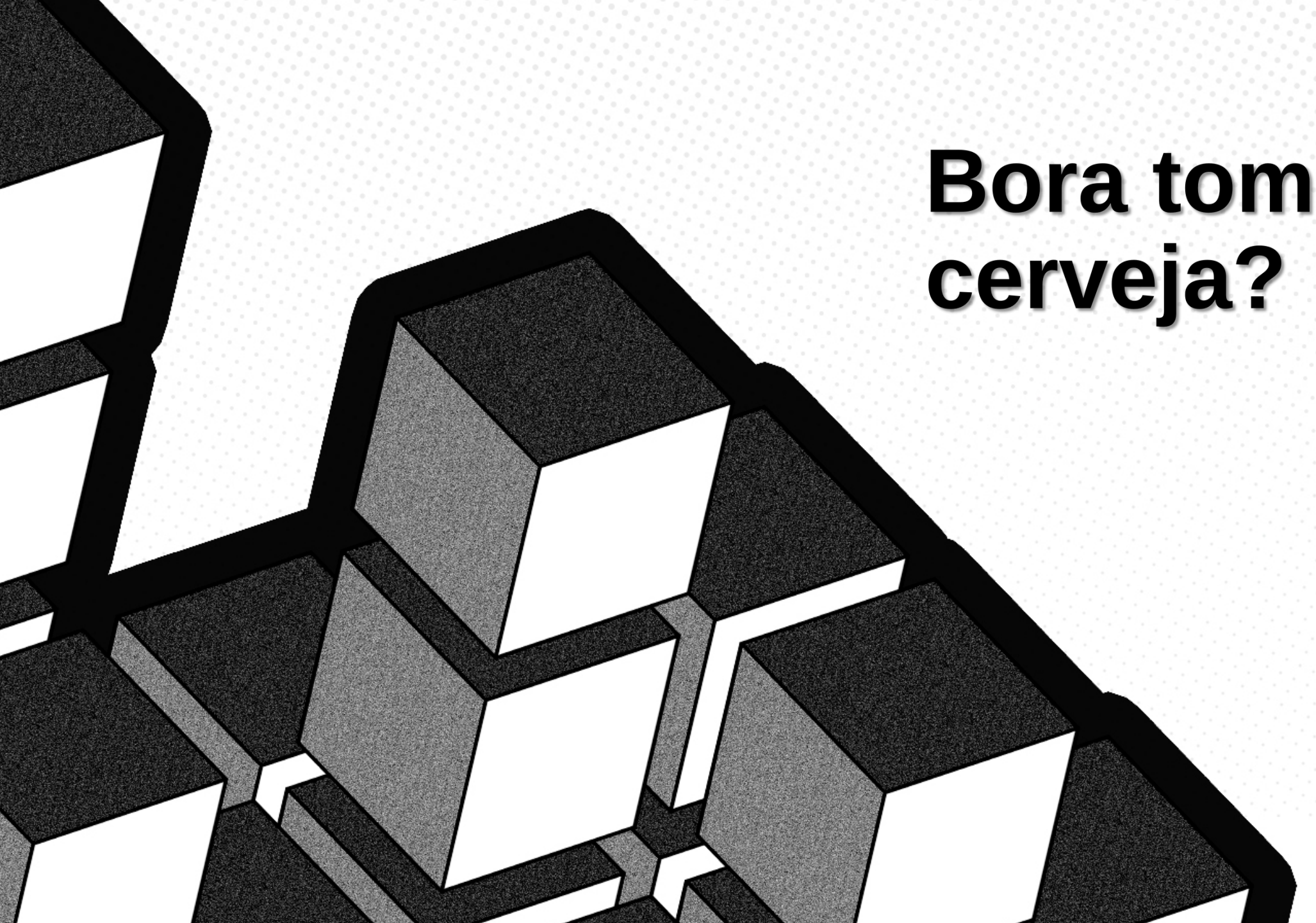
O que é Machine Learning?

O aprendizado automático (...) é um subcampo da Engenharia e da ciência da computação que evoluiu do estudo de **reconhecimento de padrões** e da teoria do aprendizado computacional em **inteligência artificial** [1]. Em 1959, Arthur Samuel definiu aprendizado de máquina como o "campo de estudo que dá aos computadores a habilidade de aprender sem serem explicitamente programados"[2]

[1] https://www.britannica.com/technology/machine-learning

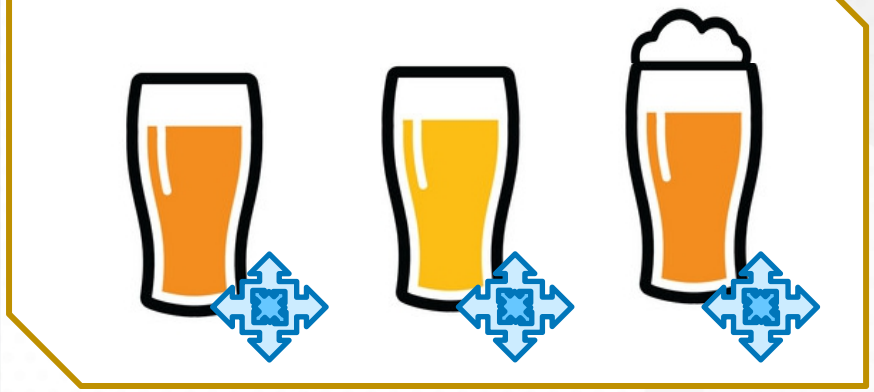
[2] https://books.google.com.br/books?id=Dn-Gdoh66sgC&pg=PA89&redir_esc=y#v=onepage&q&f=false

fonte: https://pt.wikipedia.org/wiki/Aprendizado_de_m%C3%A1quina



Bora tomar cerveja?

Pale-Ale



Weissbier

Pilsen

Quais atributos temos?

Temperatura

Tipo de copo

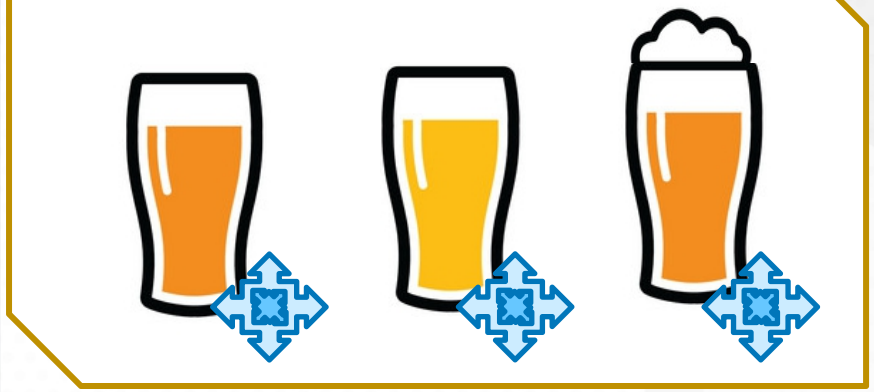
Espuma

Cor

O que me difere das demais?

Weissbier

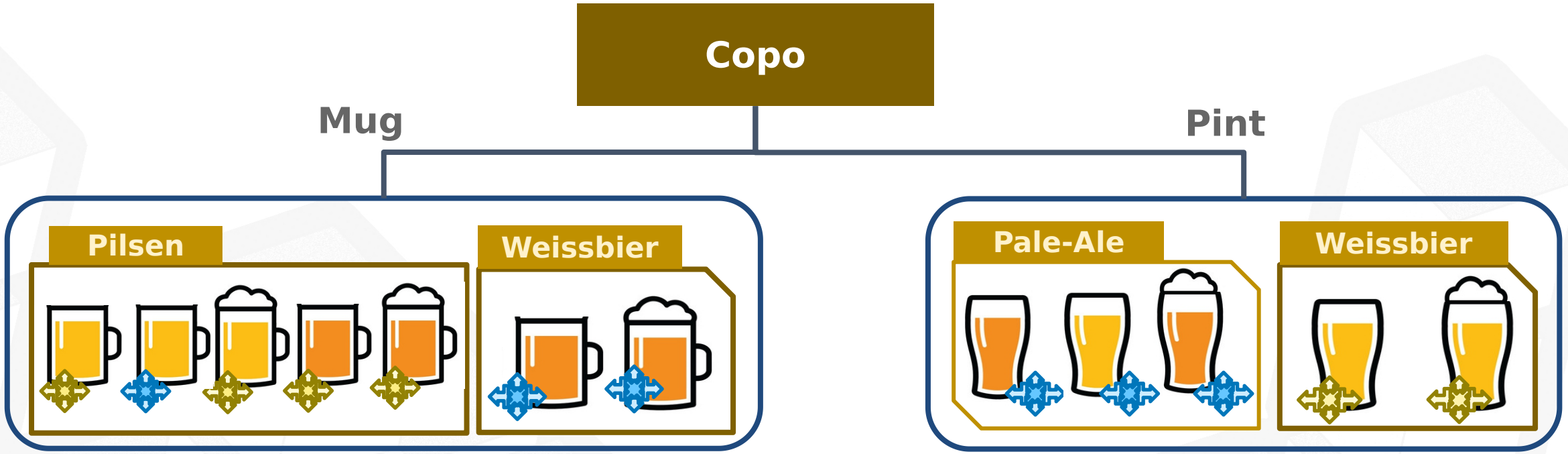
Pale-Ale



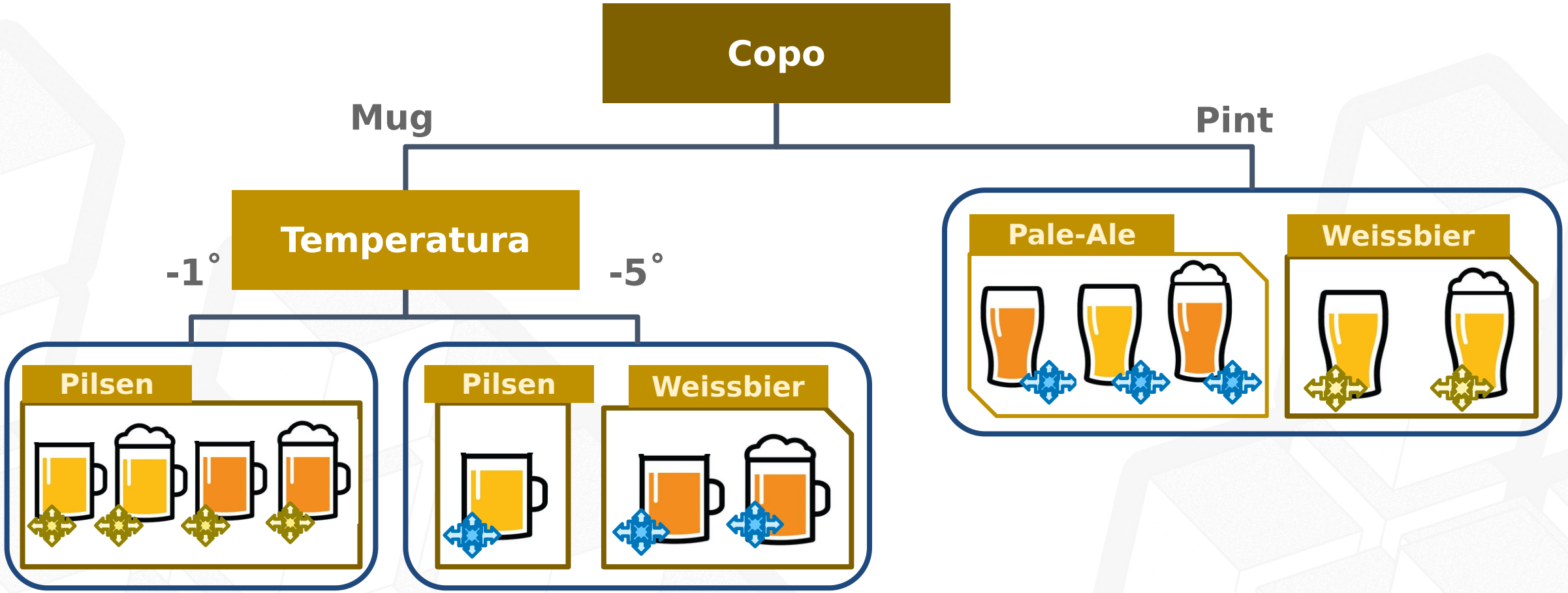
Weissbier

Pilsen

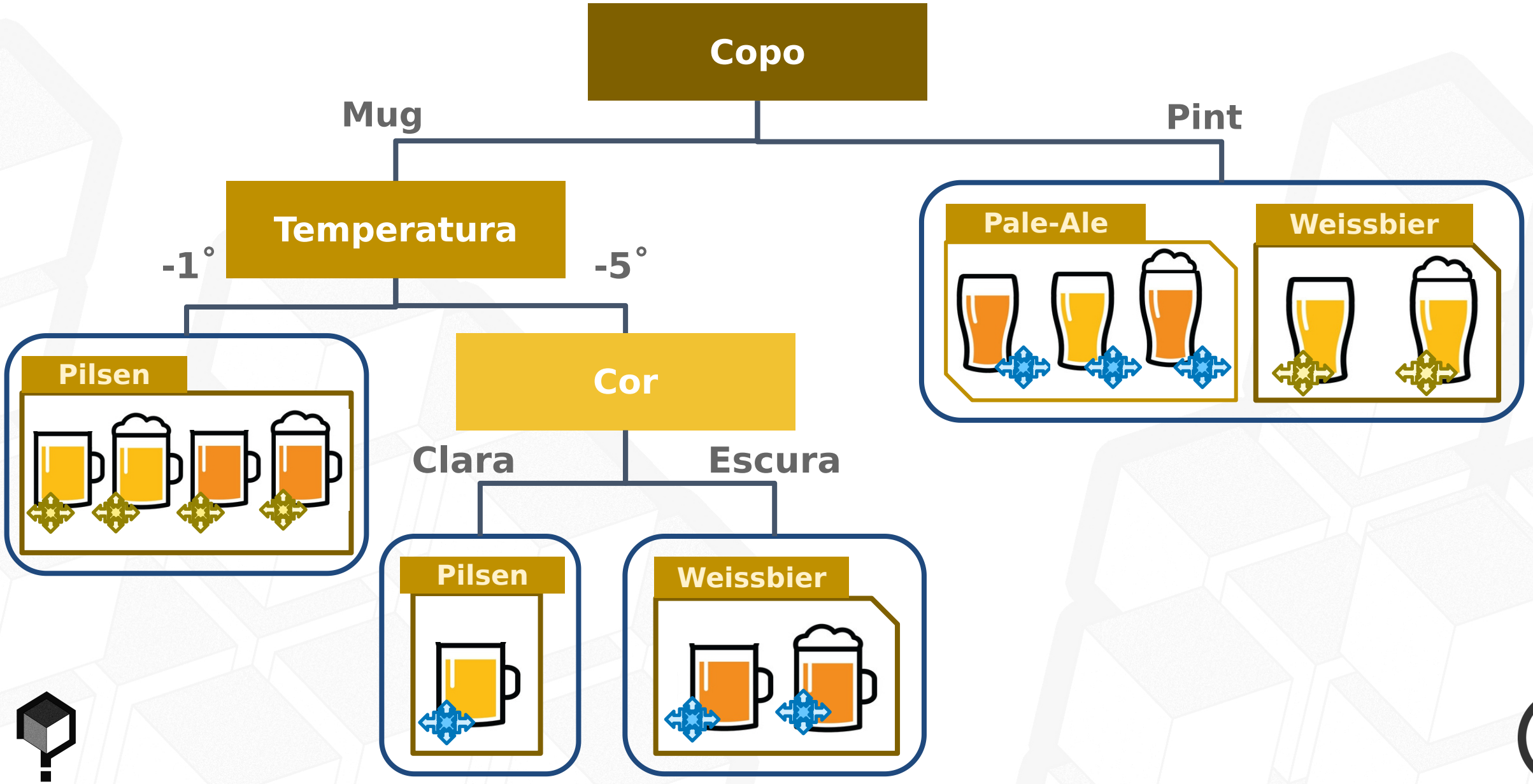
Criando regras



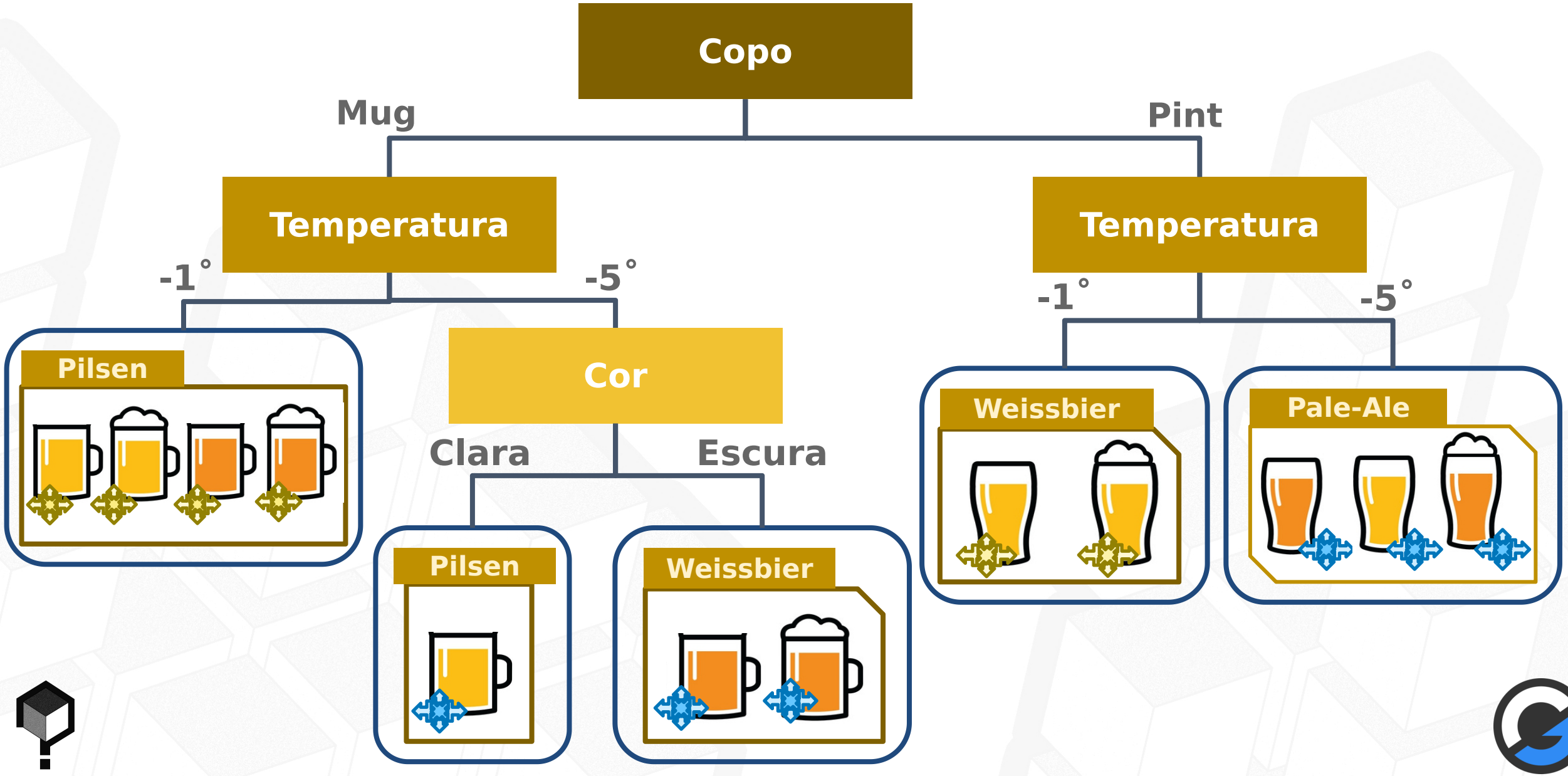
Criando regras



Criando regras

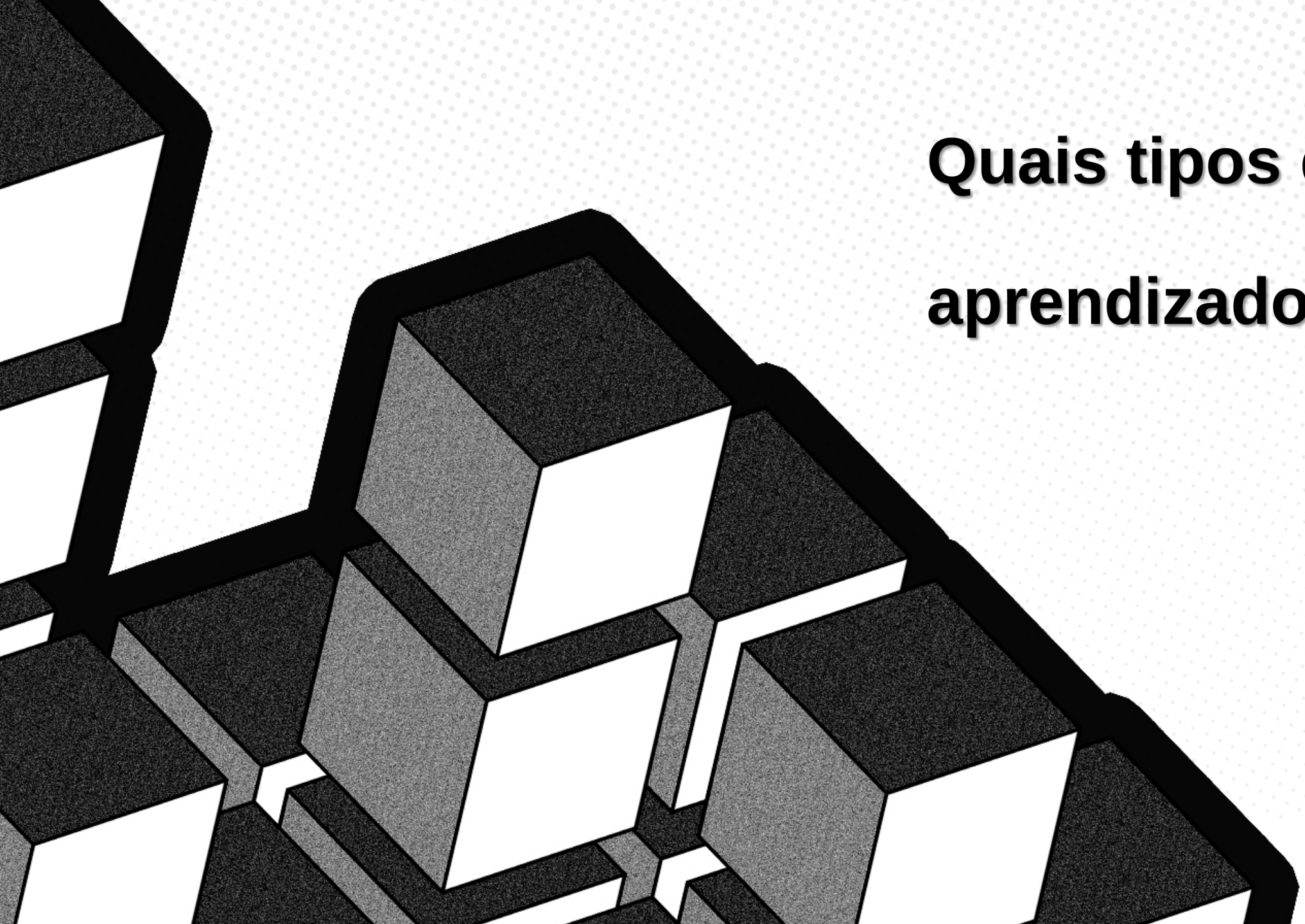


Criando regras

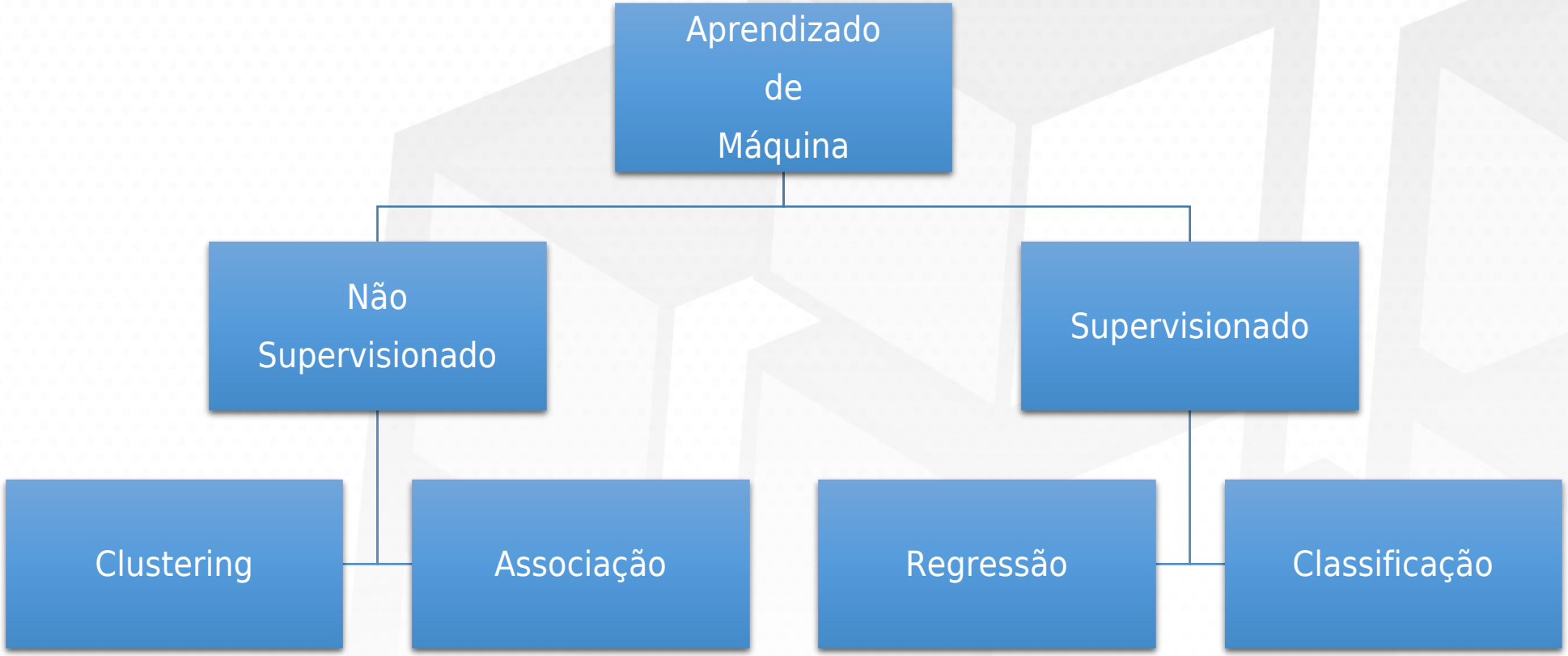


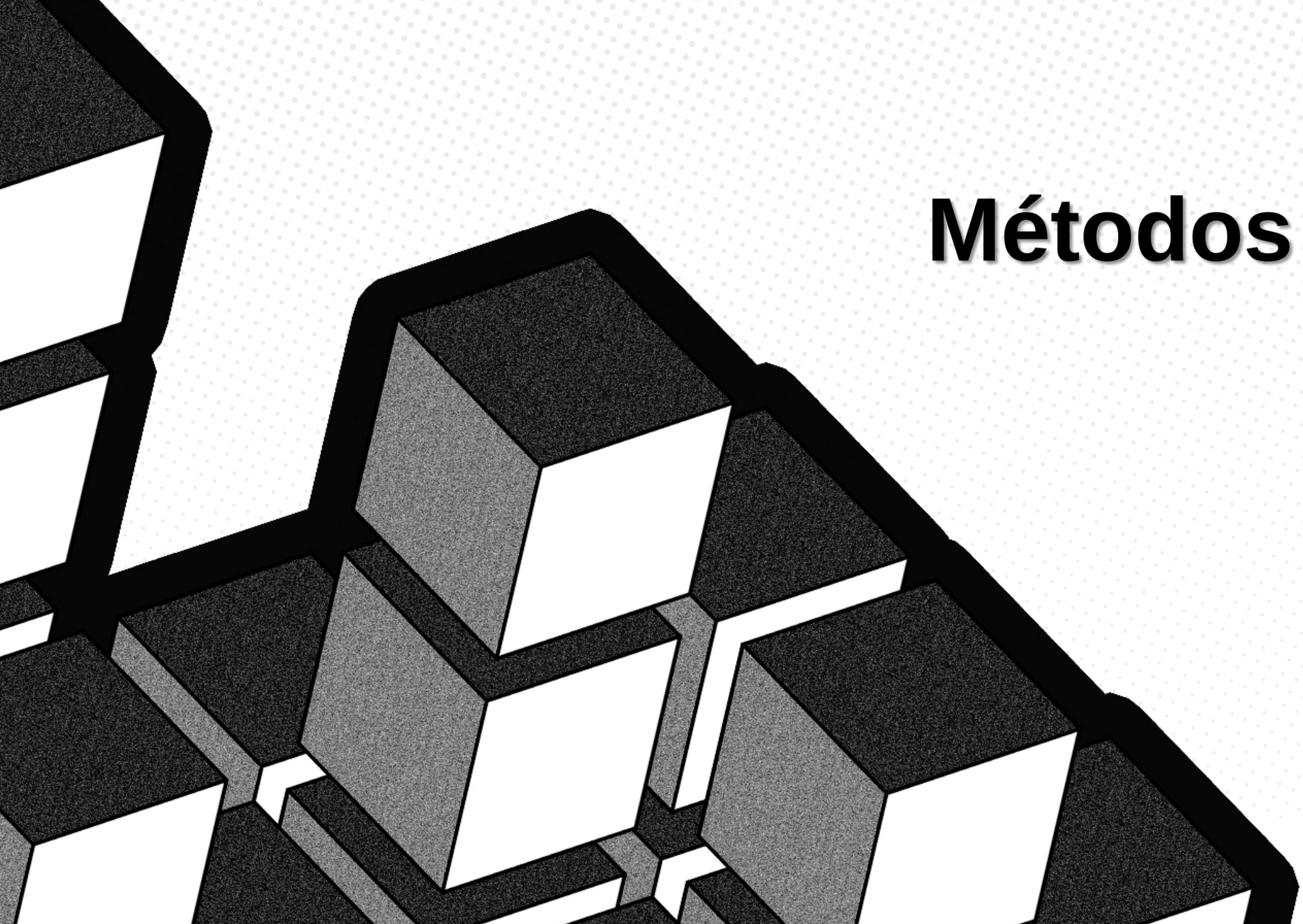
Tabela

id	temperatura	copo	espuma	cor	classe
1	-5	mud	não	escura	weissbier
2	-5	mud	sim	escura	weissbier
3	-1	pint	não	clara	weissbier
4	-1	pint	sim	clara	weissbier
5	-5	pint	não	escura	pale-ale
6	-5	pint	não	clara	pale-ale
7	-5	pint	sim	escura	pale-ale
8	-1	mud	não	clara	pilsen
9	-5	mud	não	clara	pilsen
10	-1	mud	sim	clara	pilsen
11	-1	mud	não	escura	pilsen
12	-1	mud	sim	escura	pilsen



Quais tipos de aprendizado temos?


Aprendizado de Máquina
Não Supervisionado
Supervisionado
Clustering
Associação
Regressão
Classificação



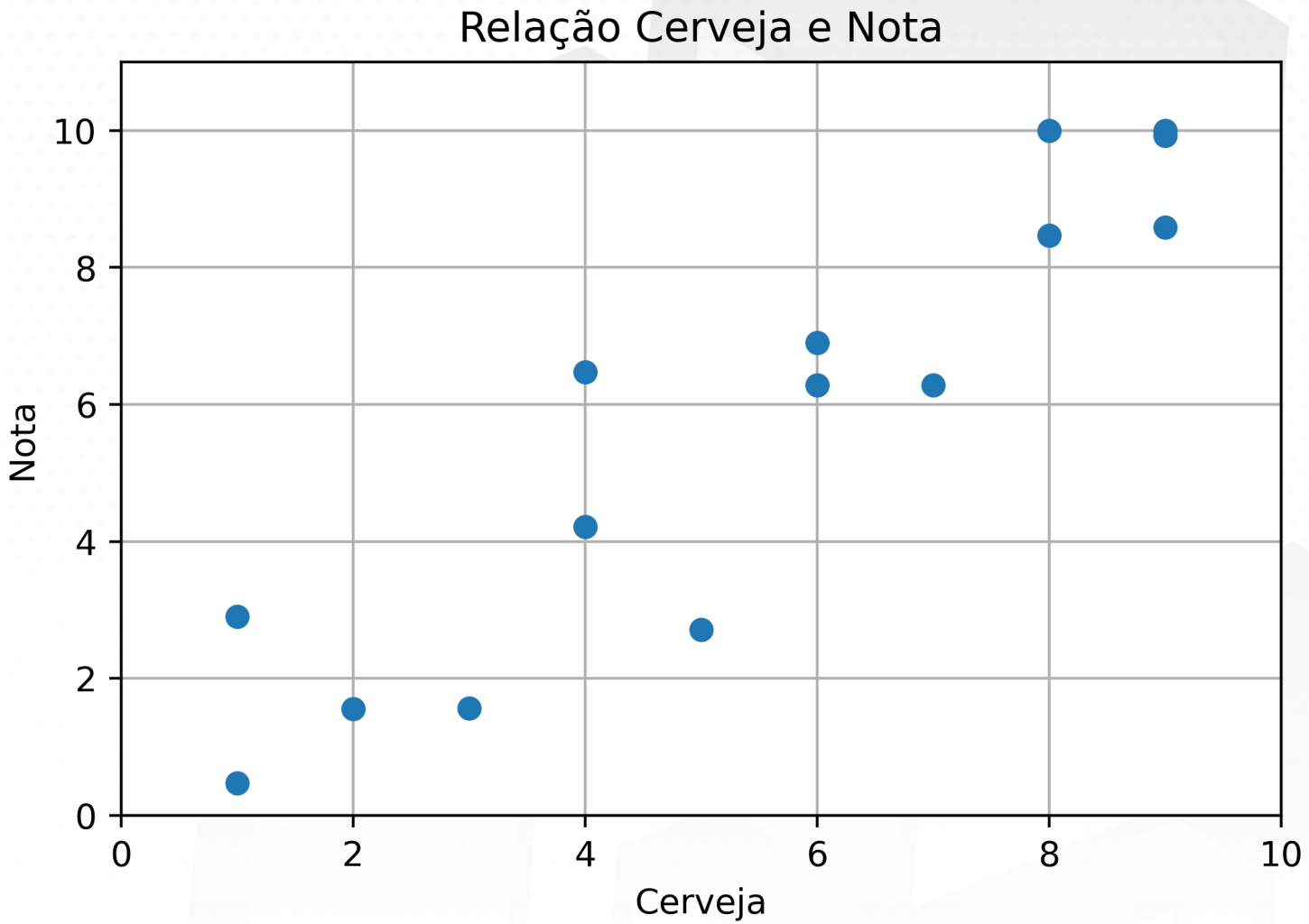
Métodos

Regressão

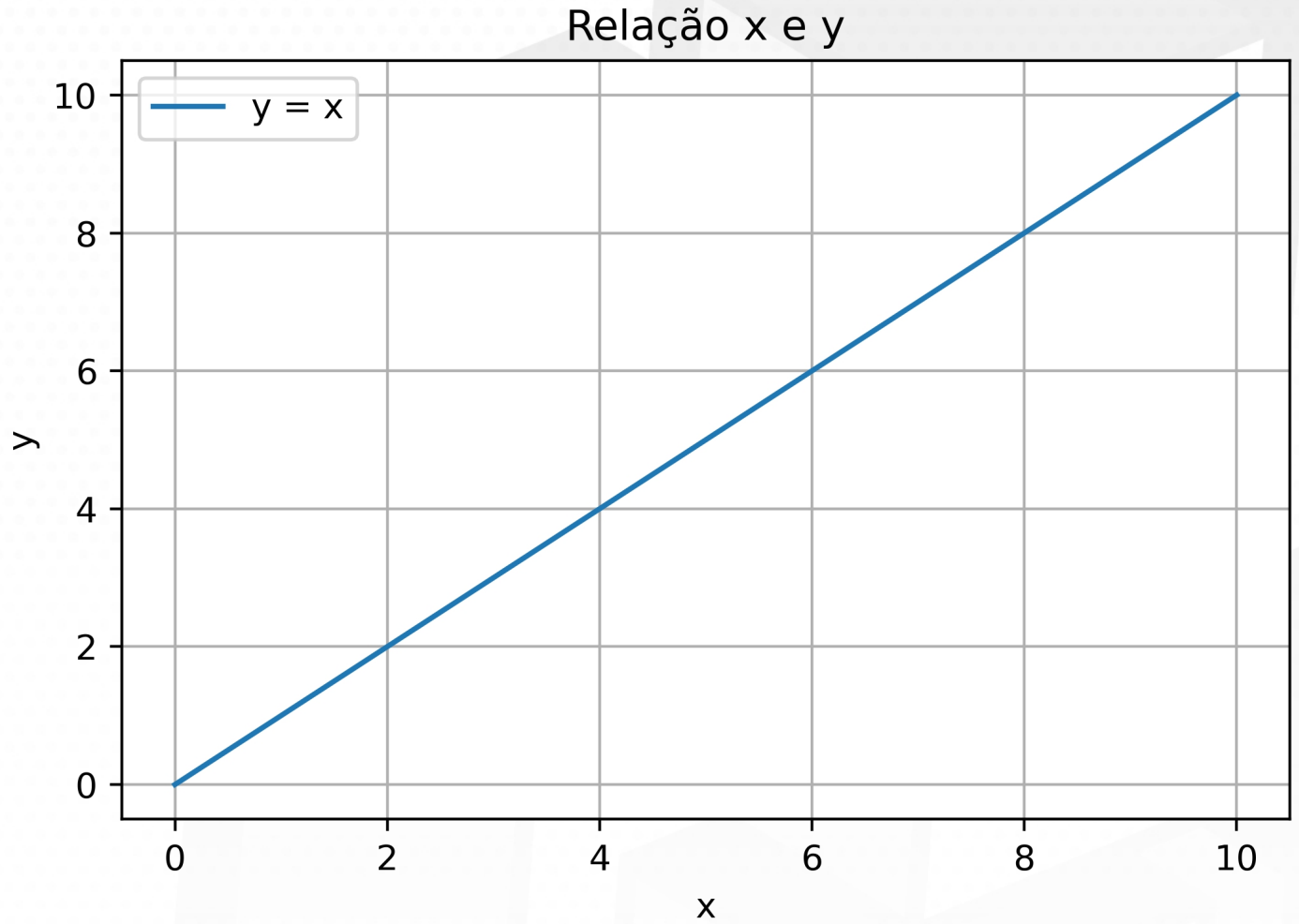
Problemas de regressão são voltados à estimativa alvo (‘target’), sendo este um número, valor. Por exemplo:

- Quantidade de vendas
- Receita presumida
- Valor de crédito
- Precificação de imóvel
- Volume de chuva

Regressão Linear

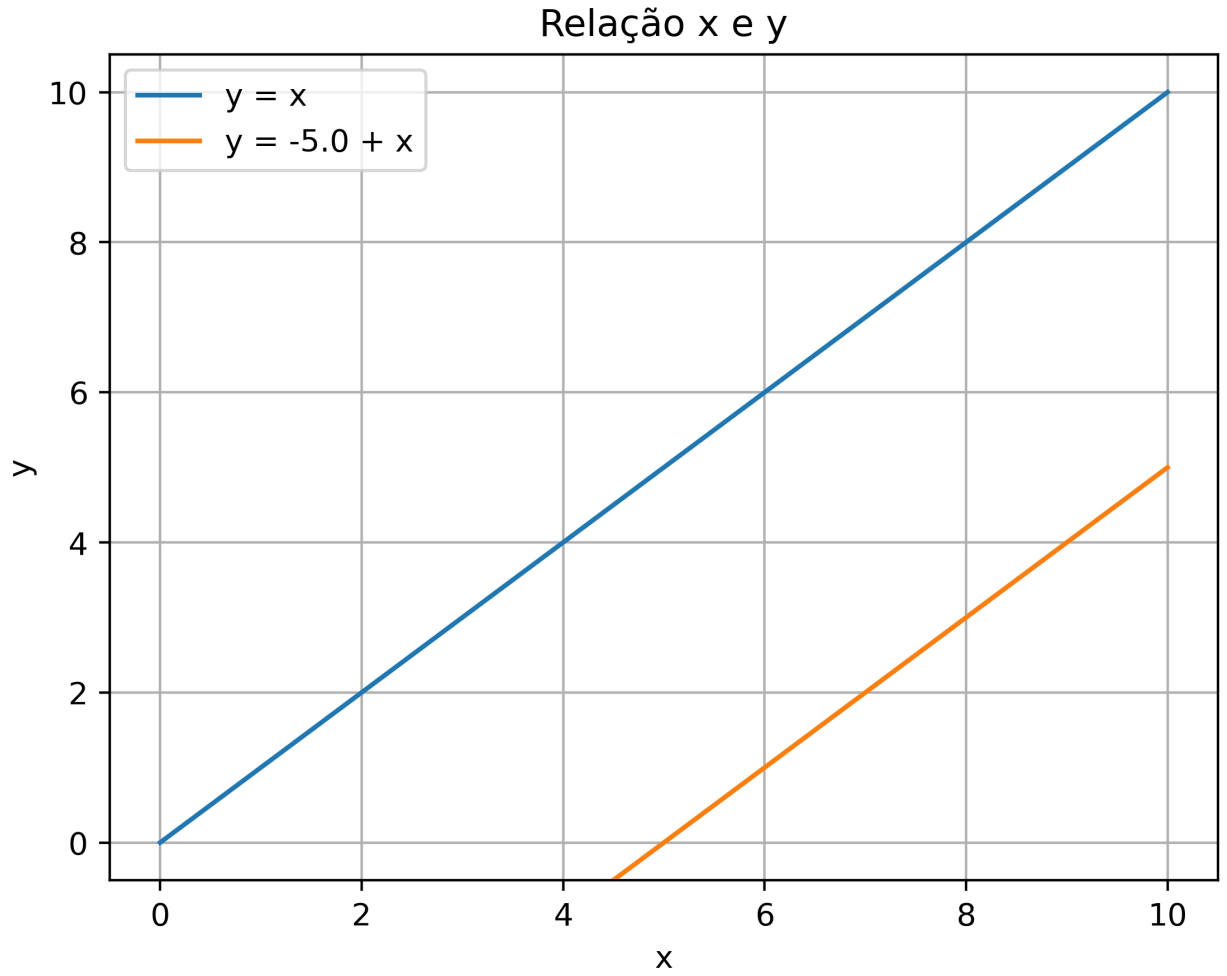


Regressão Linear



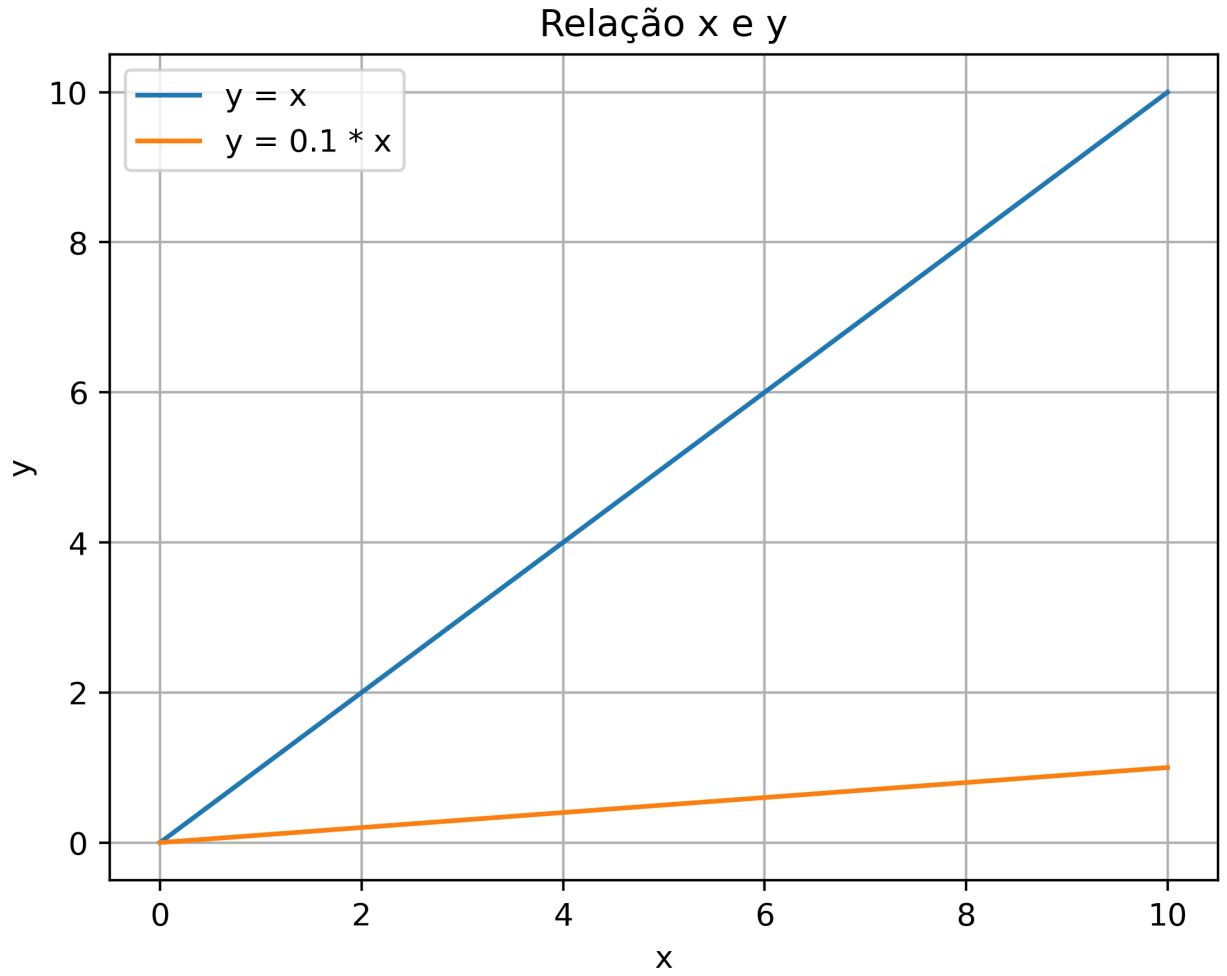
Regressão Linear

$$y = a + x$$



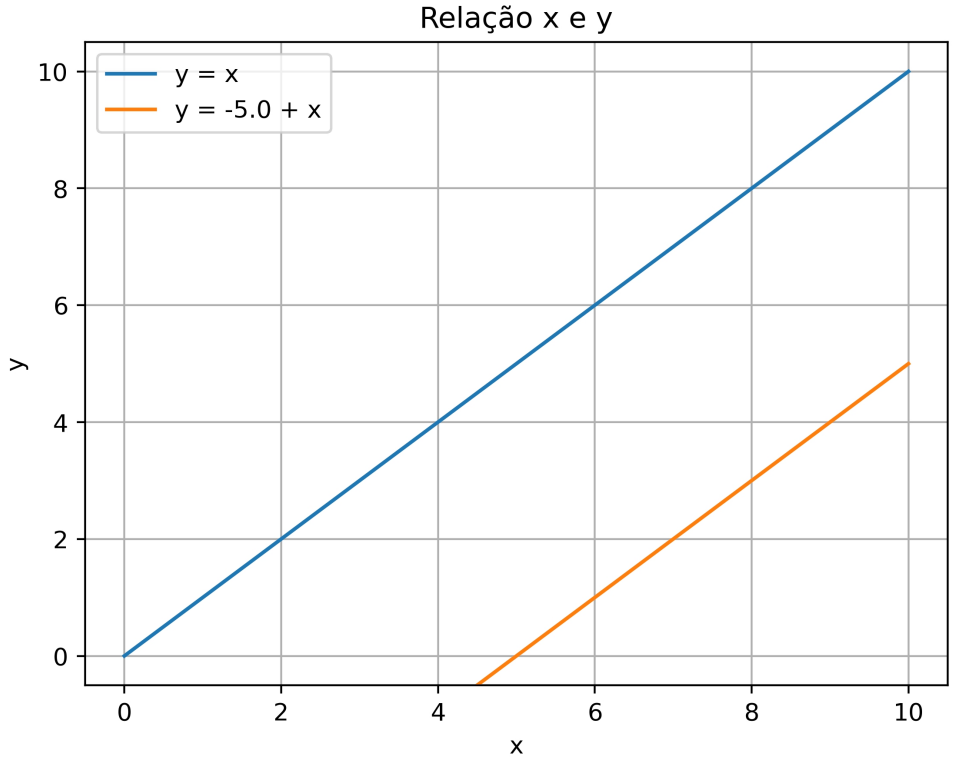
Regressão Linear

$$y = b.x$$

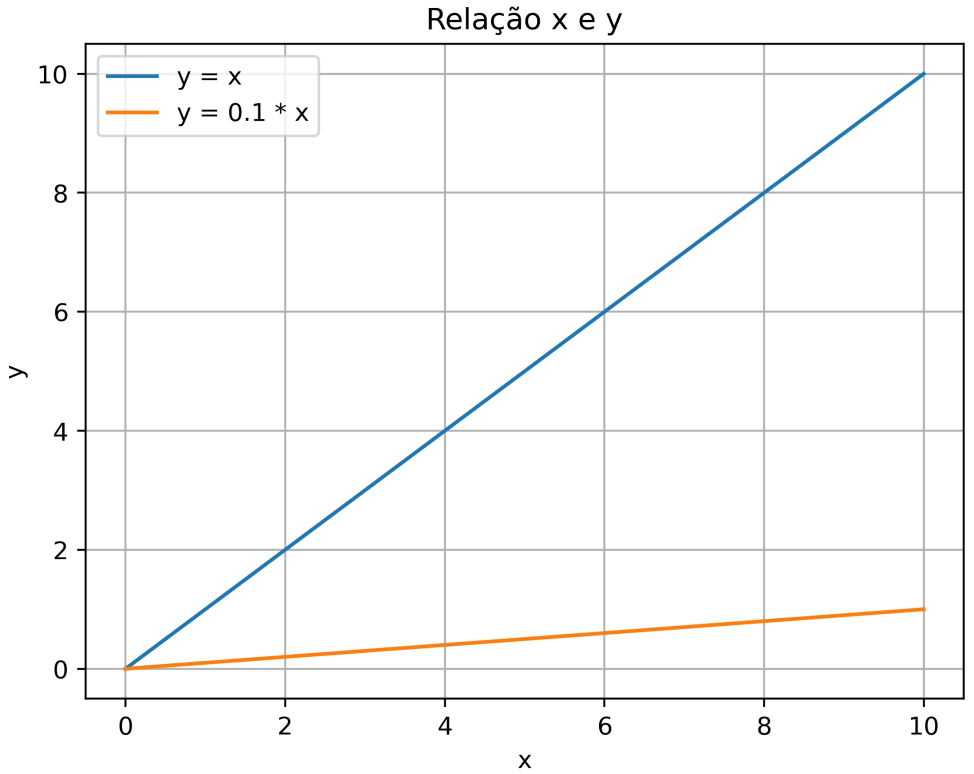


Regressão Linear

$$y = a + x$$

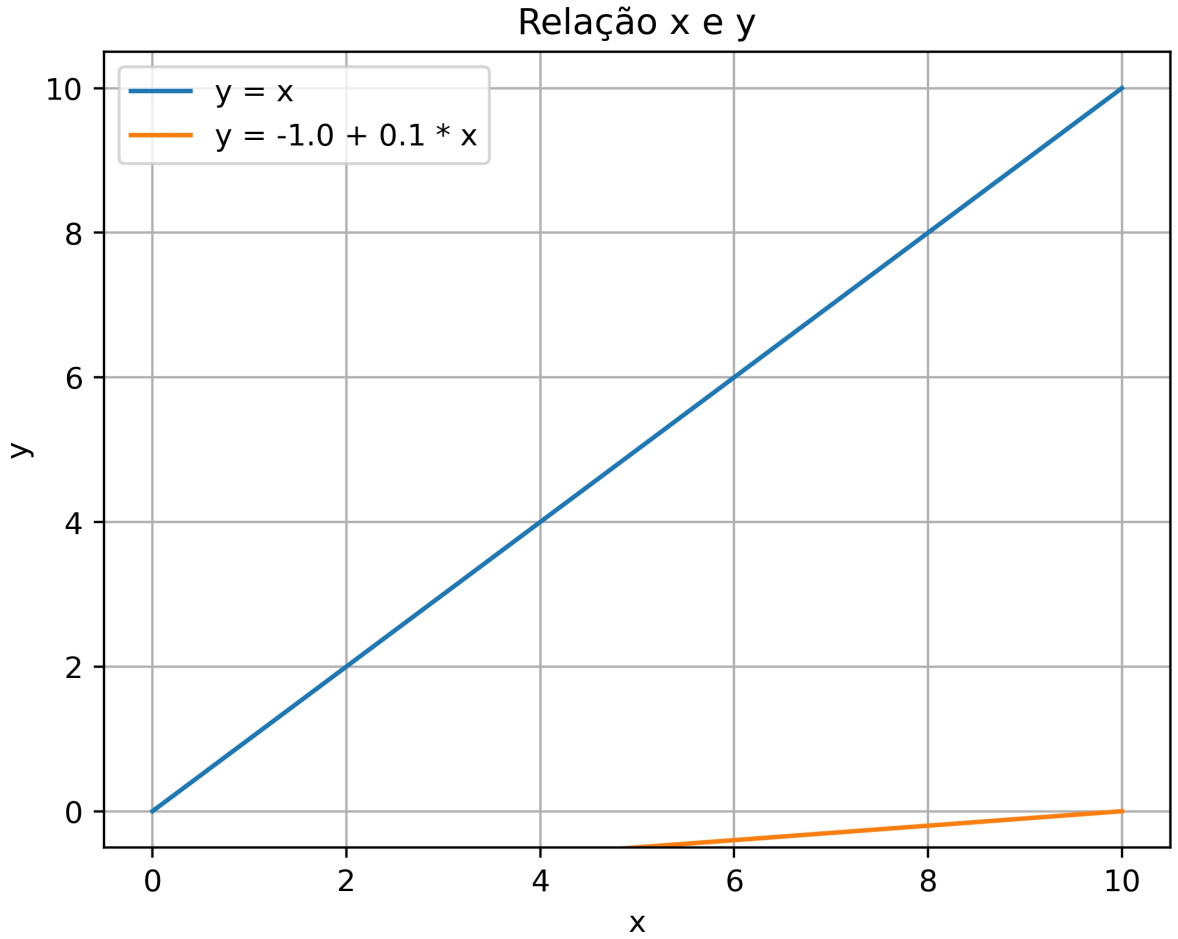


$$y = b.x$$

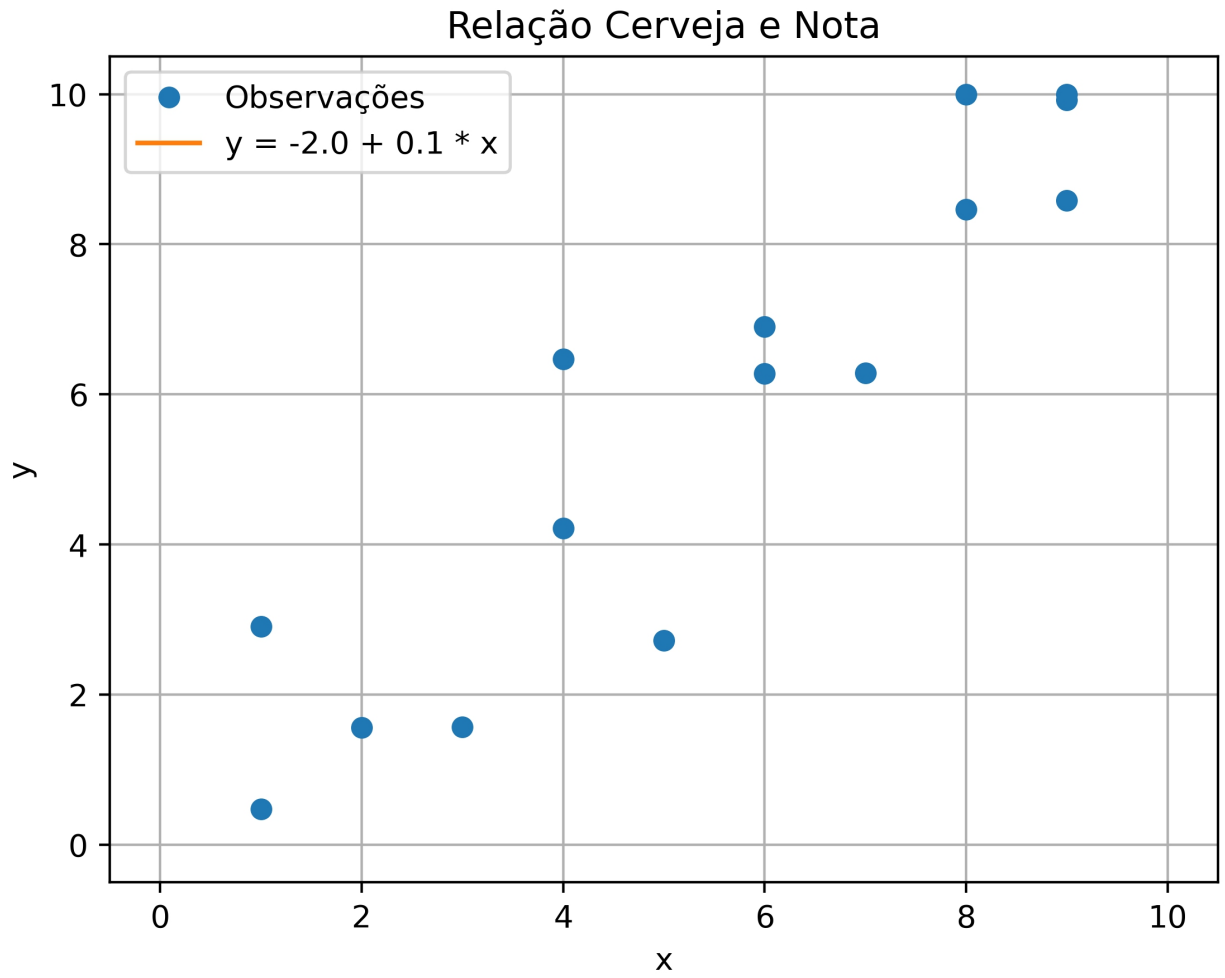


Regressão Linear

$$y = a + b.x$$



Regressão Linear



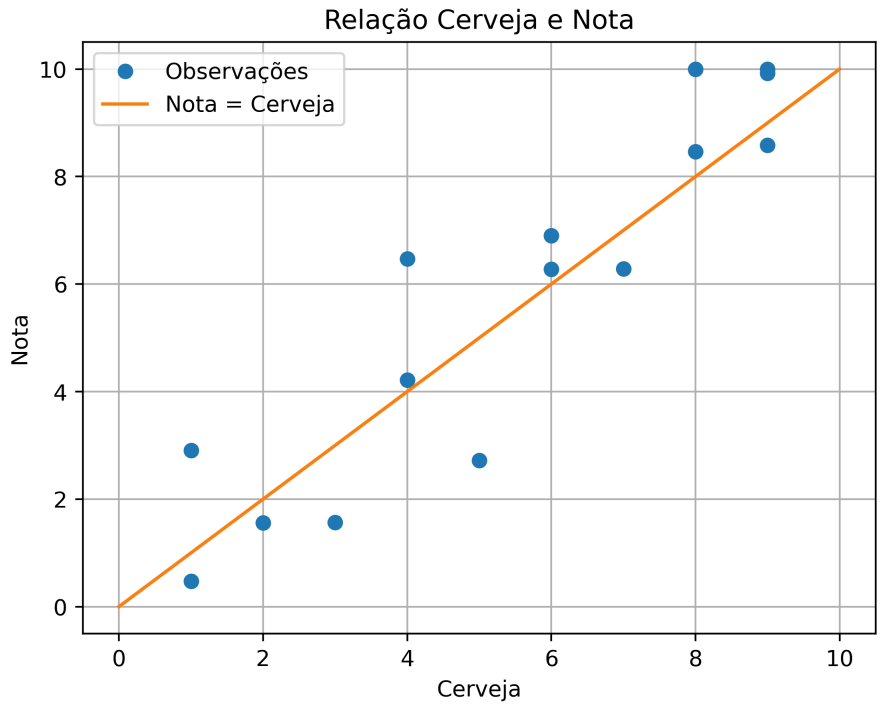
Regressão Linear

$$\hat{y} = a + b.x \Leftrightarrow \hat{Nota} = a + b.\text{Cerveja}$$

$$\text{Erro} = y - \hat{y}$$

$$\text{Erro Quadrático} = (y - \hat{y})^2$$

$$\text{Soma do Erro Quadrático} = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$



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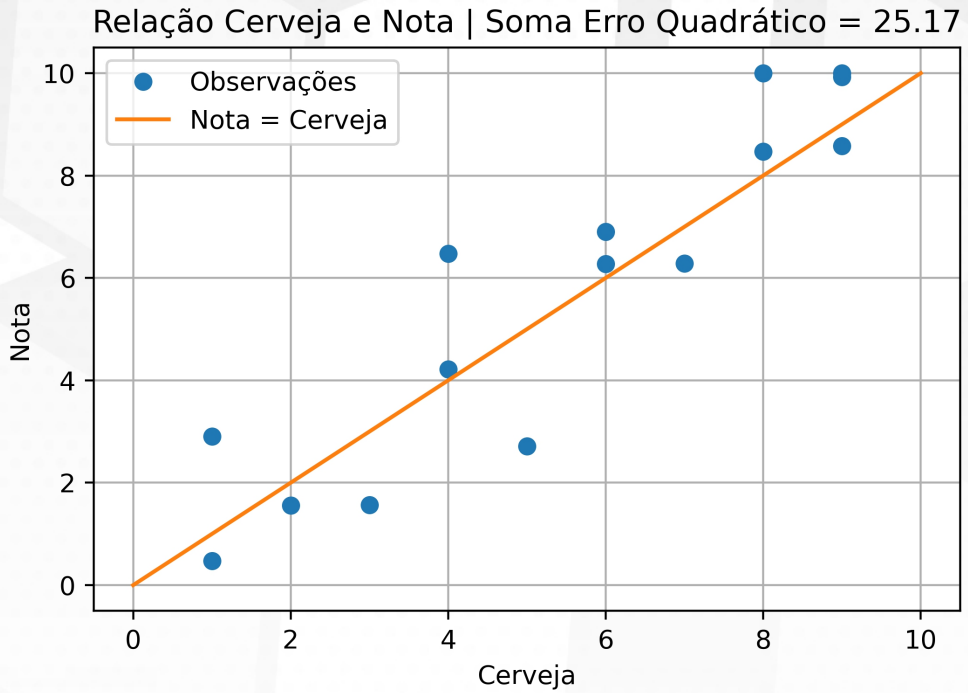
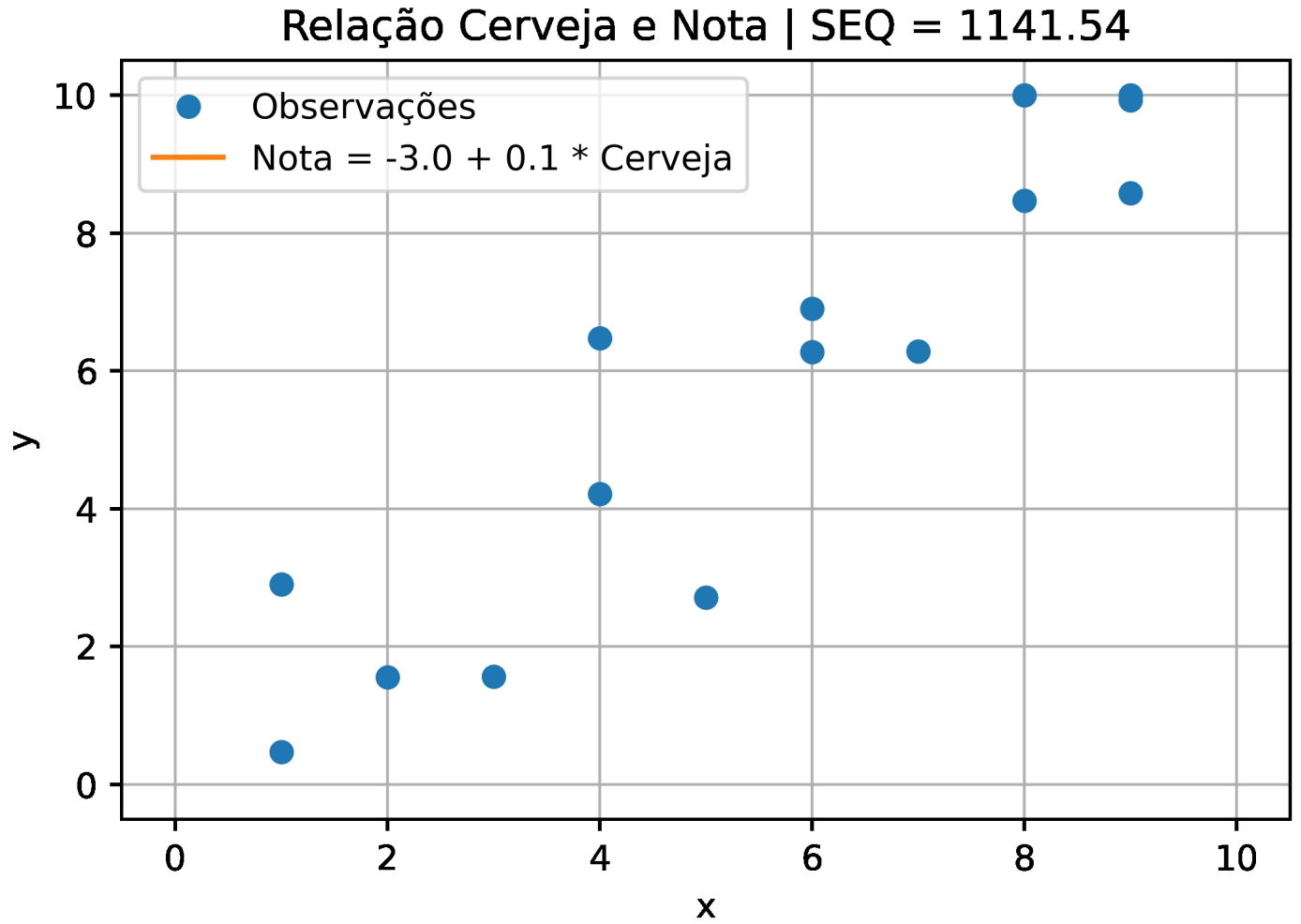


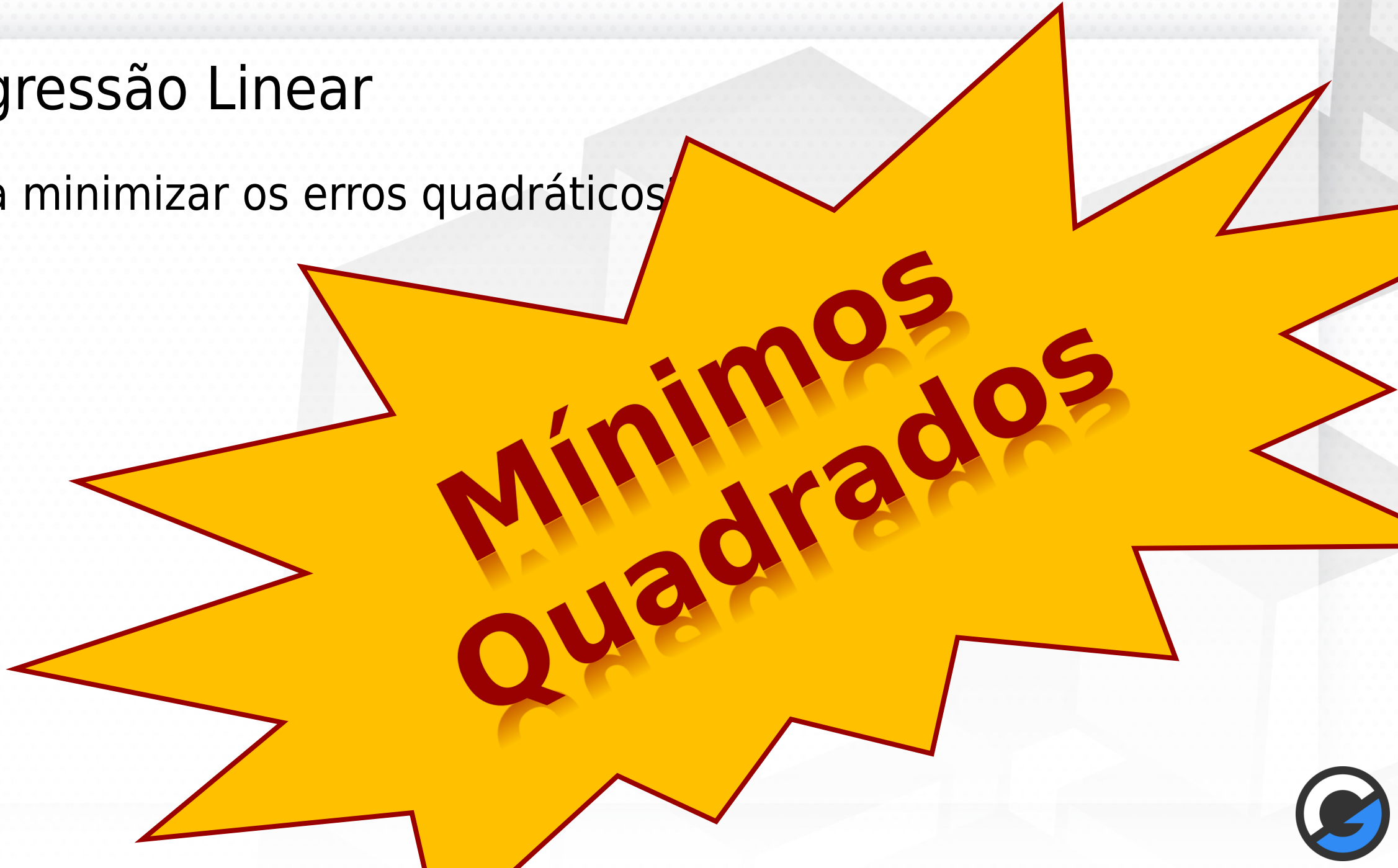
$$\text{Soma do Erro Quadrático} = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$

Regressão Linear



Regressão Linear

Bora minimizar os erros quadráticos!



Regressão Linear

Bora minimizar os erros quadráticos?

$$\hat{y} = a + b.x \Leftrightarrow N\hat{o}ta = a + b.\text{Cerveja}$$

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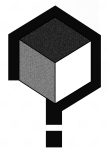
$$\text{Soma do Erro Quadrático} = \sum_{i=1}^{n} (y_i - (a + bx_i))^2$$

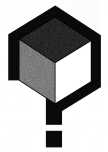


Regressão Linear

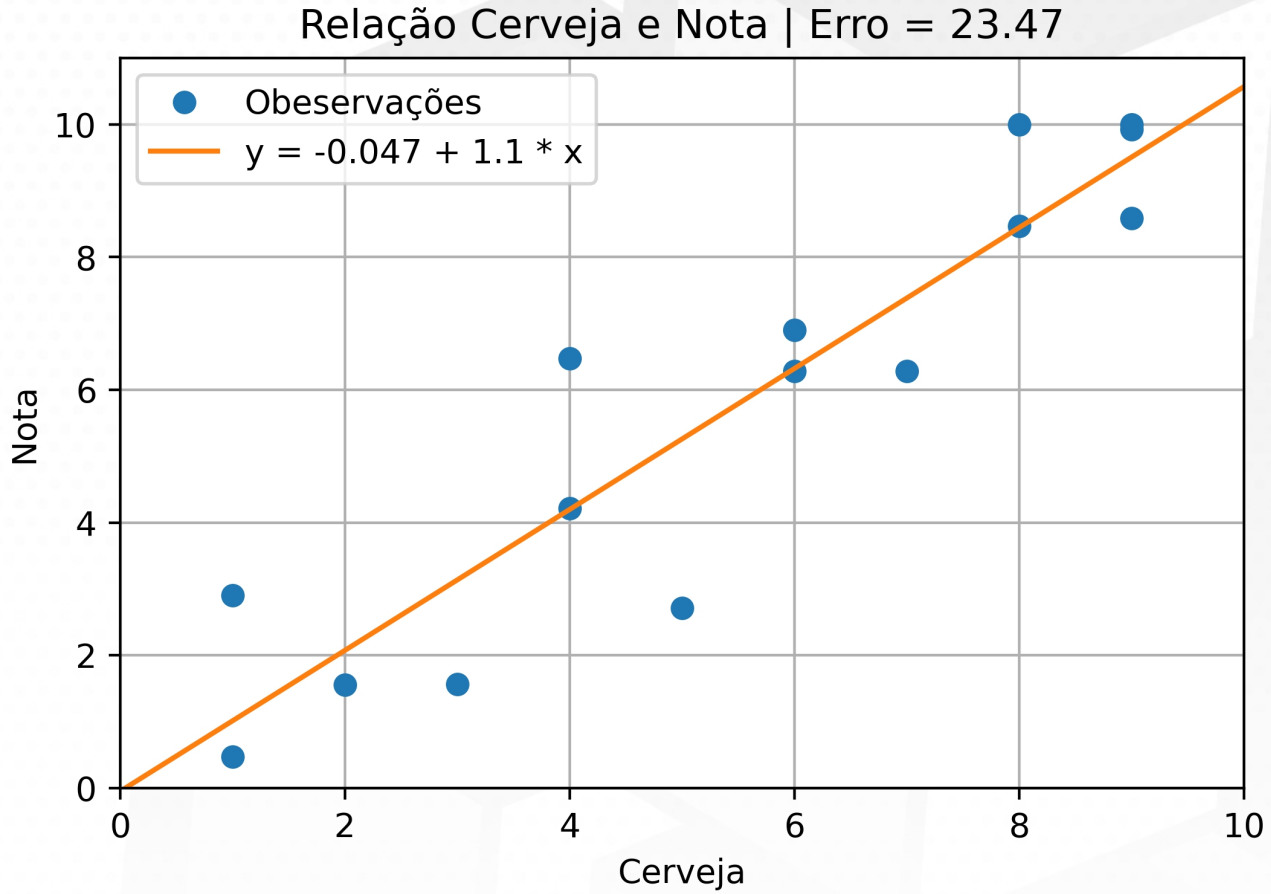
Bora minimizar os erros quadráticos?

$$\frac{\partial}{\partial a} \sum_{i=1}^{n} (y_i - (a + bx_i))^2 = 0$$

$$\frac{\partial}{\partial b} \sum_{i=1}^{n} (y_i - (a + bx_i))^2 = 0$$



Regressão Linear

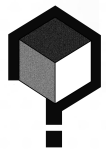


Regressão Linear

Mínimos Quadrados é o único método de ajusteda reta?

Método de Máxima Verossimilhança (Inferência Clássica)

Método Bayesiano (Inferência Bayesiana)

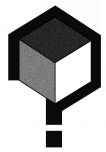


Regressão Linear

$$y = a + bx$$

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

$$y = \beta_0 + \beta_1 x_1$$



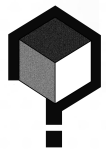
Regressão Linear Múltipla

E se tivermos afim de utilizar mais variáveis?

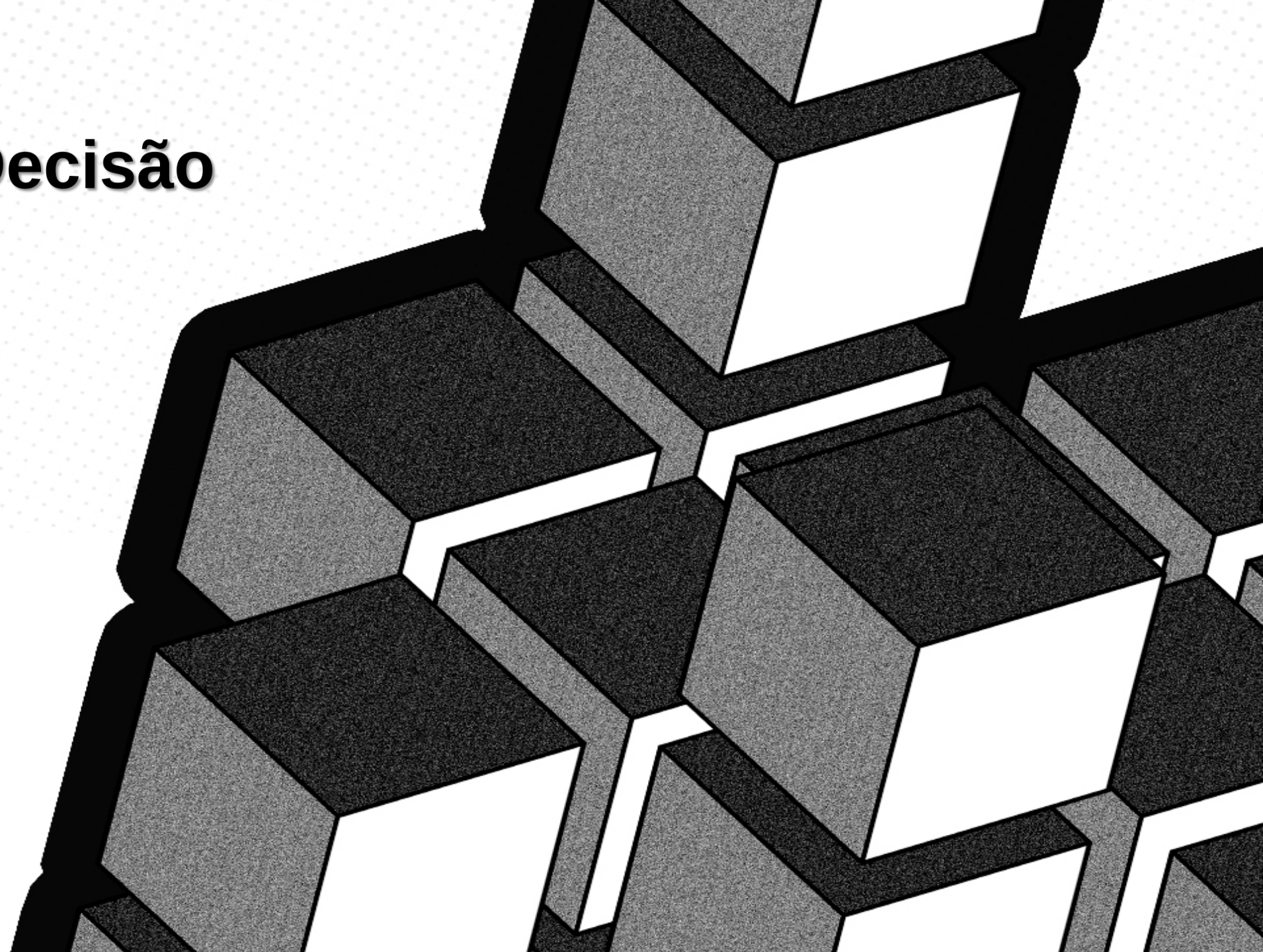
$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... \beta_p x_p$$

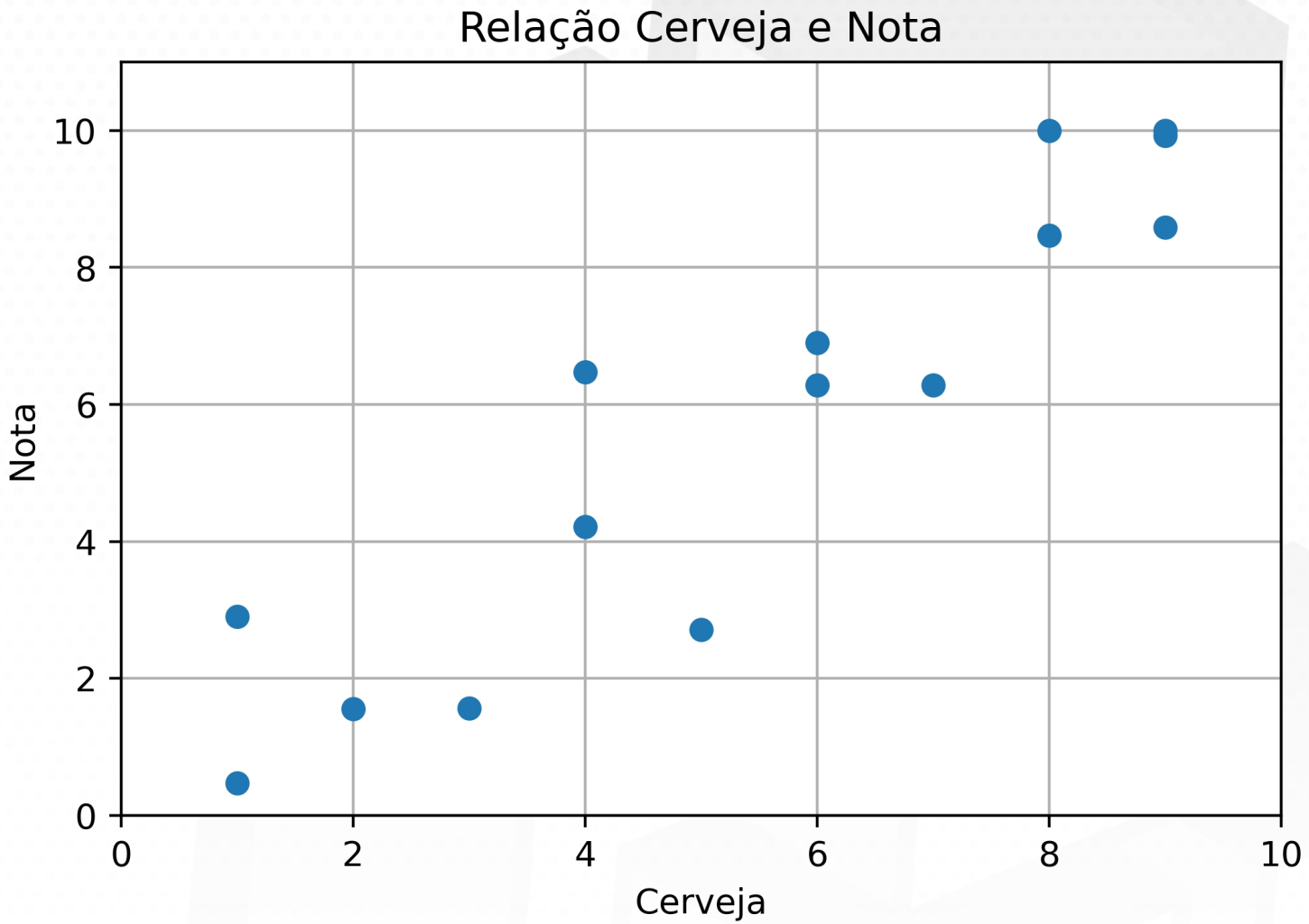
$$y = \beta_0 + \sum_{i=1}^{p} \beta_i x_i$$



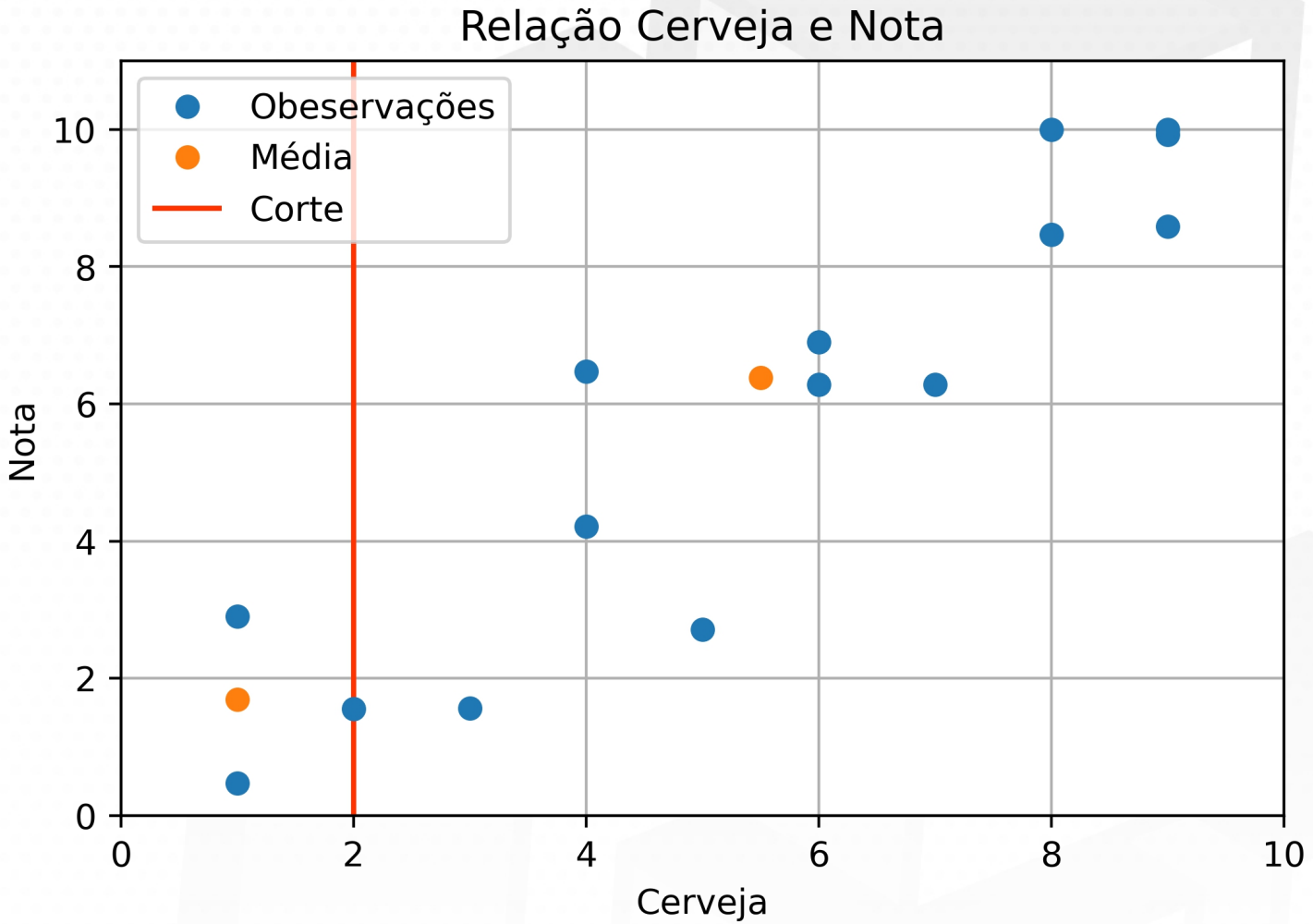
Árvore de Decisão



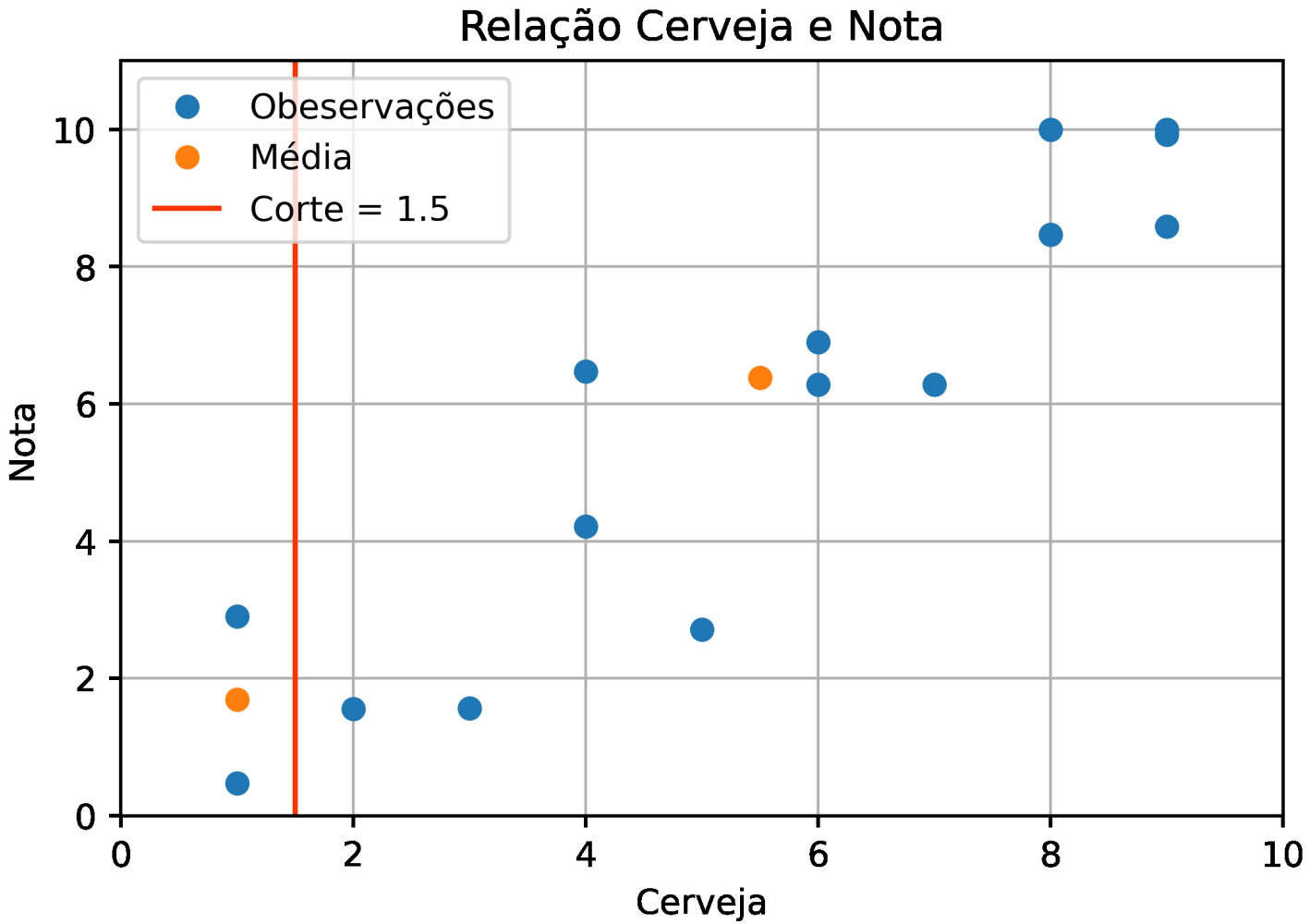
Voltando à Árvore de Decisão



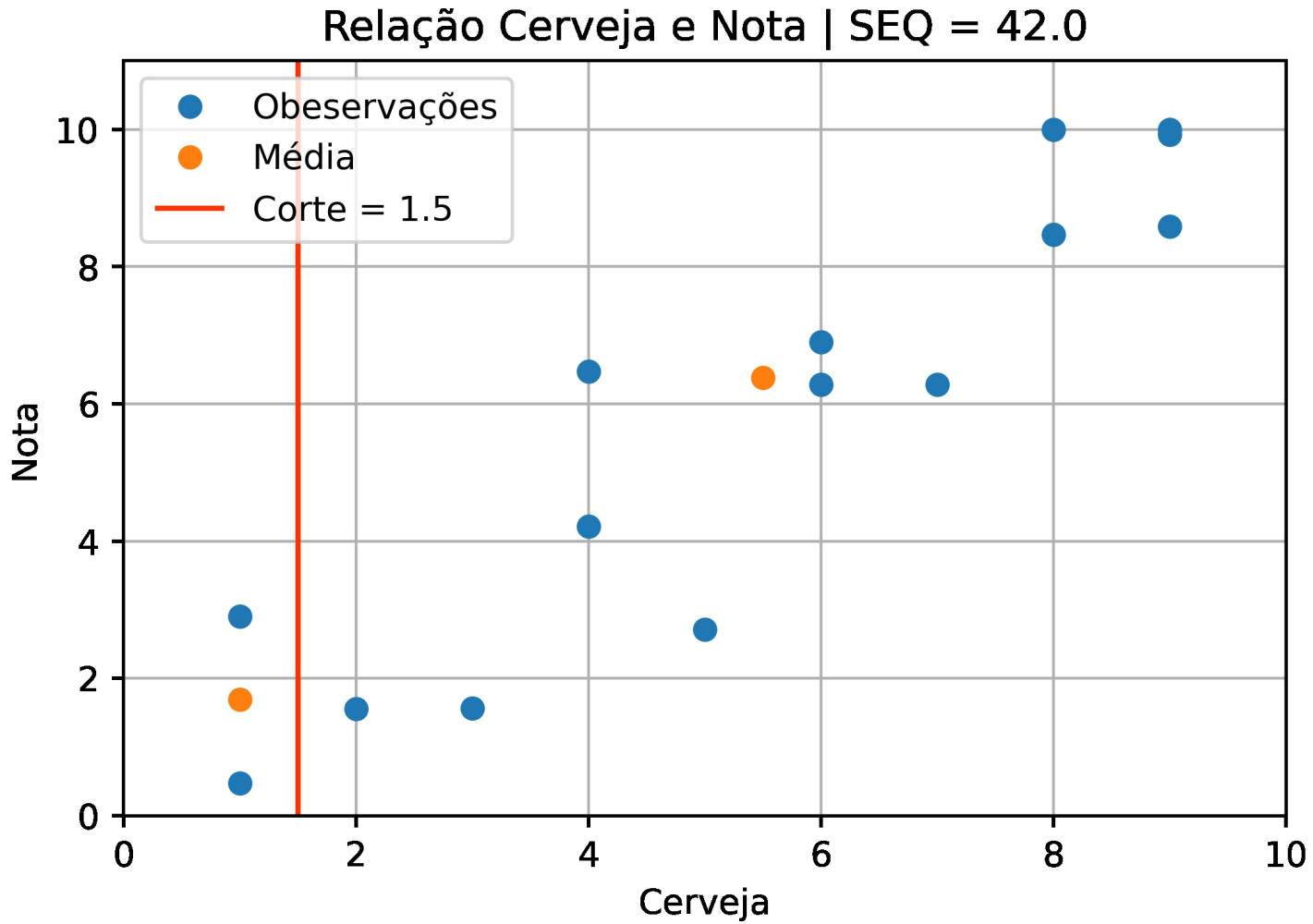
Voltando à Árvore de Decisão



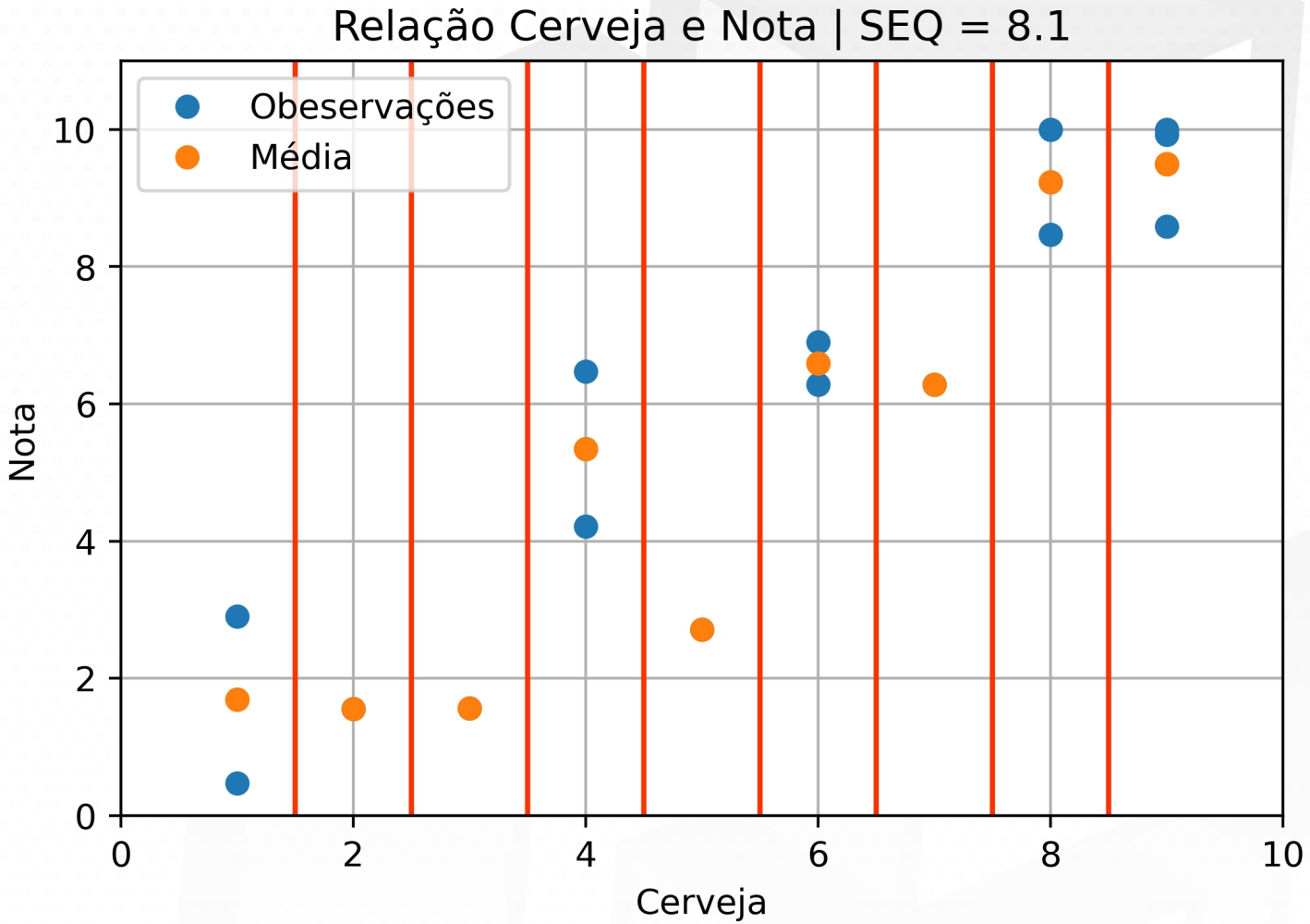
Voltando à Árvore de Decisão



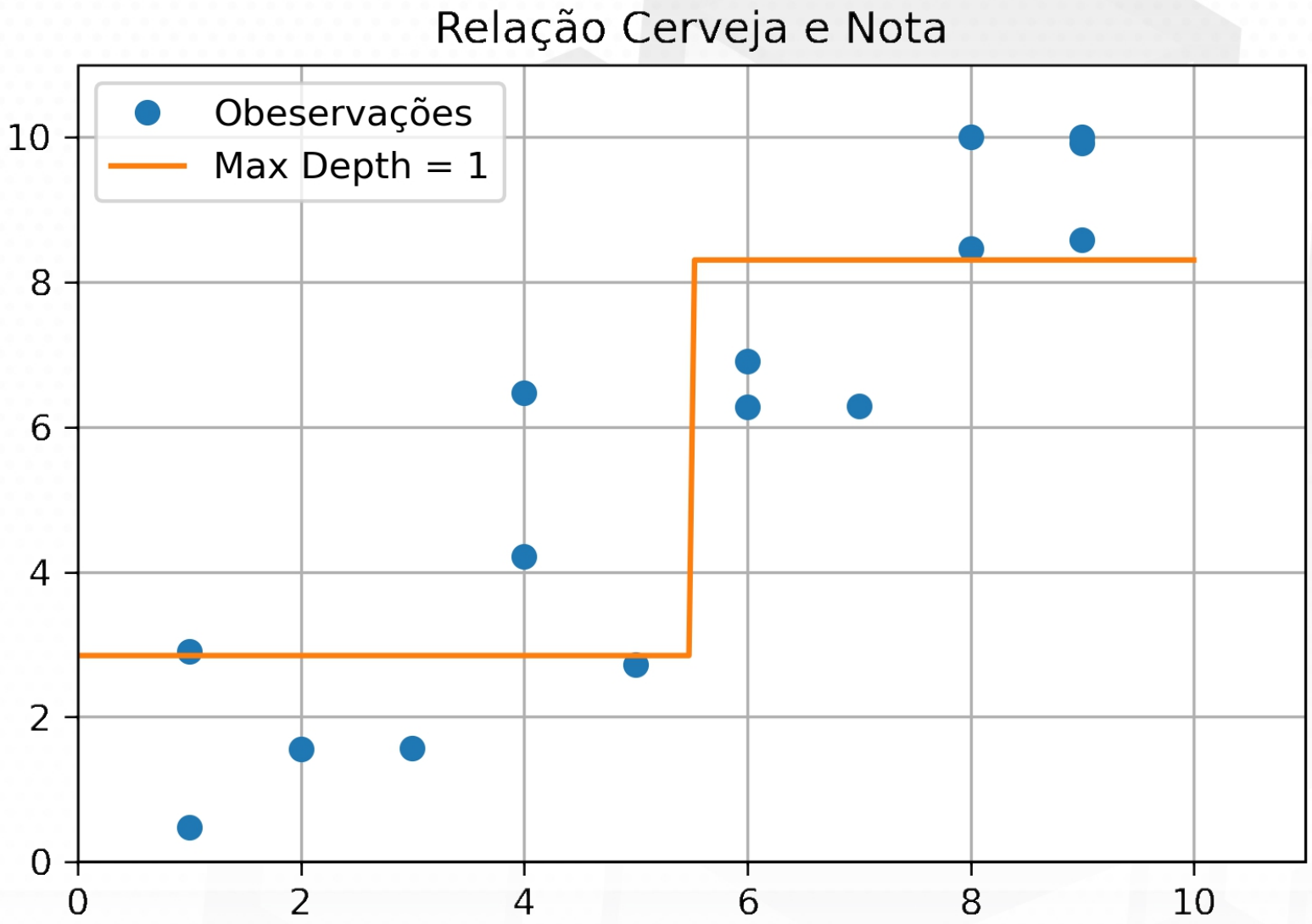
Árvore de Decisão



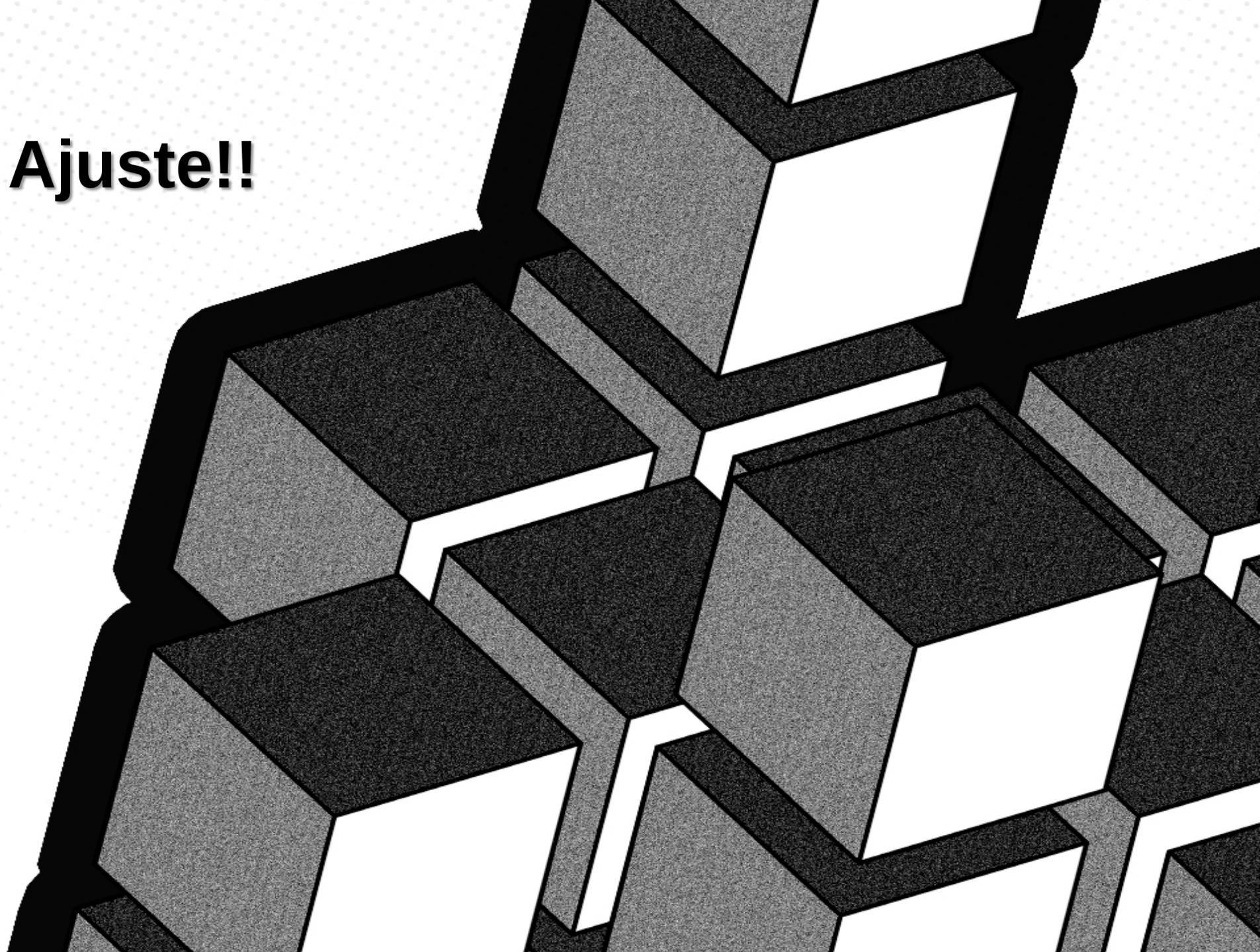
Árvore de Decisão



Árvore de Decisão



Métricas de Ajuste!!



Métricas de Ajuste

https://scikit-learn.org/stable/modules/model_evaluation.html#regression-metrics

Erro médio absoluto

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

Erro Quadrático Médio

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

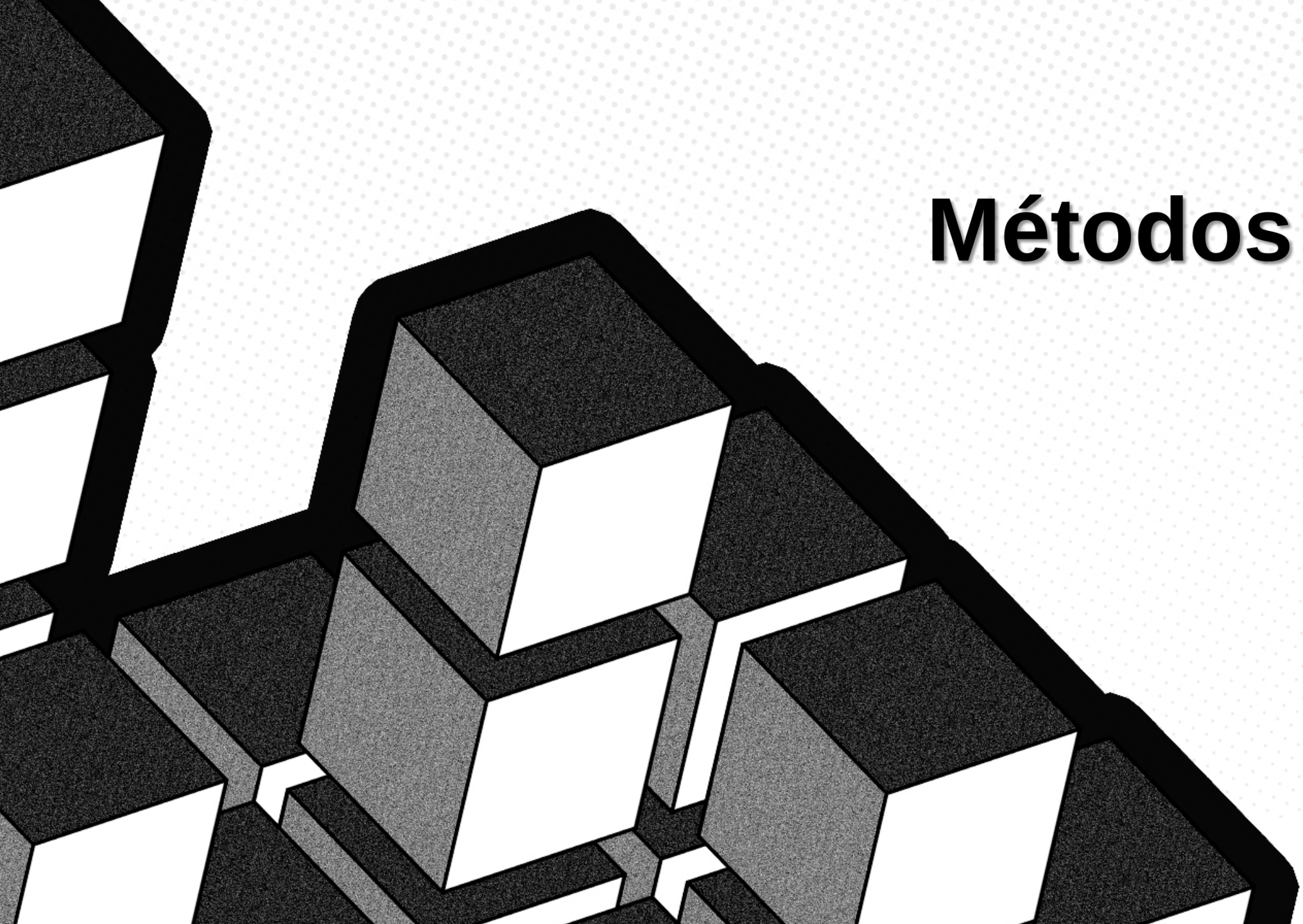
R2

$$R^2 = 1 - \frac{\sum_{i=1}^{n} (y - \hat{y})^2}{\sum_{i=1}^{n} (y - \bar{y})^2}$$

Classificação

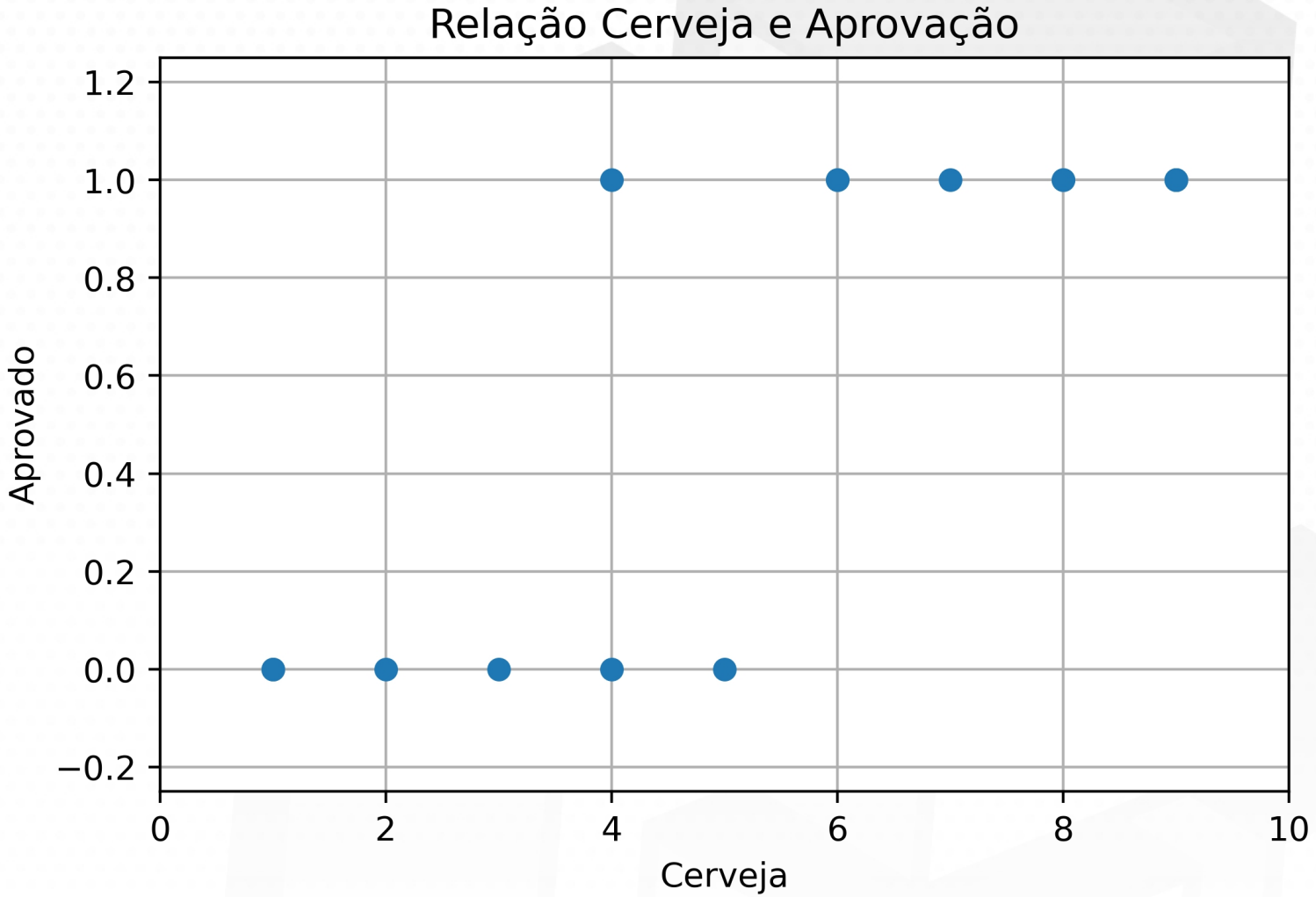
Problemas de classificação são voltamos à estimativa alvo, sendo este um rótulo ou classe. Por exemplo:

- Compradores vs Não compradores
- Churn vs Não Churn
- Objeto em uma imagem
- Inadimplente vs Adimplente (default)
- Propenção à câncer

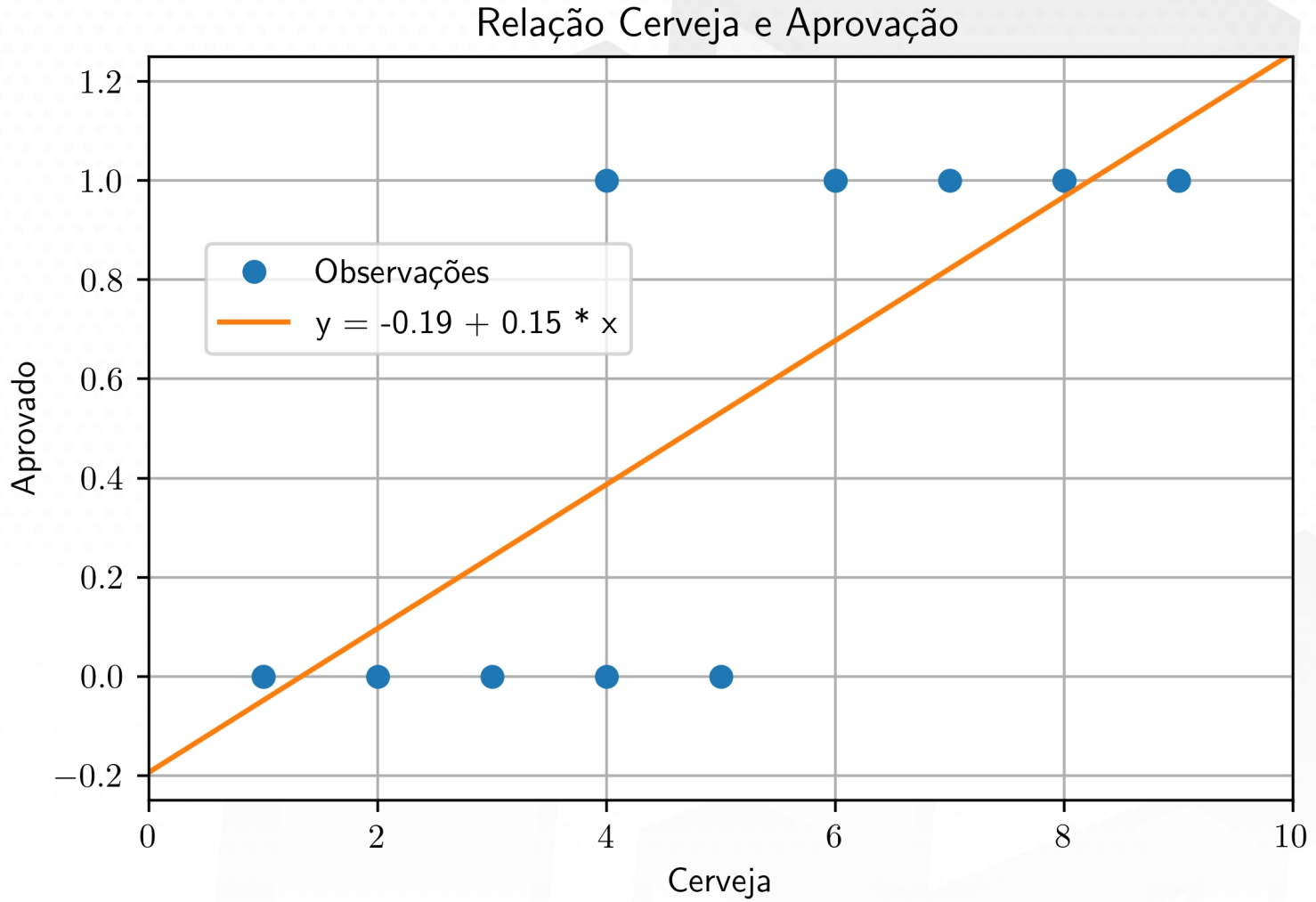


Métodos

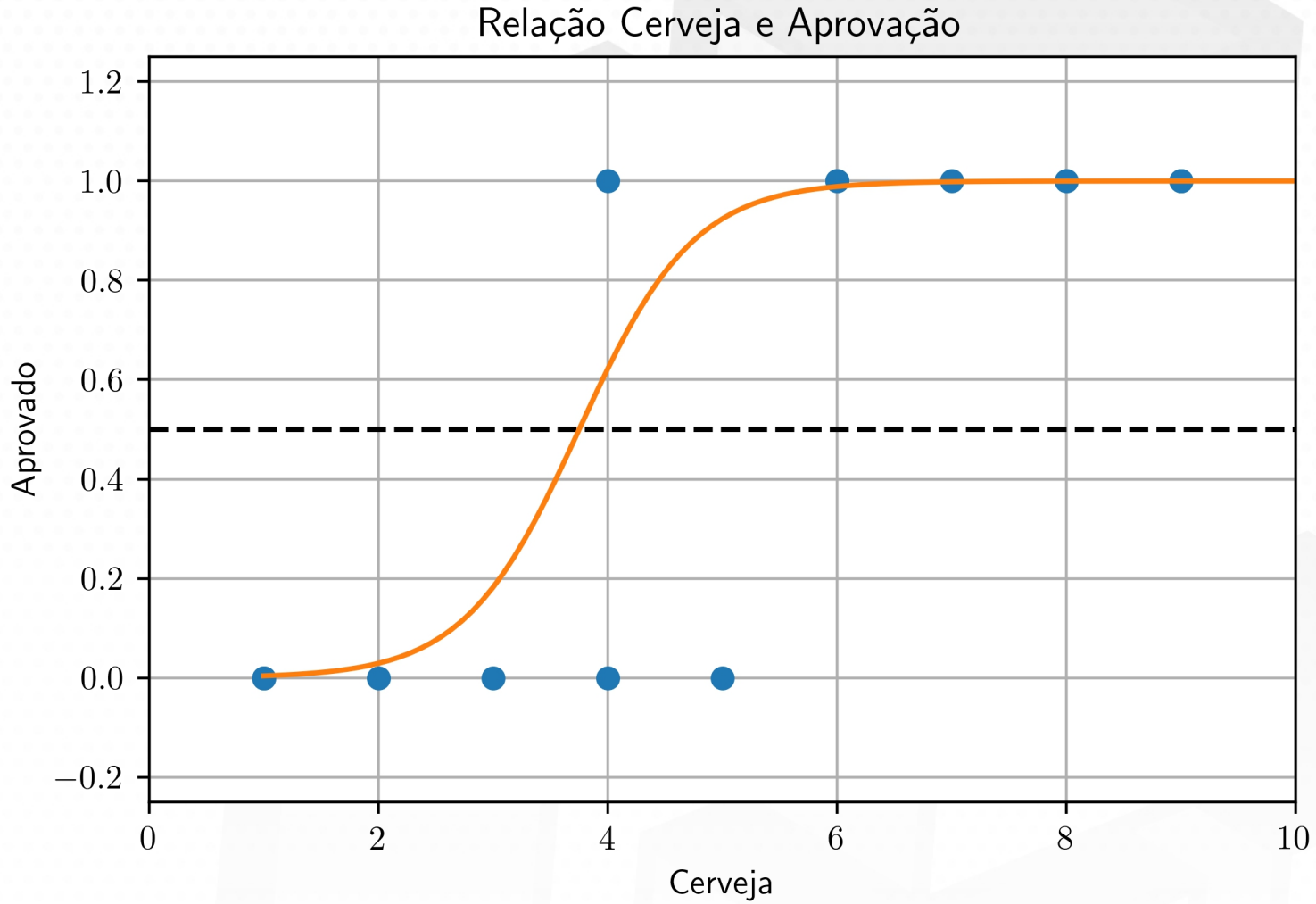
Regressão Logística



Regressão Logística

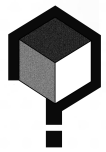


Regressão Logística

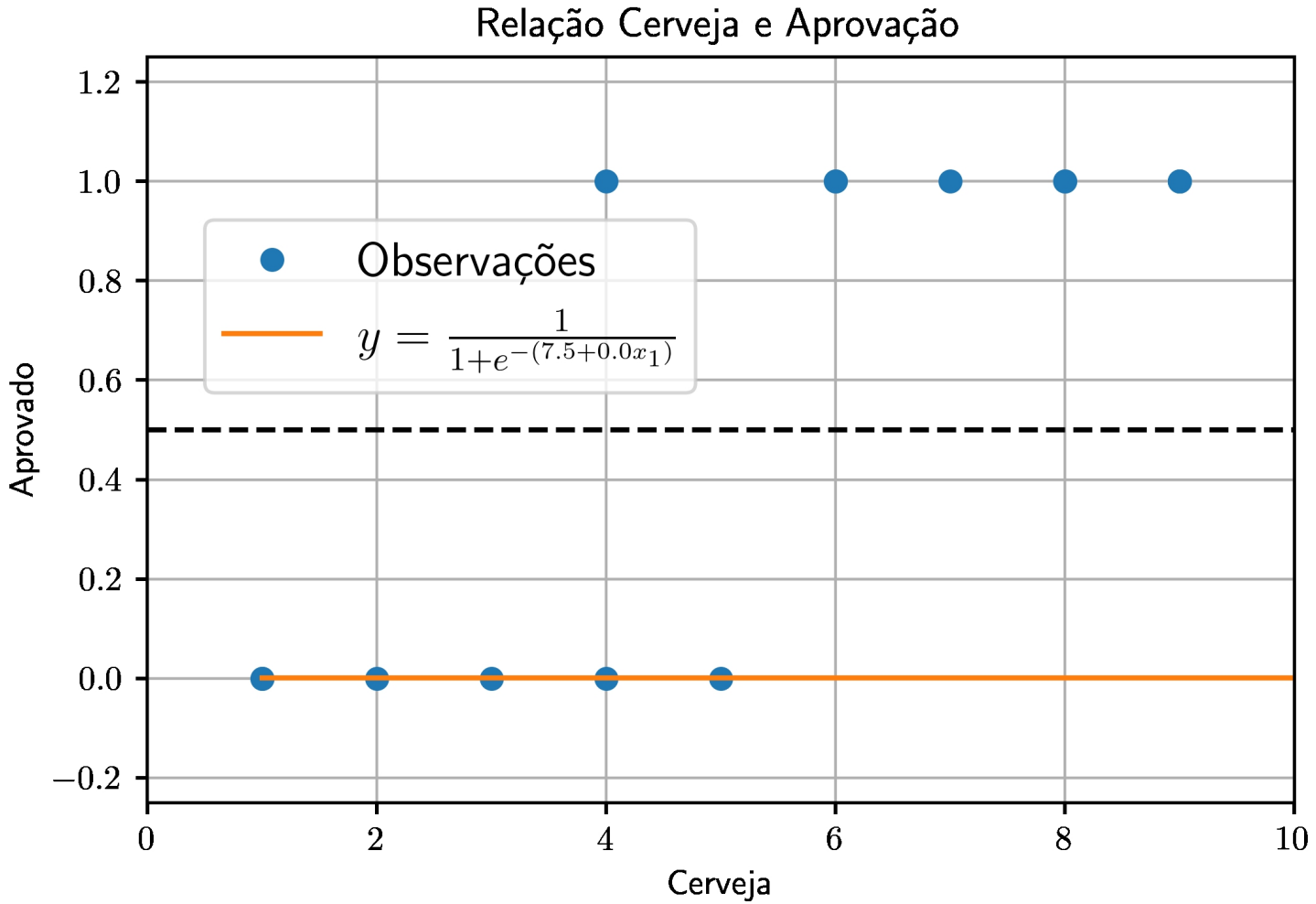


Regressão Logística

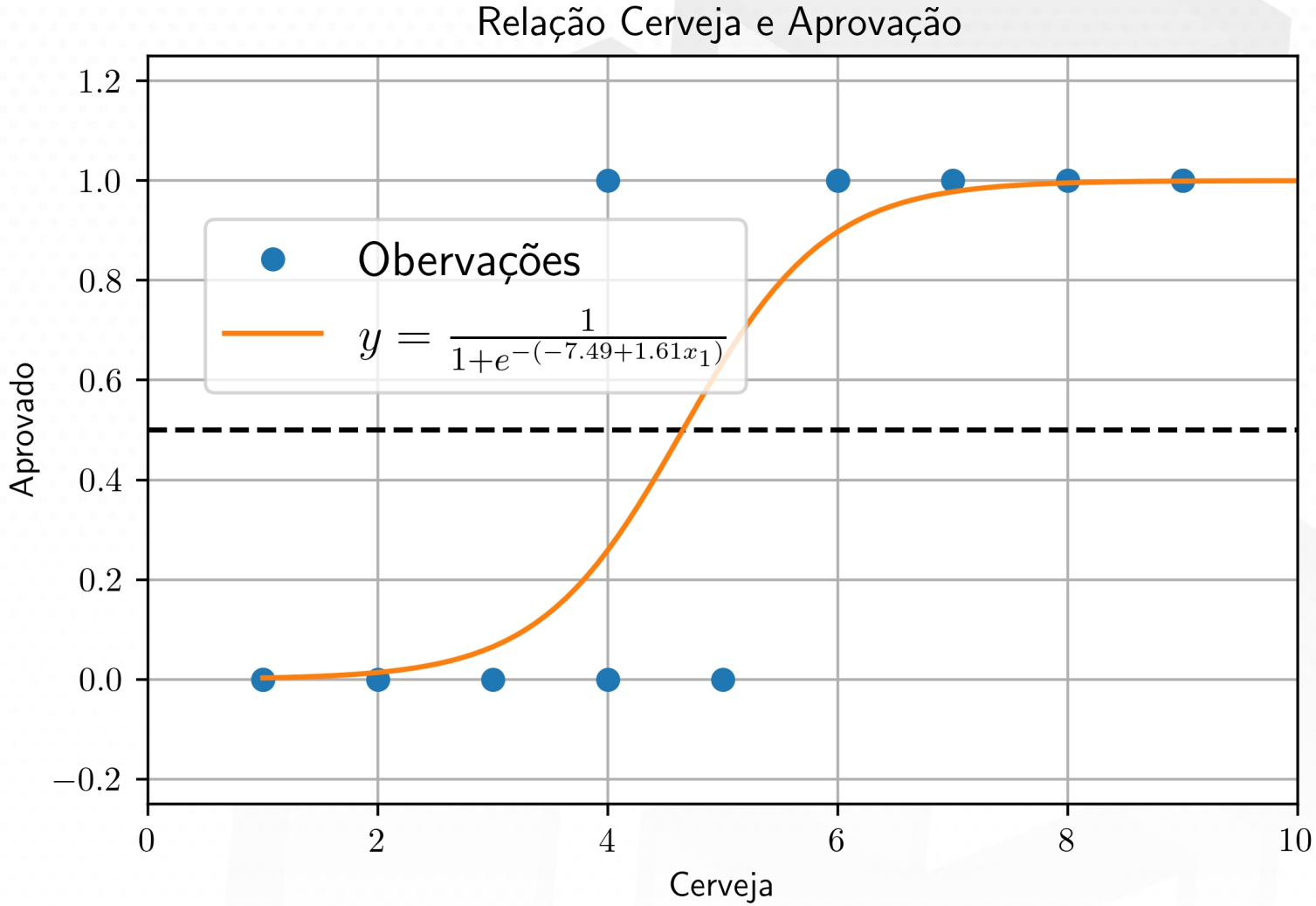
$$y = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1)}}$$



Regressão Logística



Regressão Logística

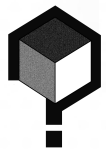


Regressão Logística

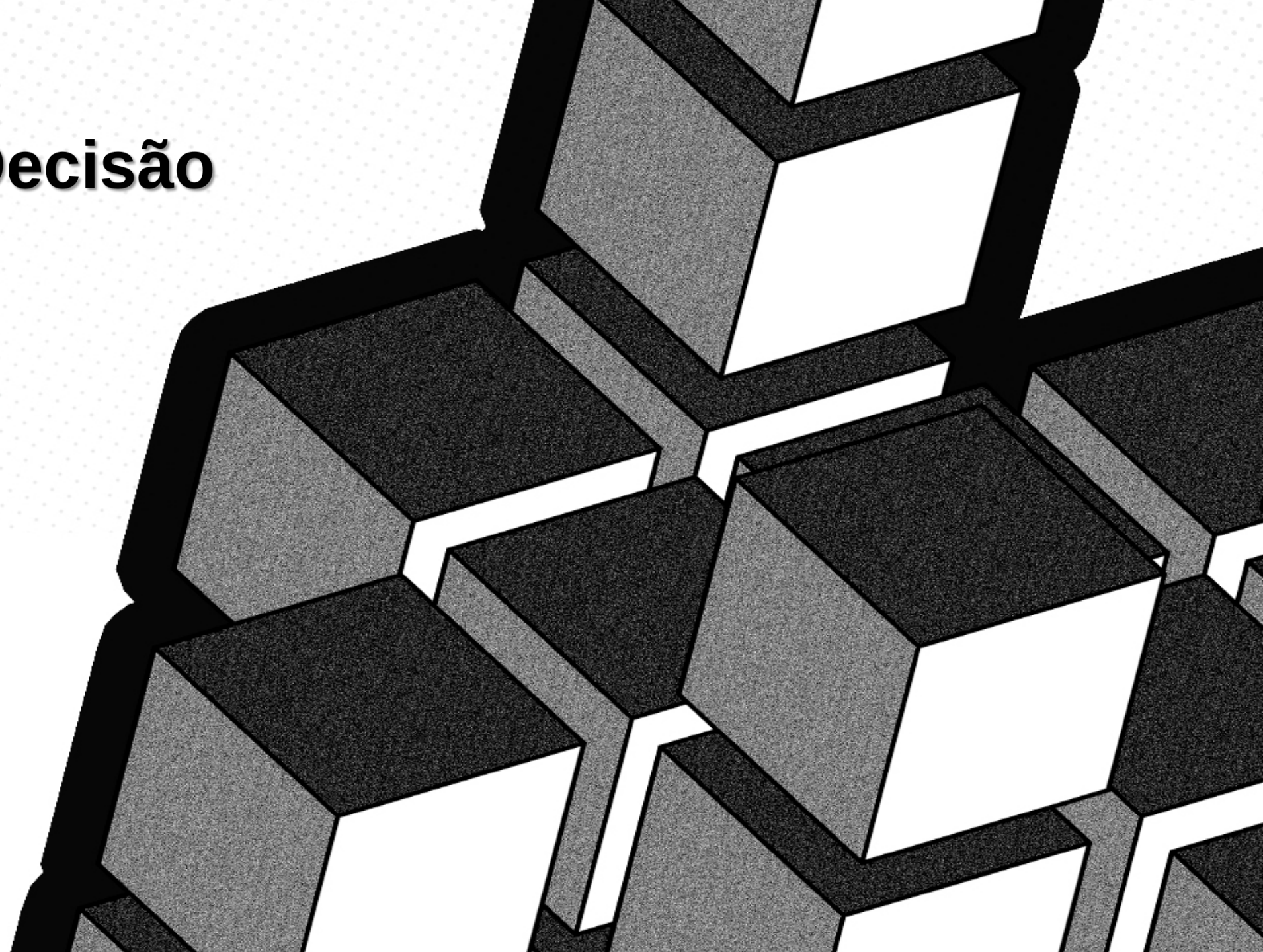
Log Loss

$$L_{\log}(y, p) = -(y\log(p) + (1 - y)\log(1 - p))$$

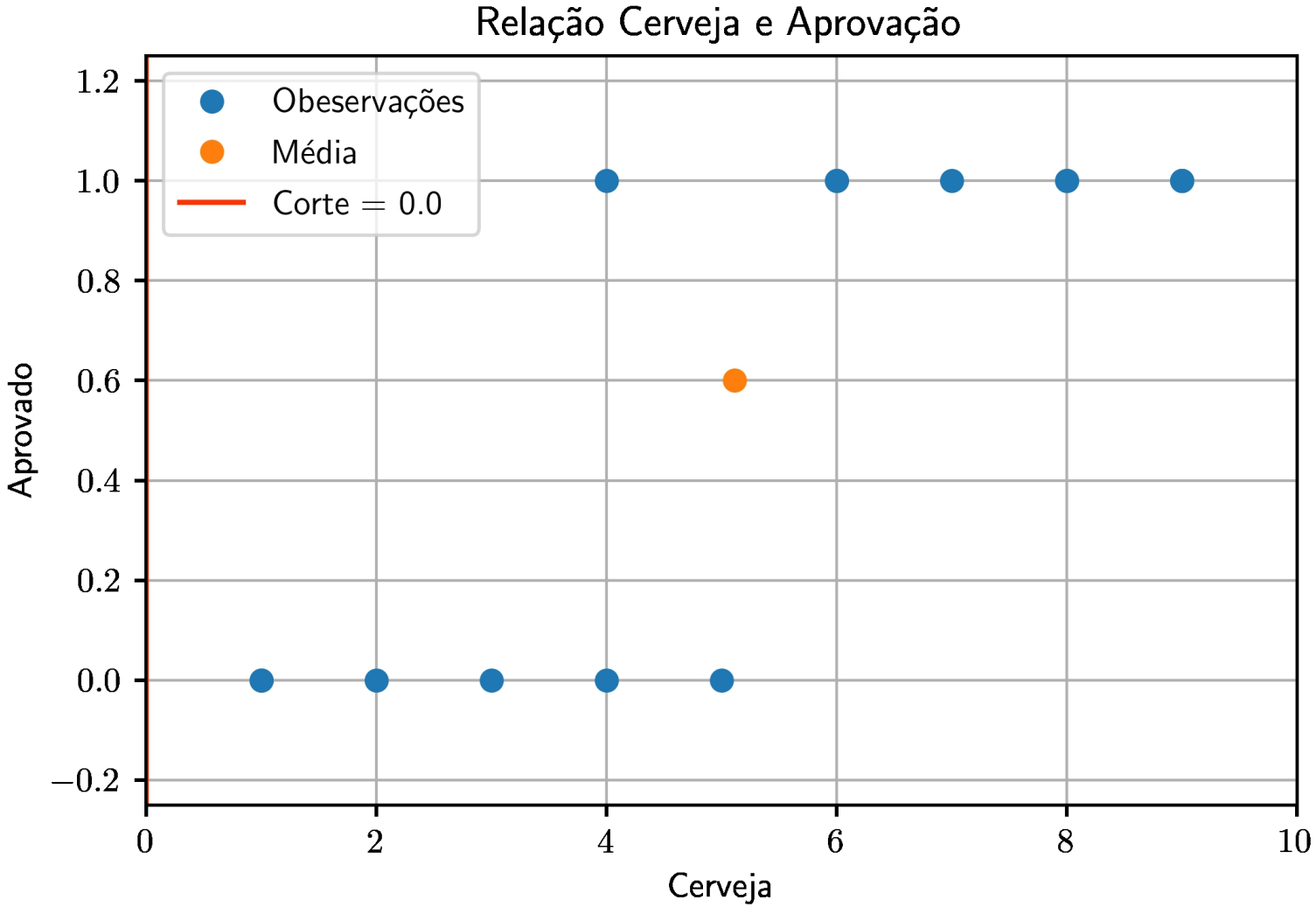
$$\sum_{i=1}^{n} L_{\log}(y_i, p_i) = -\sum_{i=1}^{n} (y_i\log(p_i) + (1 - y_i)\log(1 - p_i))$$



Árvore de Decisão



Árvore de Decisão

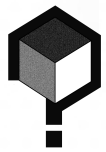


Árvore de Decisão

Anteriormente utilizamos a Soma dos Erros Quadráticos.

E Agora? Vamos usar qual medida?

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \|x_i - x_j\|}{2n^2 \bar{x}}$$



Árvore de Decisão

Há outras medidas?

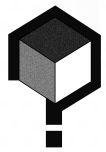
Sim!

Entropia!!

$$H = -[p \log_2(p) + (1-p) \log_2(1-p)]$$

De uma maneira mais genérica

$$H = -\sum_{i=1}^{c} p_i \log_2(p_i)$$



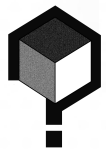
Árvore de Decisão

Gini

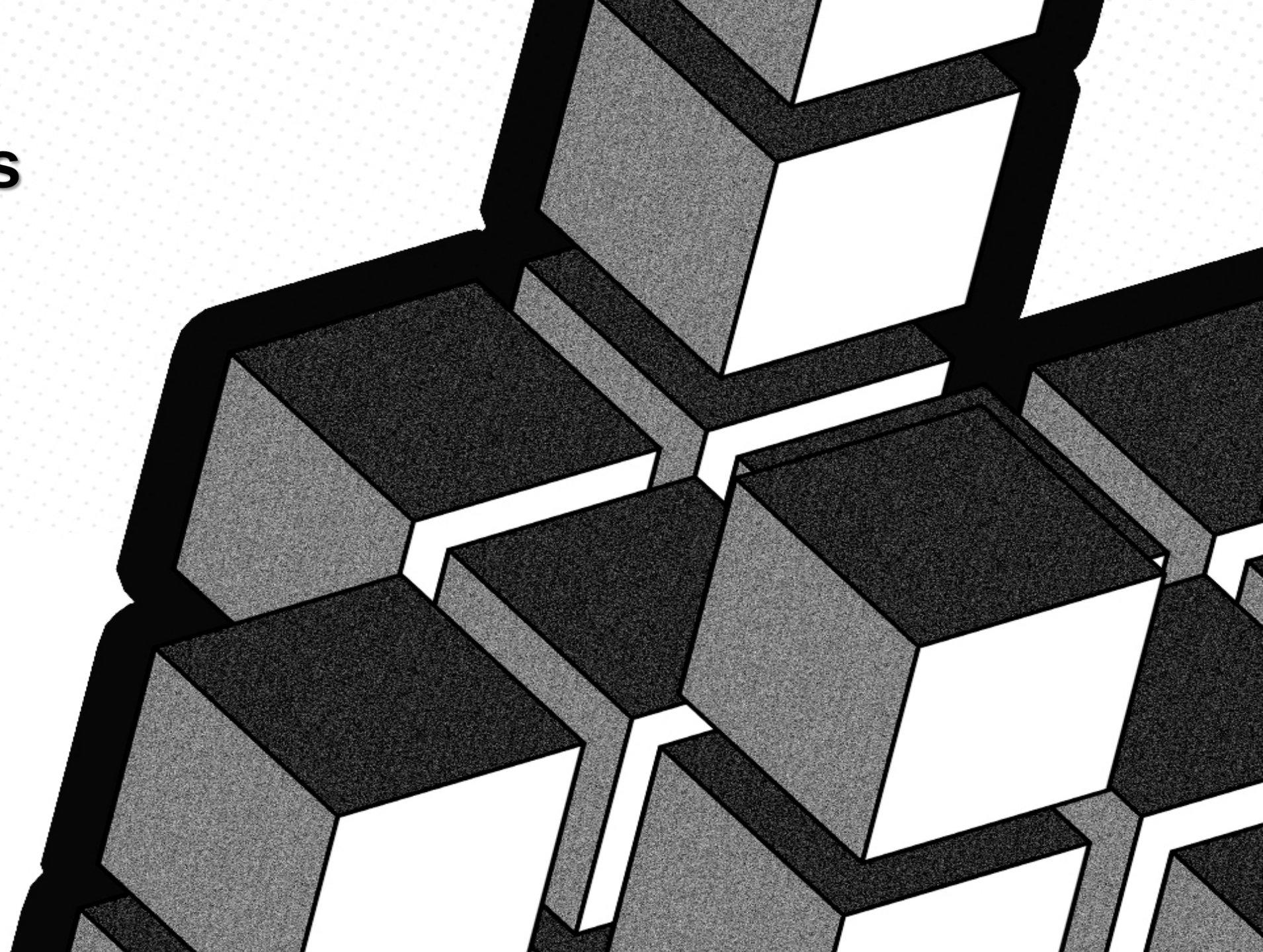
$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \|x_i - x_j\|}{2n^2 \bar{x}}$$

Entropia

$$H = -\sum_{i=1}^{c} p_i \log_2(p_i)$$

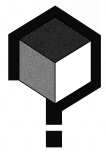


Naive Bayes



Naive-Bayes

$$P(A|B) = \frac{P(A)P(B|A)}{P(B)}$$



Naive-Bayes

y	X		
Diabetes	Histórico Familiar	Acima do Peso	Atividade Física
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0

$$y = \text{Diabetes}$$

$$x_1 = \text{Histórico Familiar}$$

$$x_2 = \text{Acima do Peso}$$

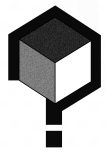
$$x_3 = \text{Atividade Física}$$

Naive-Bayes

$$P(A|B) = \frac{P(A)P(B|A)}{P(B)}$$

$$P(y|X) = P(y|x_1, x_2, x_3) = \frac{P(y)P(x_1, x_2, x_3|y)}{P(x_1, x_2, x_3)}$$

$$P(y|X) = \frac{P(y)P(x_1|y)P(x_2|y)P(x_3|y)}{P(x_1, x_2, x_3)} = \frac{P(y)\prod_{i=1}^{p} P(x_i|y)}{P(X)}$$



Naive-Bayes

y	X		
Diabetes	Histórico Familiar	Acima do Peso	Atividade Física
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0

$$P(y = 1) =$$

$$P(x_1|y = 1) =$$

$$P(x_2|y = 1) =$$

$$P(x_3|y = 1) =$$

Naive-Bayes

y	X		
Diabetes	Histórico Familiar	Acima do Peso	Atividade Física
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0

$$P(y = 0) =$$

$$P(x_1|y = 0) =$$

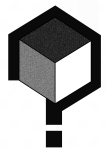
$$P(x_2|y = 0) =$$

$$P(x_3|y = 0) =$$

Naive-Bayes

$$P(x_1, x_2, x_3)$$

$$P(x_1, x_2, x_3) = P(y = 1)P(x_1, x_2, x_3|y = 1)$$
$$+P(y = 0)P(x_1, x_2, x_3|y = 0)$$



Naive-Bayes

Juntando tudo

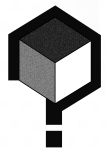
Naive-Bayes

Complicando um pouco, mas nem tanto

Distribuição Bernoulli

$$f(x_i; \theta) = \theta^{x_i}(1-\theta)^{1-x_i}$$

$$f(x_i; \theta|y) = \theta_y^{x_i}(1-\theta_y)^{1-x_i}$$



Naive-Bayes

Para “Histórico familiar”

y	X		
Diabetes	Histórico Familiar	Acima do Peso	Atividade Física
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0

$$f(x_1;\theta) =$$

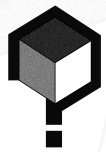
$$f(x_1;\theta|y=1) =$$

$$f(x_1;\theta|y=0) =$$

Naive-Bayes

Para “Acima do Peso”

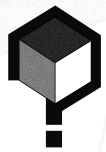
y	X		
Diabetes	**Histórico Familiar**	**Acima do Peso**	**Atividade Física**
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0



Naive-Bayes

Para “Atividade Física”

y	X		
Diabetes	**Histórico Familiar**	**Acima do Peso**	**Atividade Física**
1	1	1	1
1	1	1	0
1	0	1	0
1	1	0	0
0	1	0	1
0	0	1	1
0	0	0	0



Naive-Bayes

Juntando tudo

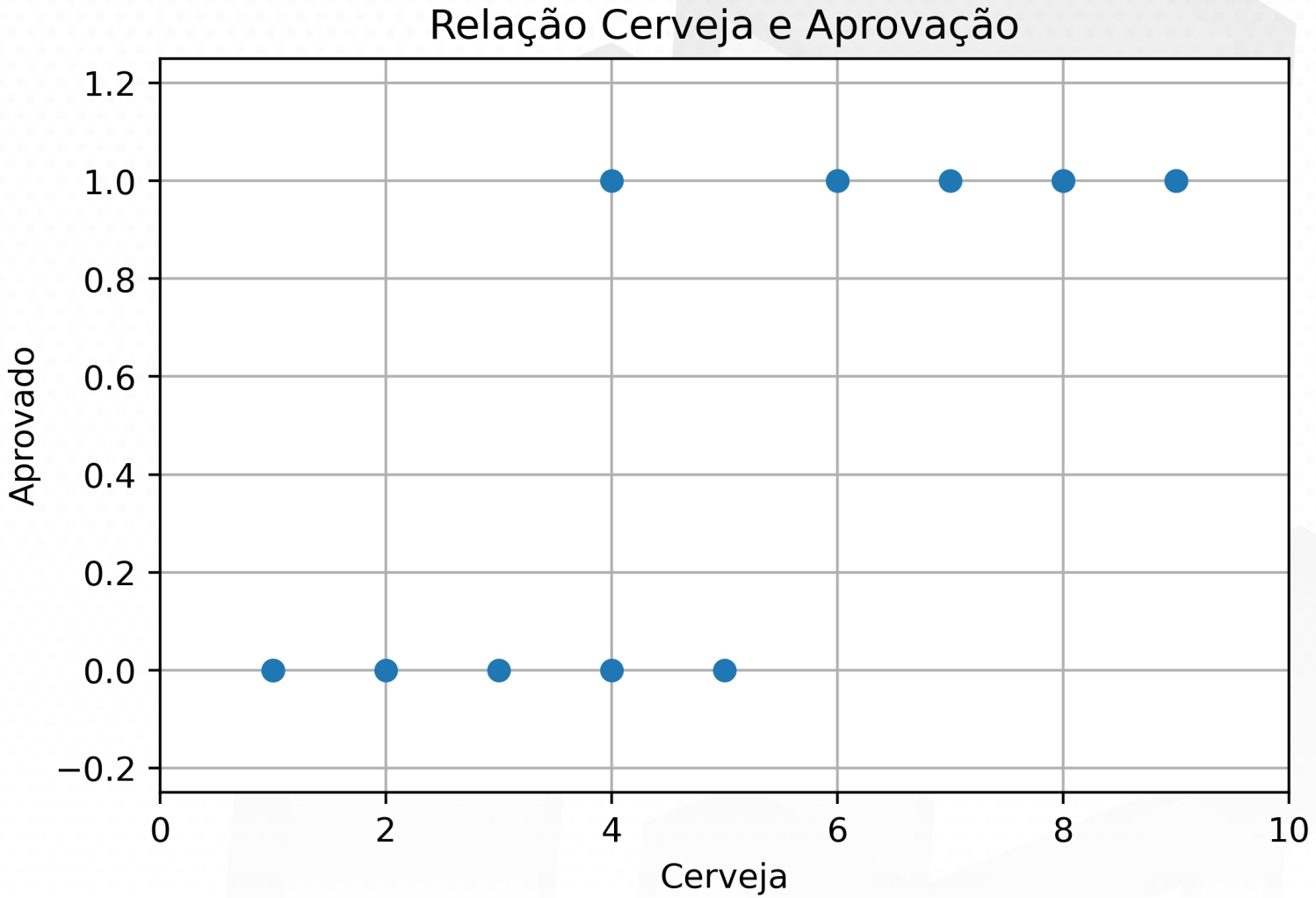
Naive-Bayes

A fórmula mais genérica

$$P(y_c|X) = \frac{P(y_c)\prod_{i=1}^{p} f(x_i;\theta|y_c)}{P(X)}$$

$$P(y_c|X) = \frac{P(y_c)\prod_{i=1}^{p} f(x_i;\theta|y_c)}{\sum_{c=0}^{C} P(y_c)\prod_{i=1}^{p} f(x_i;\theta|y_c)}$$

Voltando à Cerveja e Aprovação



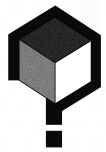
Voltando à Cerveja e Aprovação

Nossas variáveis são numéricas e não mais booleanas ou categóricas!!

Podemos usar outra distribuição para x?

$$f(x; \mu, \sigma^2) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$$

Distribuição Normal



Voltando à Cerveja e Aprovação

Estatísticas de **Cerveja**

Média: 5,46
Variância: 8.26
Desvio Padrão: 2.87

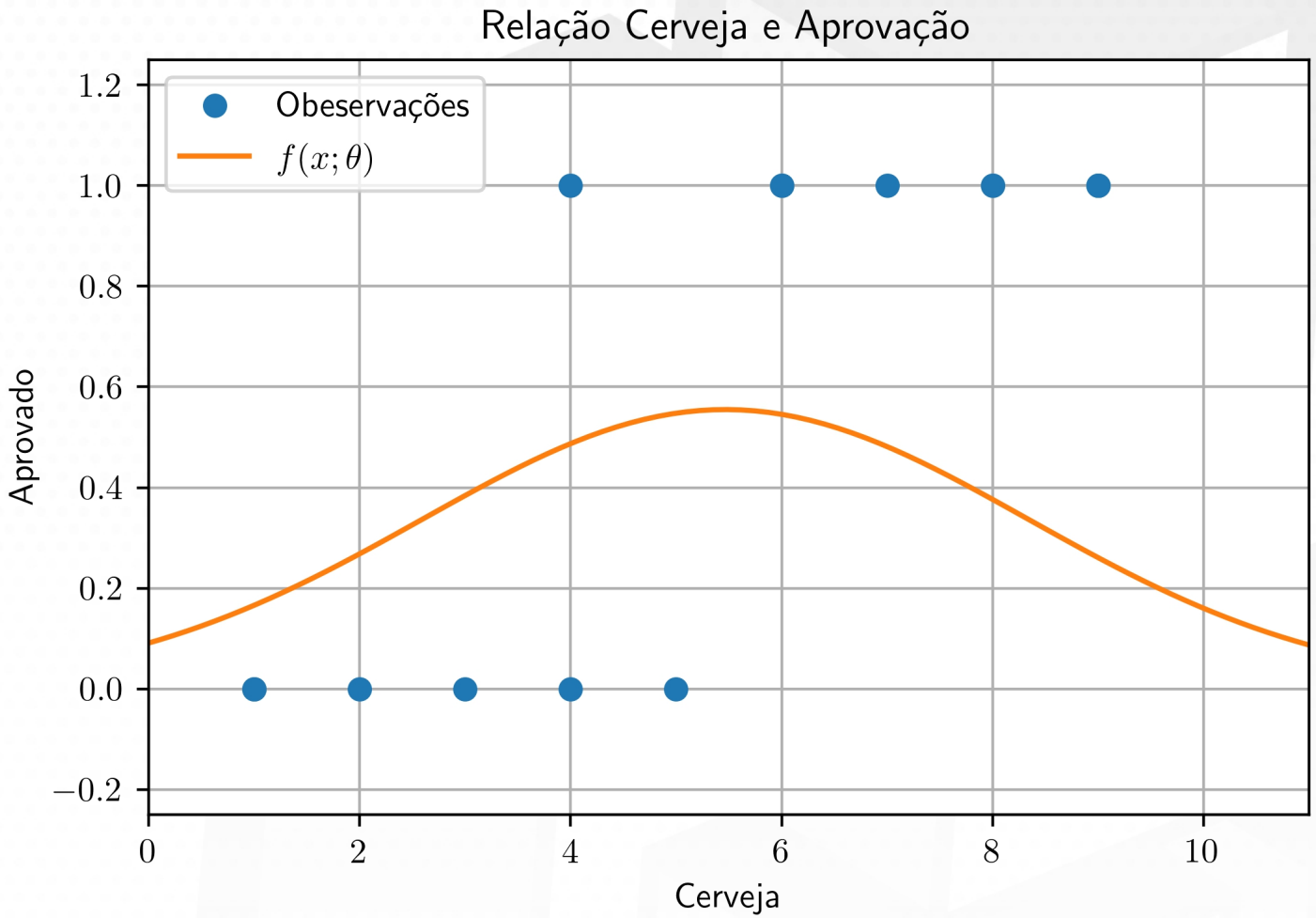
Estatísticas de **Cerveja | Nota = 0**

Média: 2,66
Variância: 2.66
Desvio Padrão: 1.63

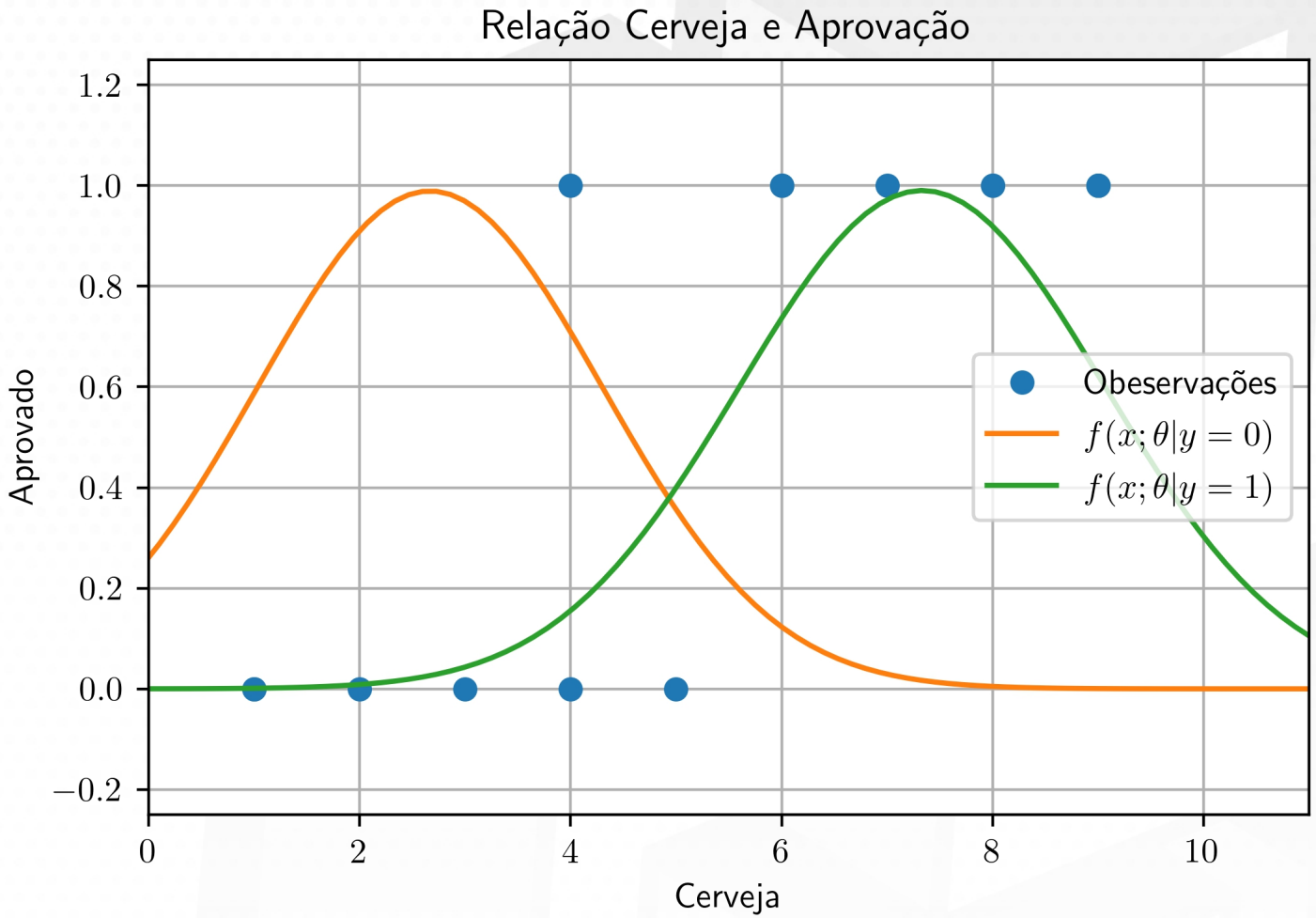
Estatísticas de **Cerveja | Nota = 1**

Média: 7,33
Variância: 3.00
Desvio Padrão: 1.73

Voltando à Cerveja e Aprovação

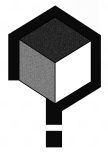


Voltando à Cerveja e Aprovação



Naive-Bayes

$$\hat{y} = \arg\max_y P(y)P(X|y)$$



Métricas de Ajuste

Canal Téo Me Why

- Matriz de Confusão
- Acurácia
- Precisão
- Recall
- Curva ROC

Obrigado

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