

# Estatística Monte Carlo e fundamentos de programação em R para ecologia

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Ilhéus - BA

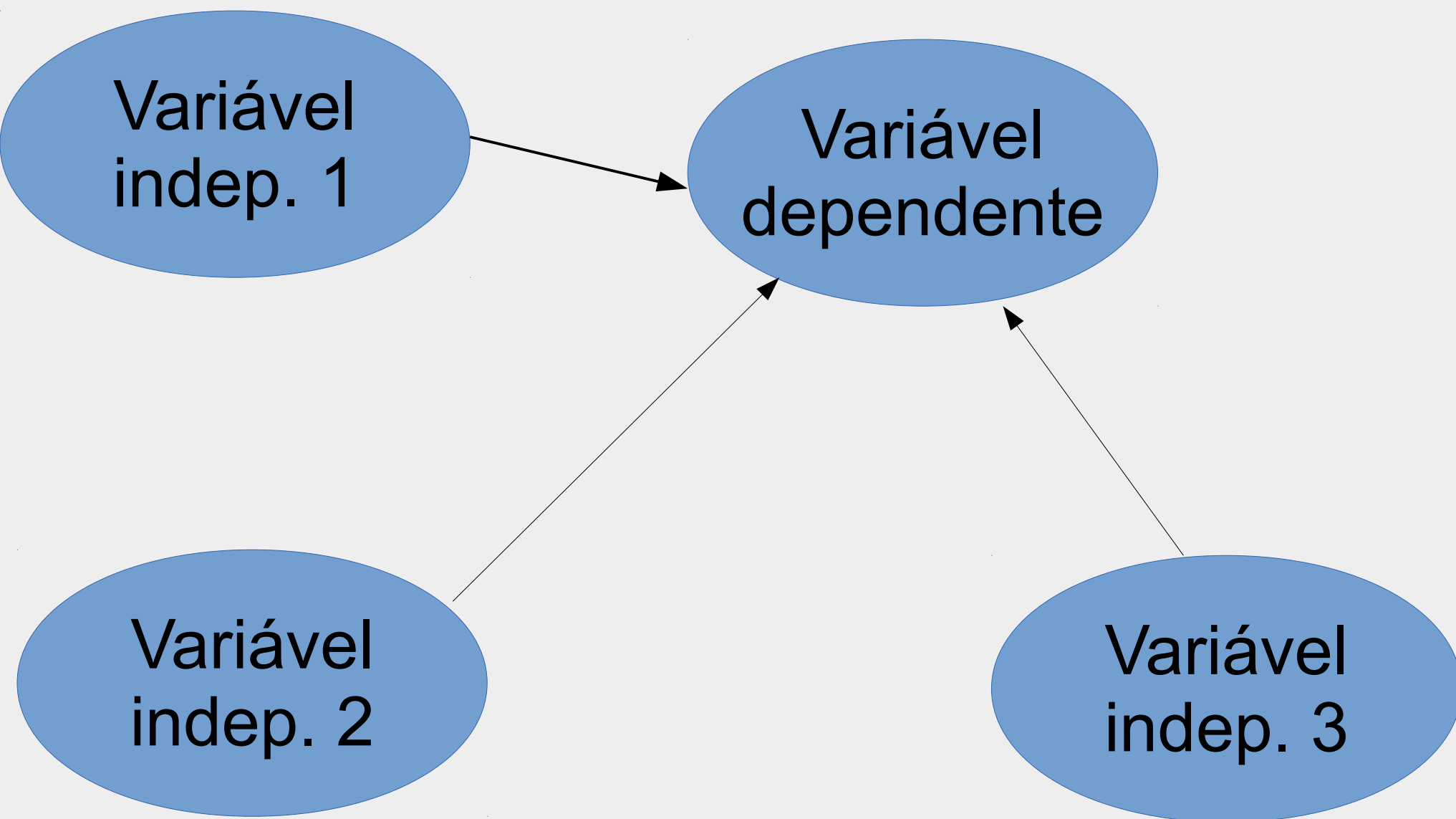
# Aula teórica 3 – Permutações II

Regressão múltipla

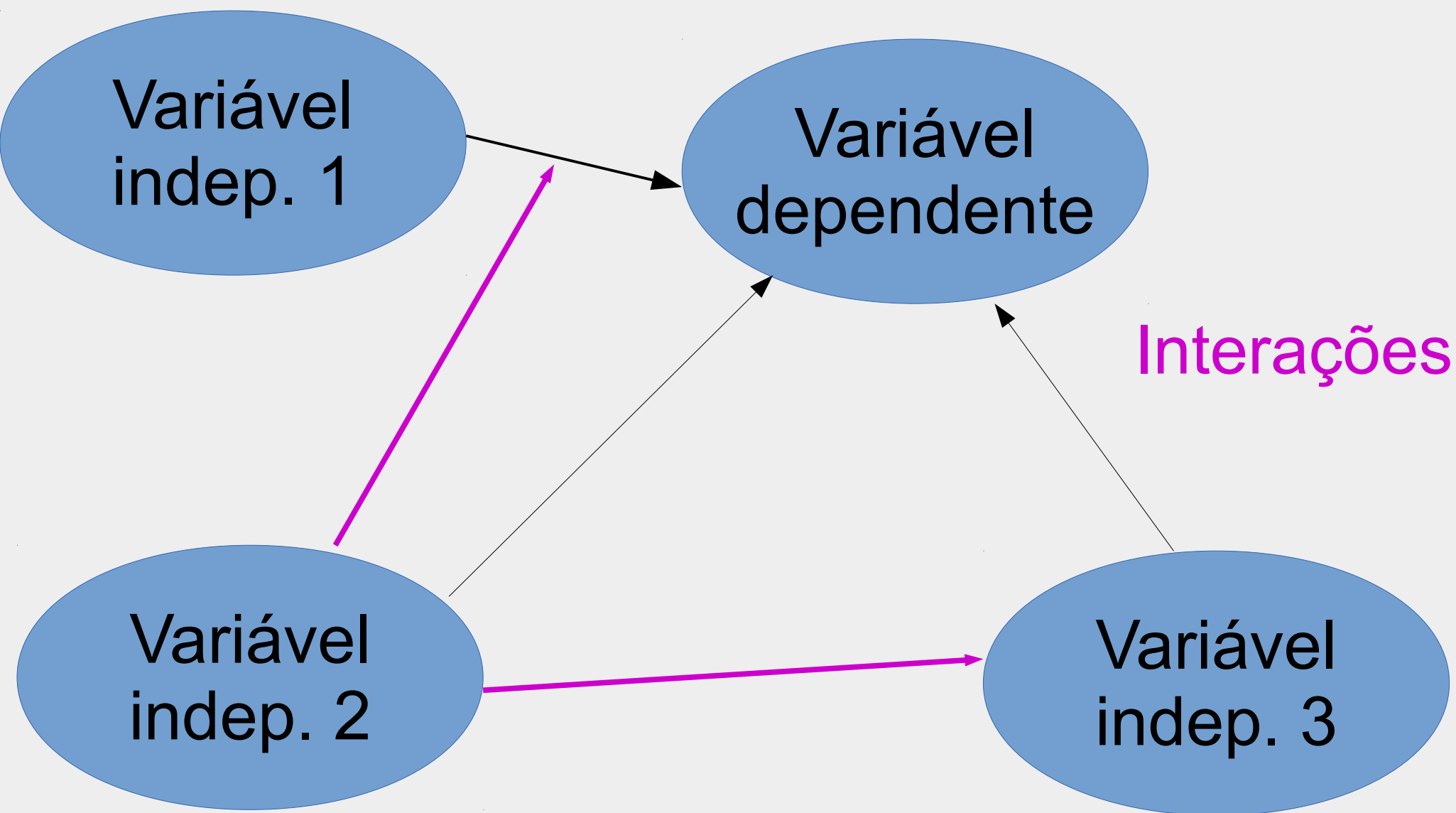
Teste de Mantel

PERMANOVA

# Regressão múltipla

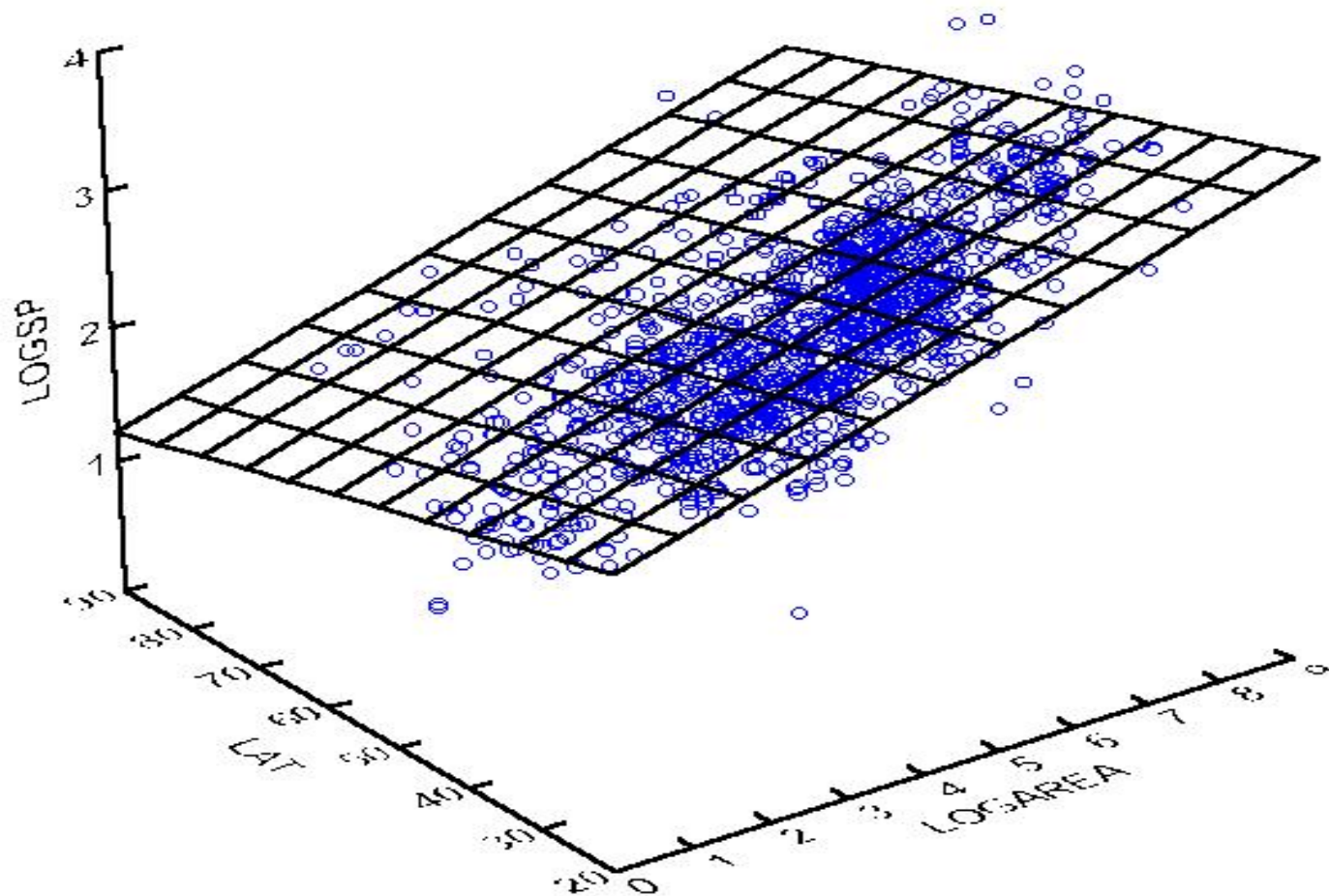


# Regressão múltipla



# Regressão múltipla

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_p X_{pi} + \epsilon_i$$



# Notação matricial

$$Y = X\beta + \epsilon$$

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_{11} & x_{12} & \dots & x_{1p} \\ 1 & x_{21} & x_{22} & \dots & x_{2p} \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & x_{n1} & x_{n2} & \dots & x_{np} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{bmatrix} + \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \\ \epsilon_n \end{bmatrix}$$

# Estatística de teste

$$Y = X\beta + \epsilon$$



# Estatística de teste

$$Y = X\beta + \epsilon$$

**F:** Variação  
explicada /  
variação residual



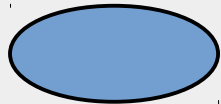
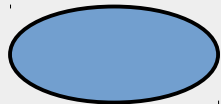
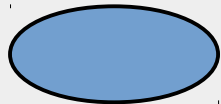
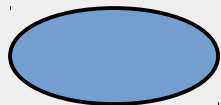
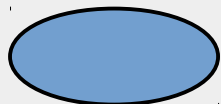
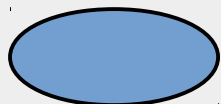
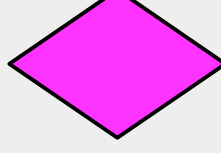
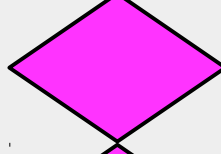
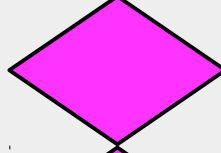
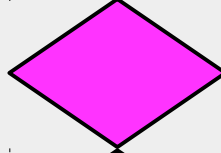
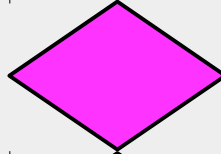
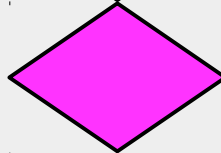
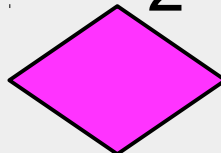
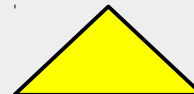
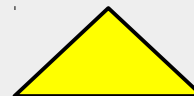
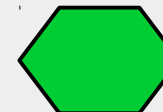
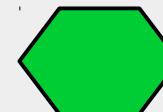
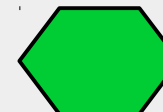
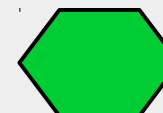
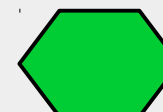
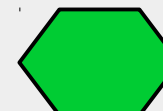
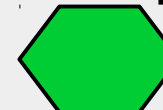
# Estatística de teste

$$Y = X\beta + \epsilon$$

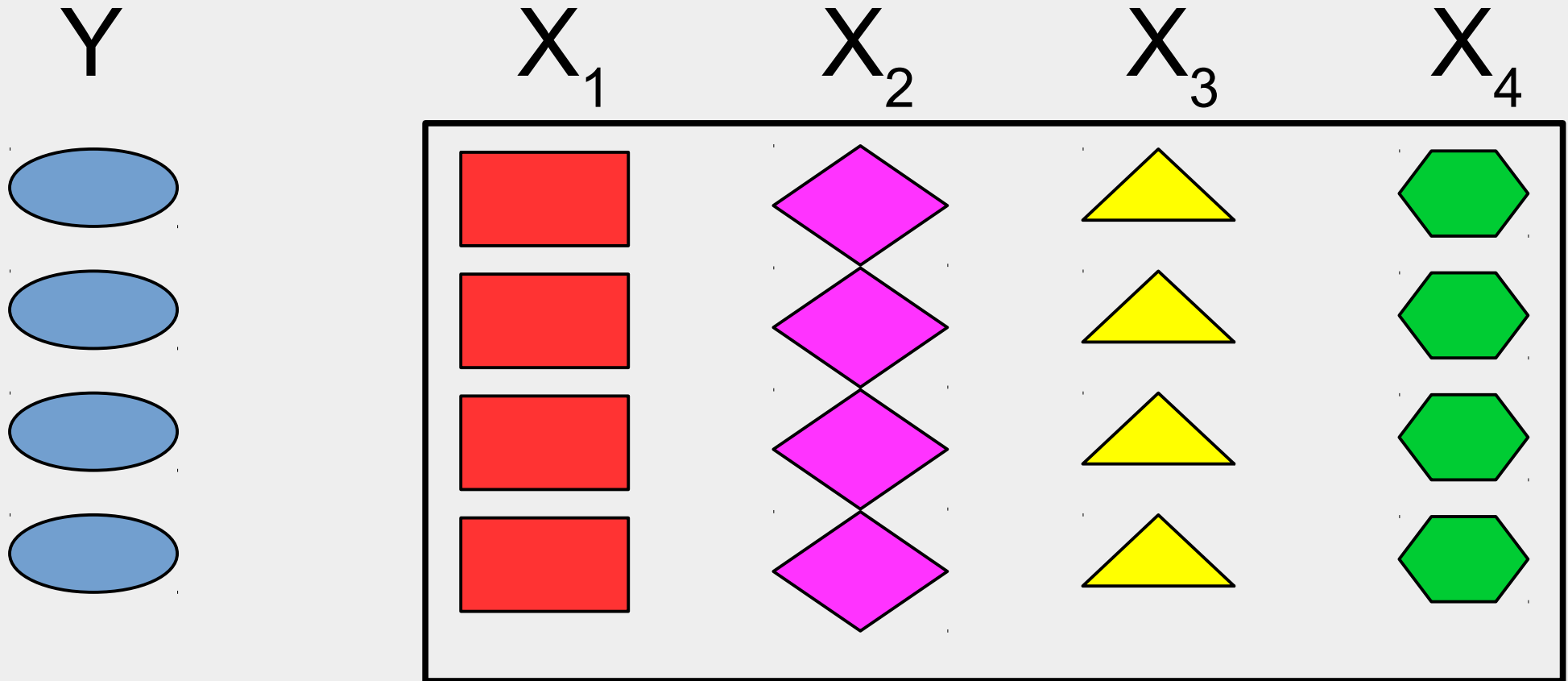
**R<sup>2</sup>**: quantidade de  
variação em Y  
que é explicada  
pelo modelo

# Como aleatorizar?

**Y**

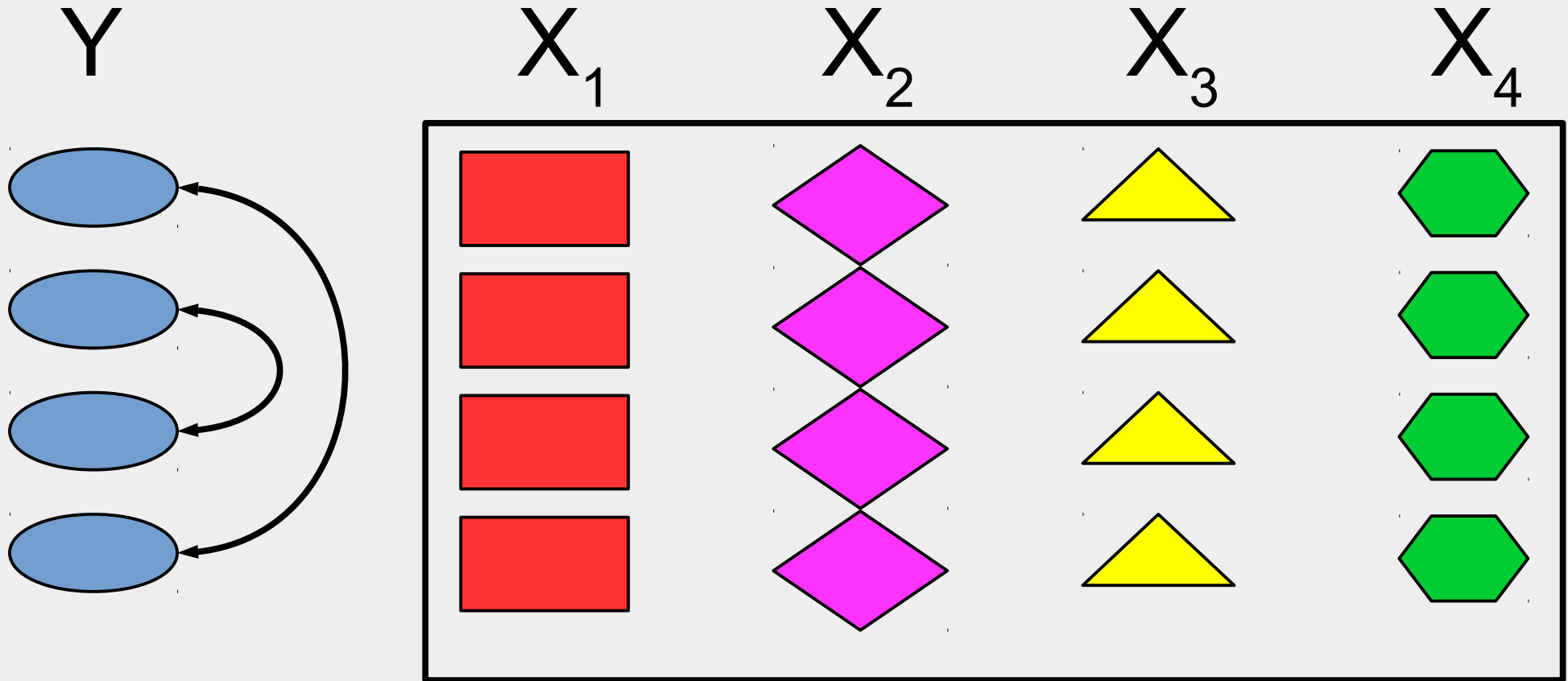
 $x_1$ 
$$X_2$$

$$X_3$$
X<sub>4</sub>

# Depende da pergunta...



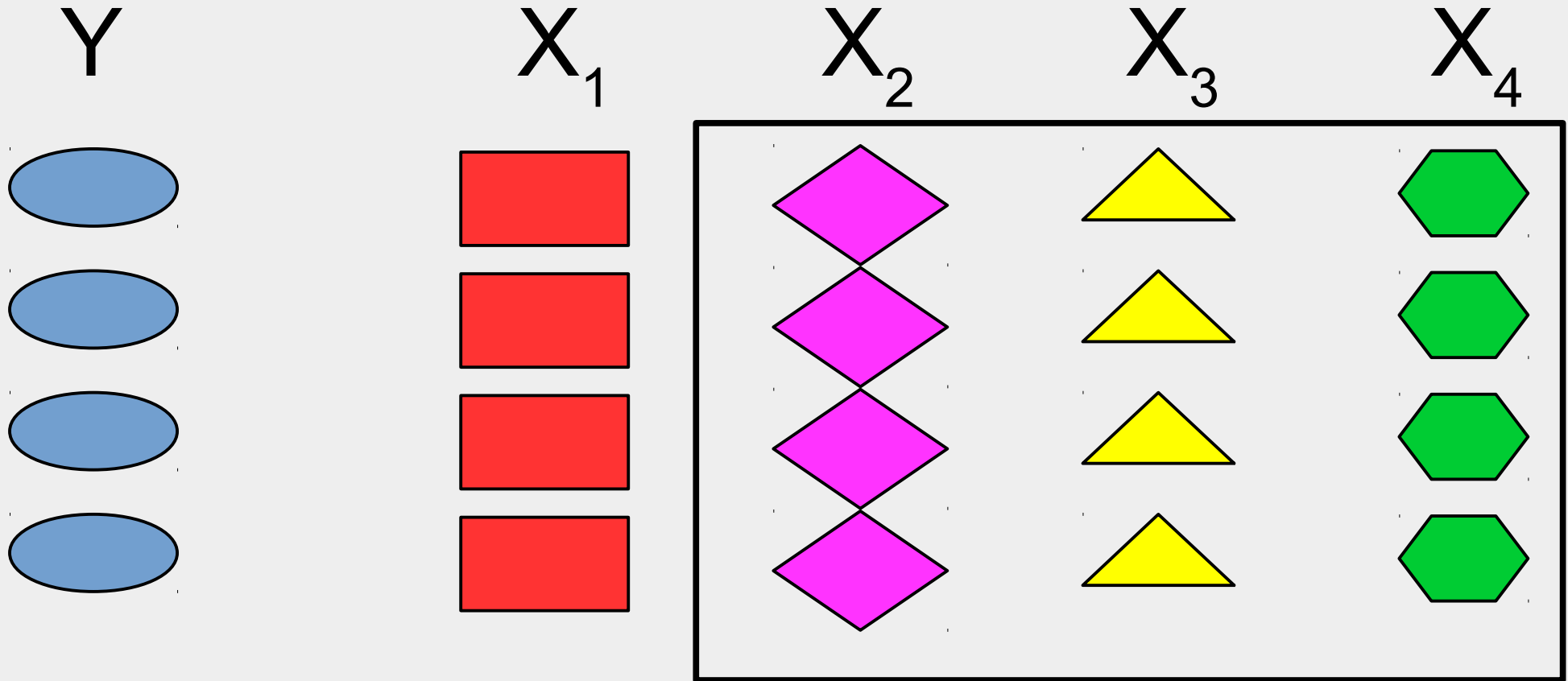
Efeito de todas as variáveis  
juntas

# Depende da pergunta...



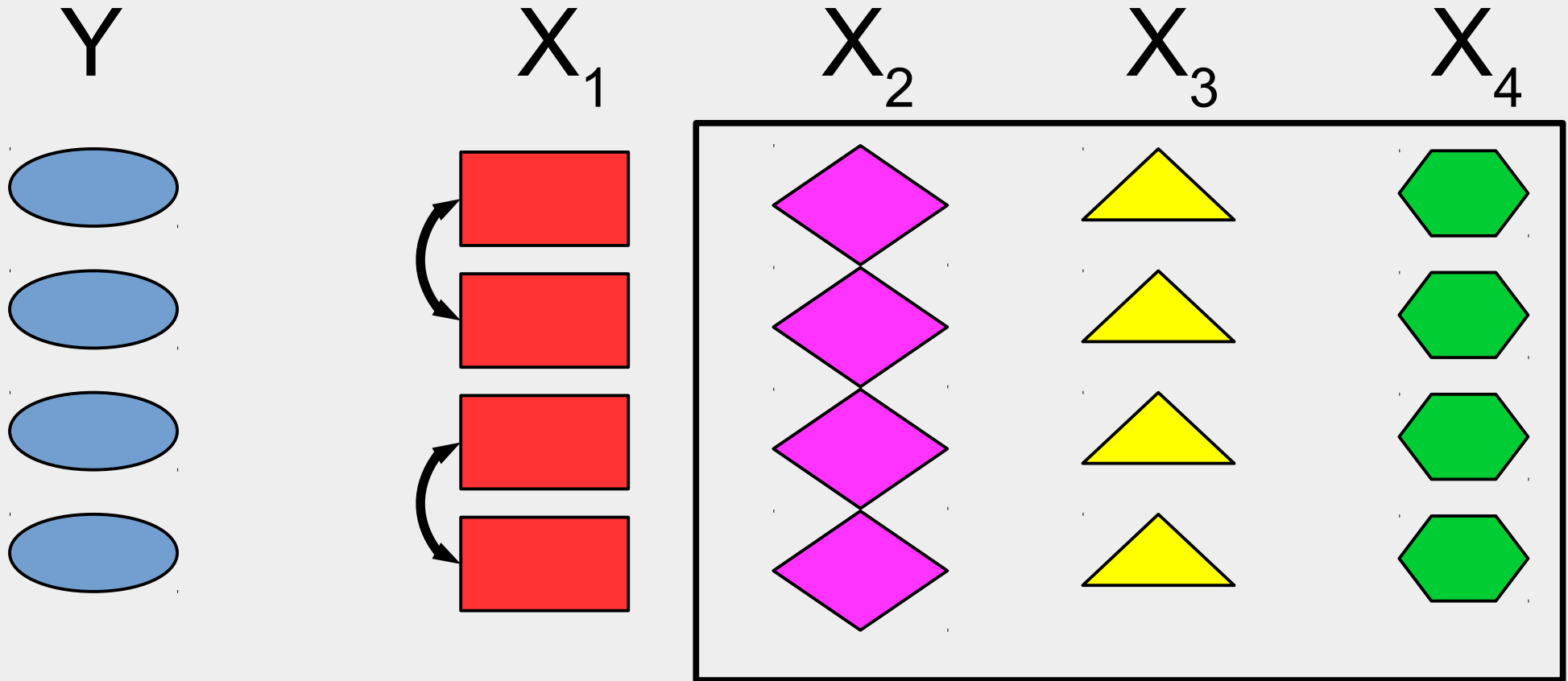
Efeito de todas as variáveis  
juntas

# Depende da pergunta...



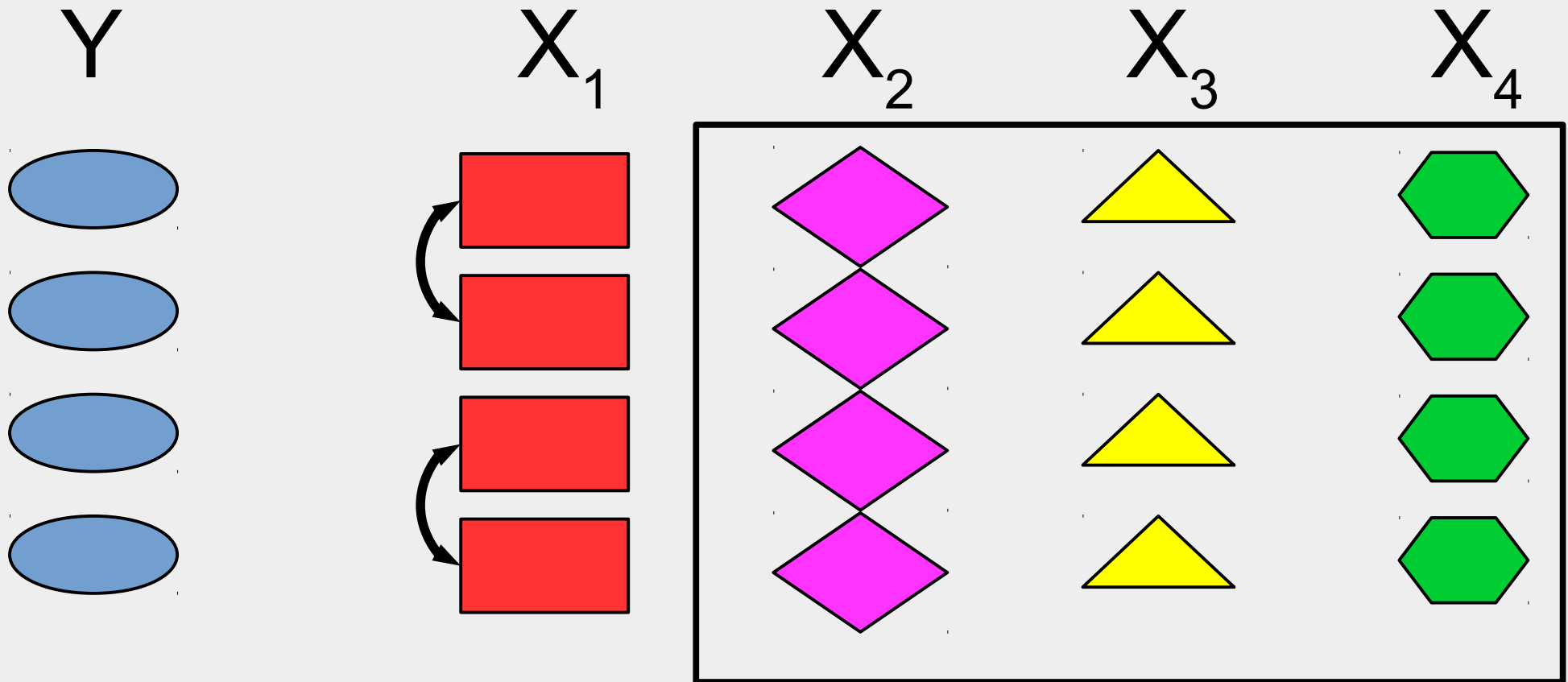
Efeito de uma variável depois de controlar pelos efeitos das outras

# Depende da pergunta...



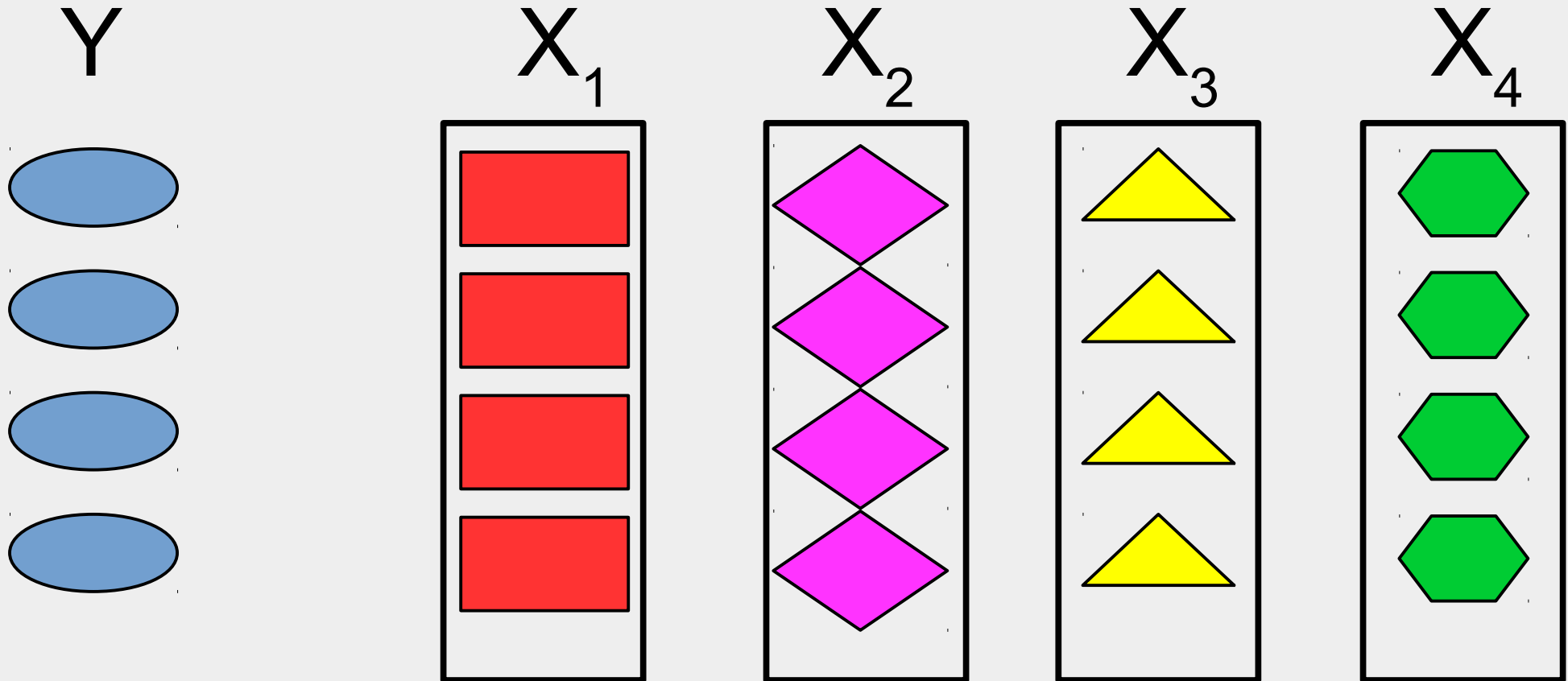
Efeito de uma variável depois de controlar pelos efeitos das outras

# Depende da pergunta...



Equivale a comparar o modelo completo com um reduzido

# Depende da pergunta...



Determinar quais variáveis de fato importam



# Determinar quais variáveis importam

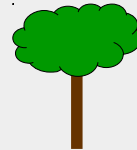
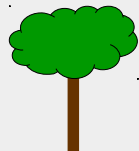
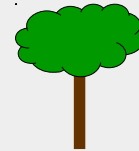
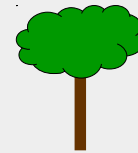
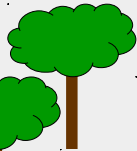
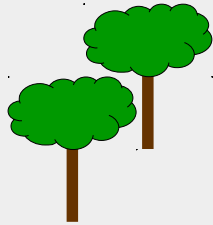
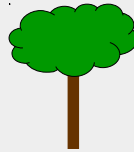
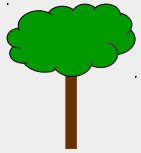
Testes sequencias entre modelos aninhados  
Seleção de modelos + *bootstrap*  
*Multi-model inference*

# Determinar quais variáveis importam

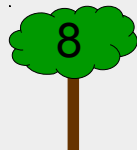
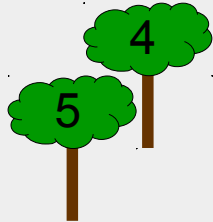
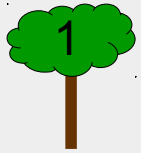
Testes sequencias entre modelos aninhados  
Seleção de modelos + *bootstrap*  
*Multi-model inference*

Quem sabe em outra disciplina... :-)  
(Exceto *bootstrap* semana que vem!)

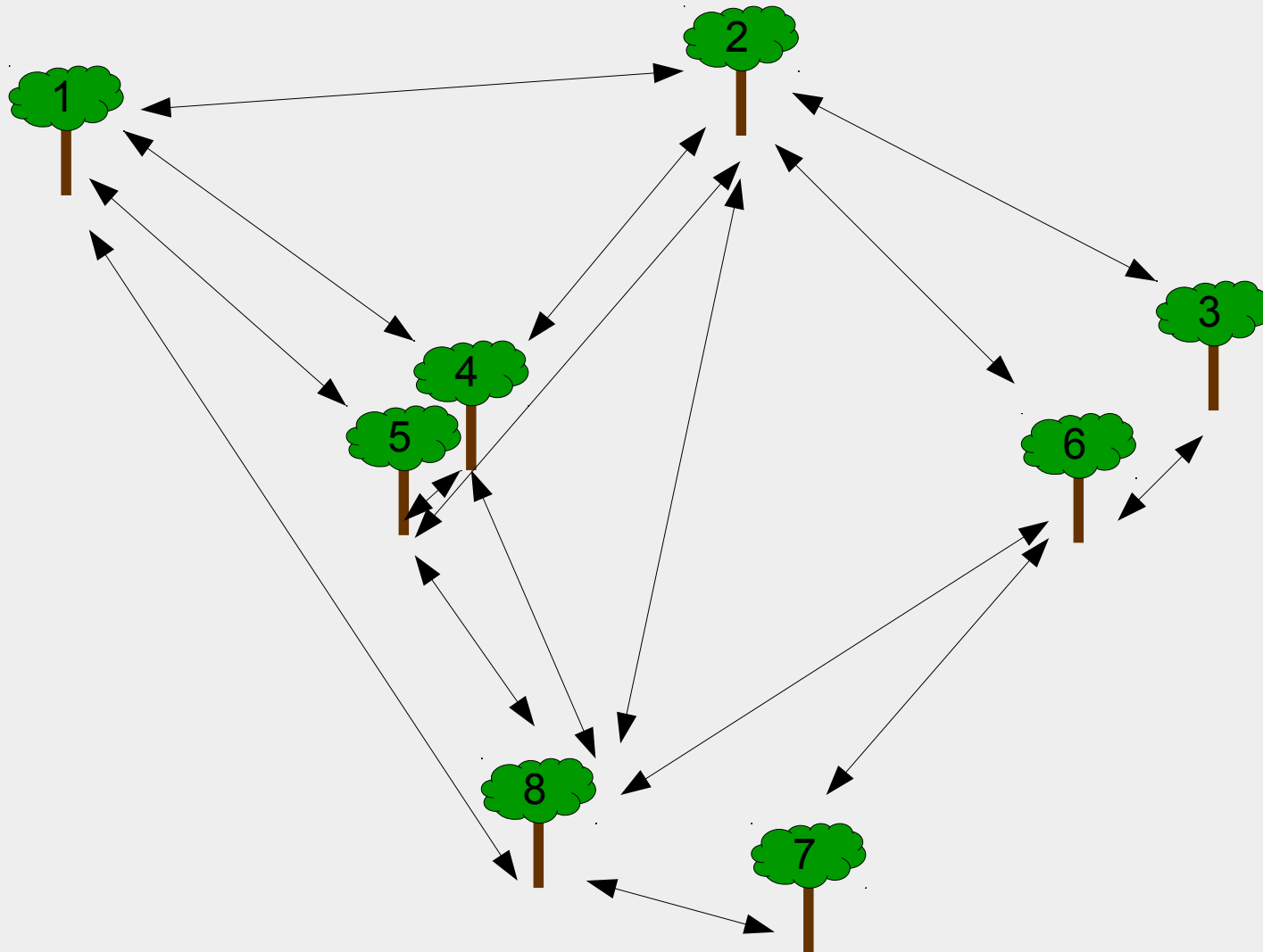
# Matrizes de distância



# Matrizes de distância



# Matrizes de distância



# Matrizes de distância

	1	2	3	4	5	6	7	8
1		5	10	4	4	11	13	12
2			5	5	4	6	12	10
3				6	6	2	9	8
4					1	5	5	6
5						5	3	5
6							5	7
7								2
8								

# Matrizes de distância

	1	2	3	4	5	6	7	8
1	0	5	10	4	4	11	13	12
2		0	5	5	4	6	12	10
3			0	6	6	2	9	8
4				0	1	5	5	6
5					0	5	3	5
6						0	5	7
7							0	2
8								0

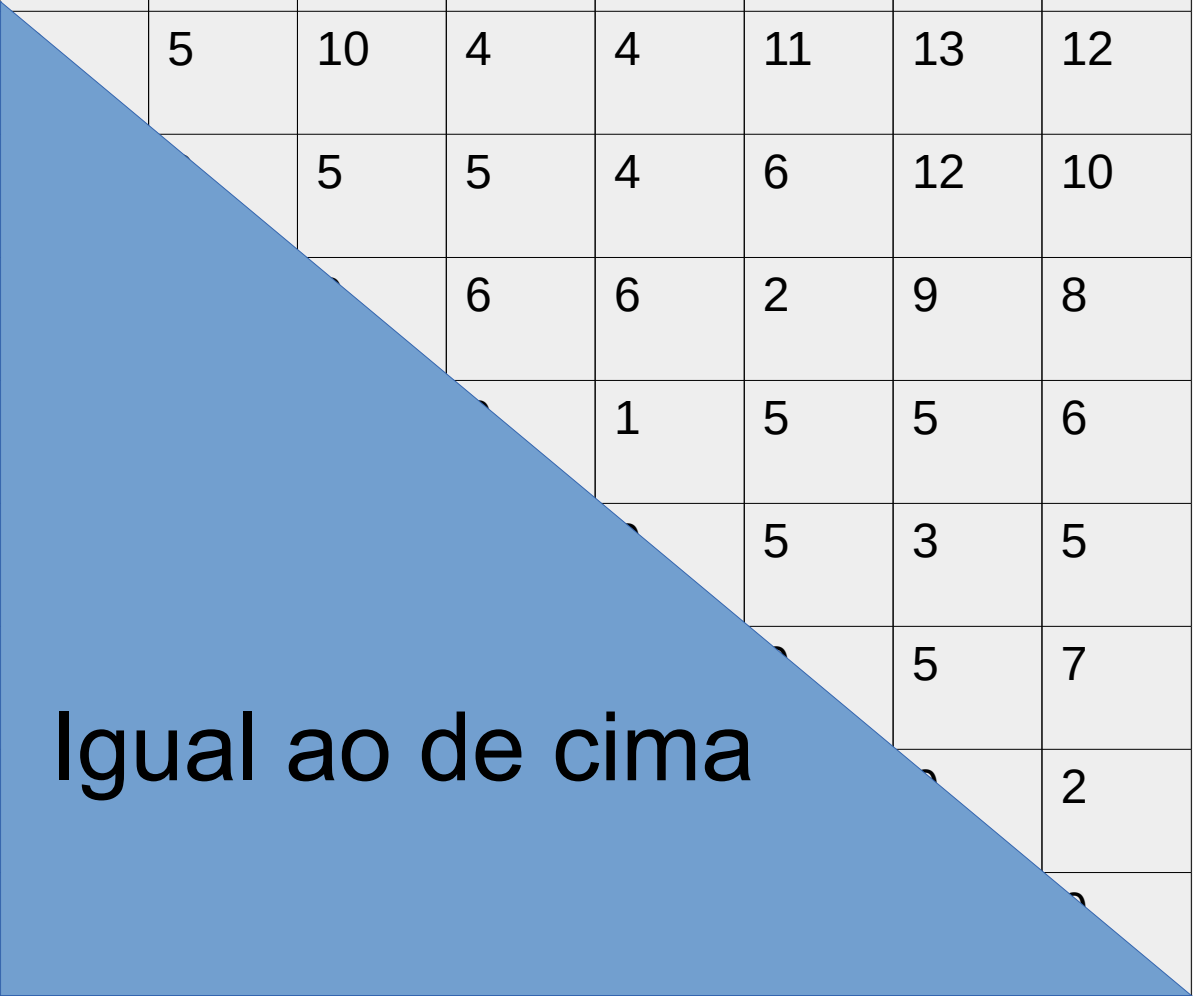
# Matrizes de distância

	1	2	3	4	5	6	7	8
1	0	5	10	4	4	11	13	12
2	?	0	5	5	4	6	12	10
3	?	?	0	6	6	2	9	8
4	?	?	?	0	1	5	5	6
5	?	?	?	?	0	5	3	5
6	?	?	?	?	?	0	5	7
7	?	?	?	?	?	?	0	2
8	?	?	?	?	?	?	?	0



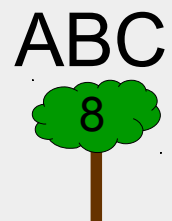
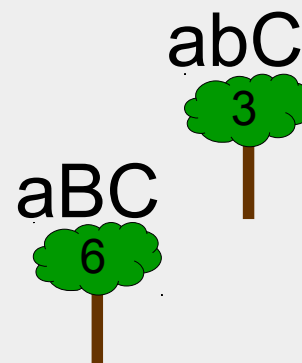
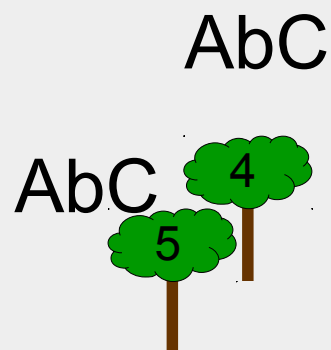
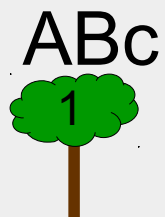
# Matrizes de distância

	1	2	3	4	5	6	7	8
1		5	10	4	4	11	13	12
2			5	5	4	6	12	10
3				6	6	2	9	8
4					1	5	5	6
5						5	3	5
6							5	7
7								2
8								

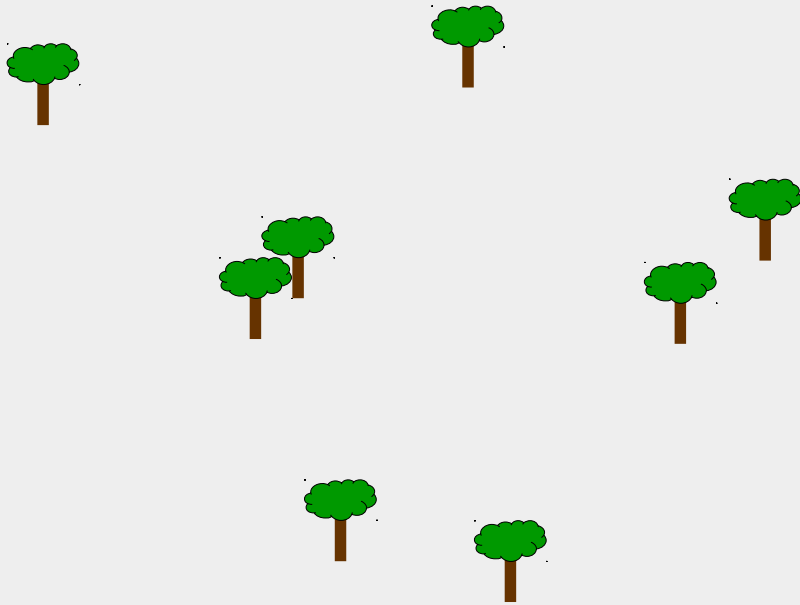


Igual ao de cima

# Matrizes de distância

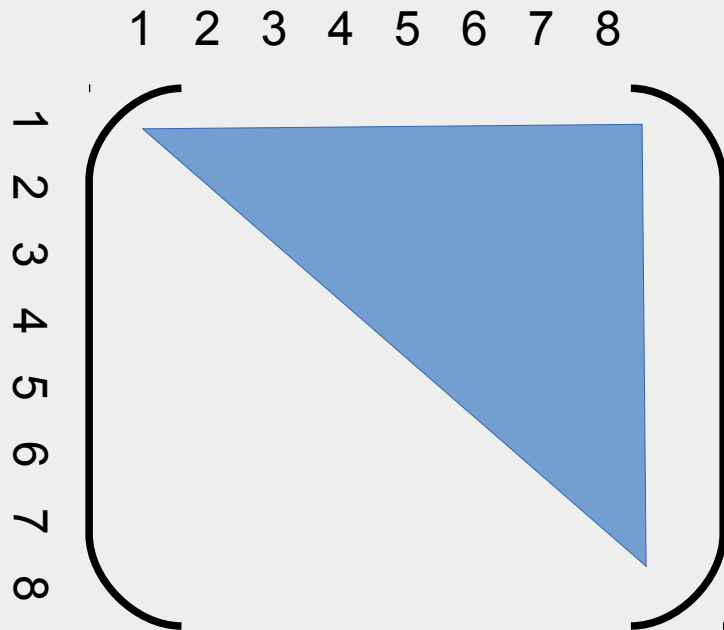


# Pergunta

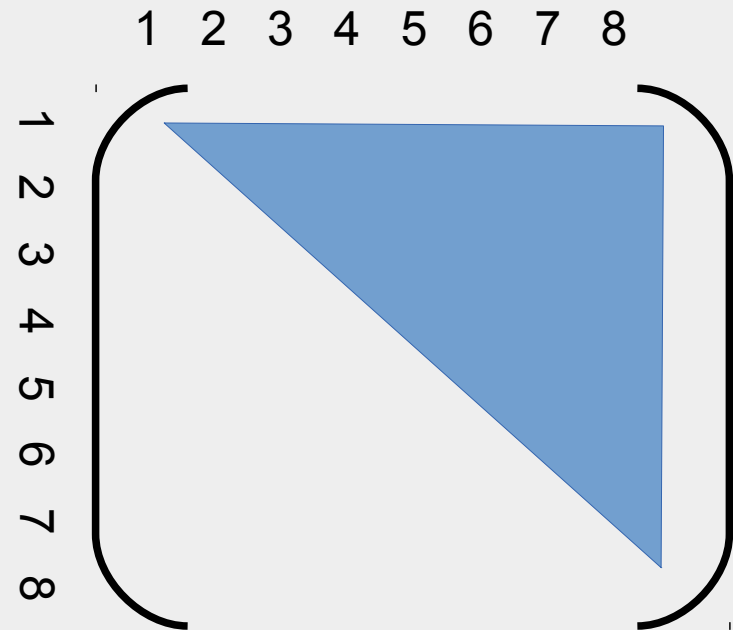


**Árvores mais  
próximas são  
mais parecidas  
geneticamente?**

# Relação entre duas matrizes de distância

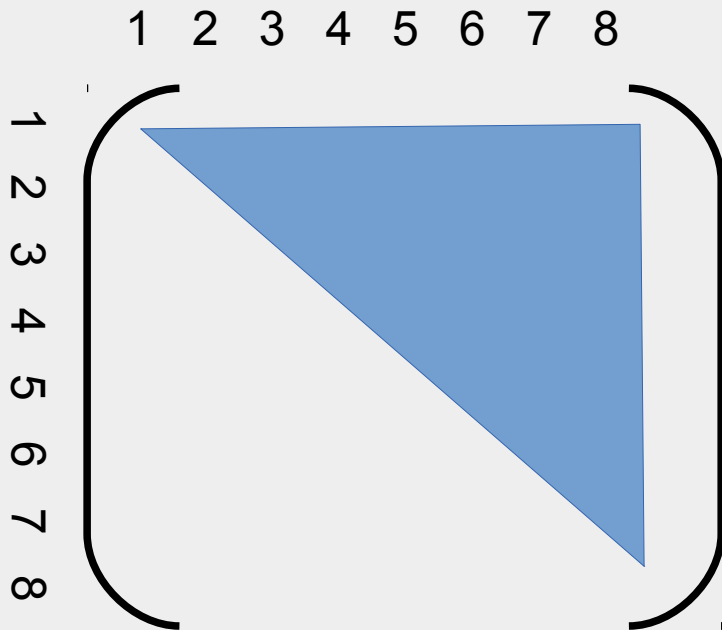


Distâncias  
genéticas

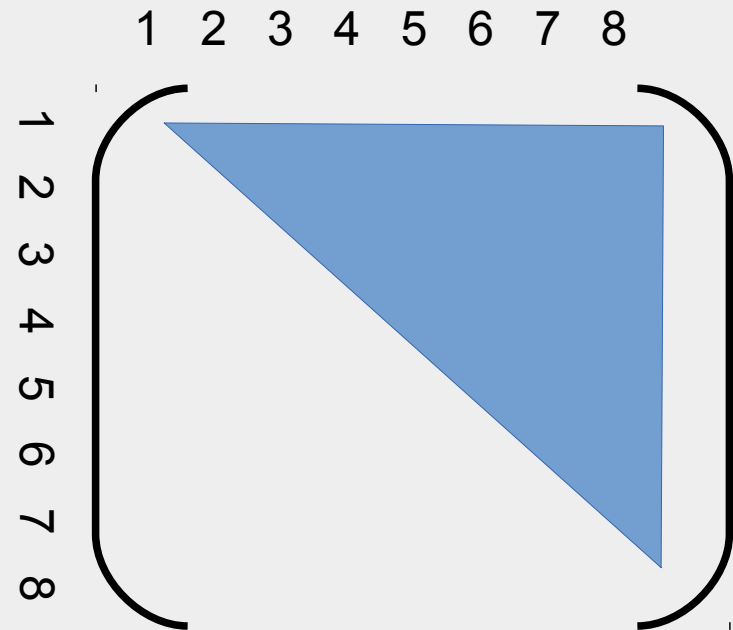


Distâncias  
espaciais

# Estatística de teste



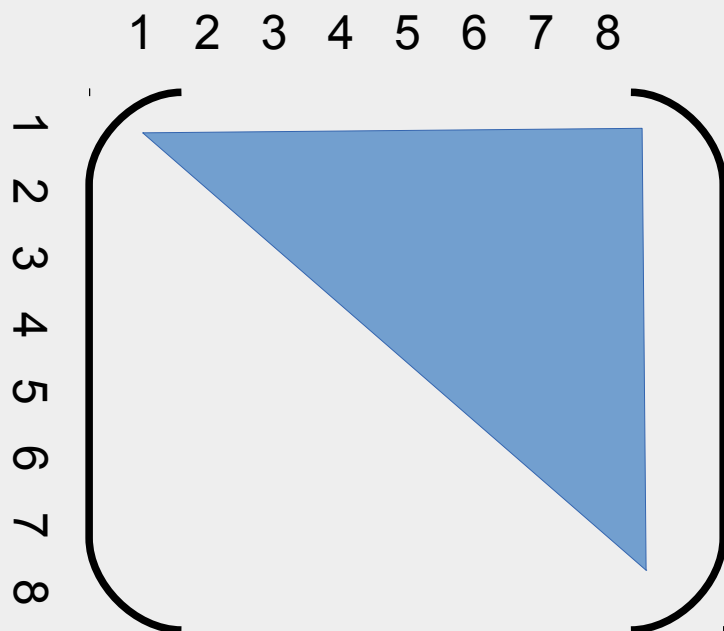
Distâncias  
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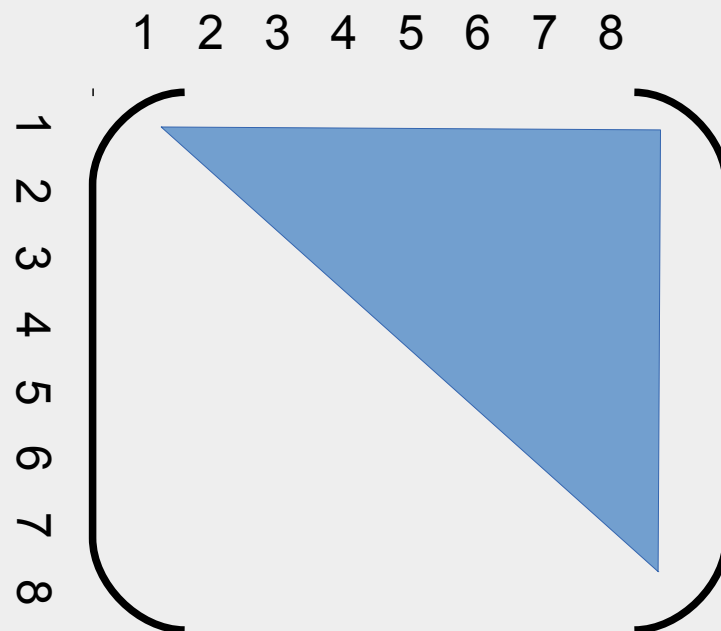
Distâncias  
espaciais

**Coeficiente de correlação (R)** entre os  
elementos das duas matrizes

# Como aleatorizar?

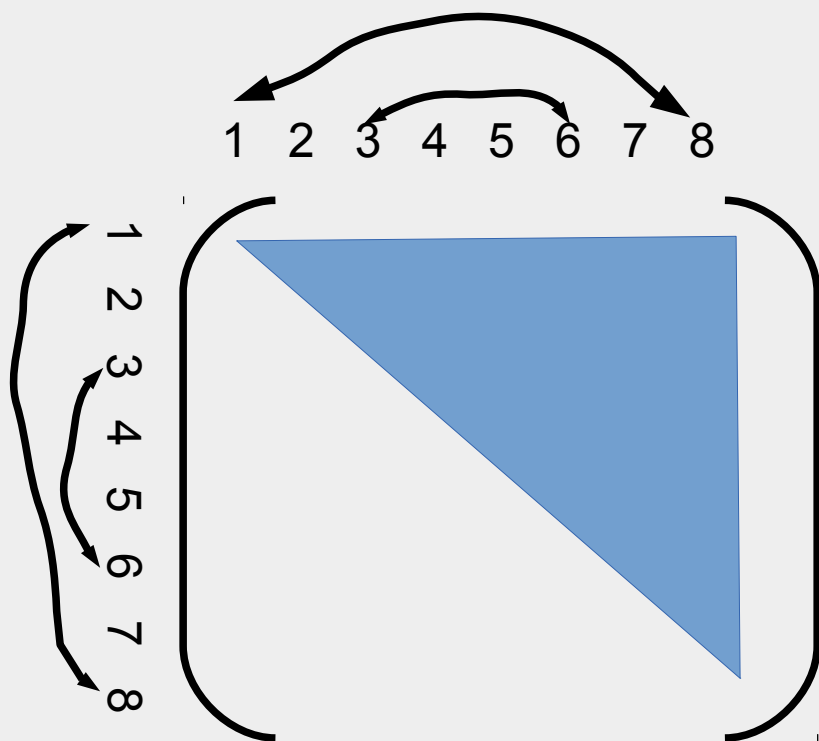


Distâncias  
genéticas

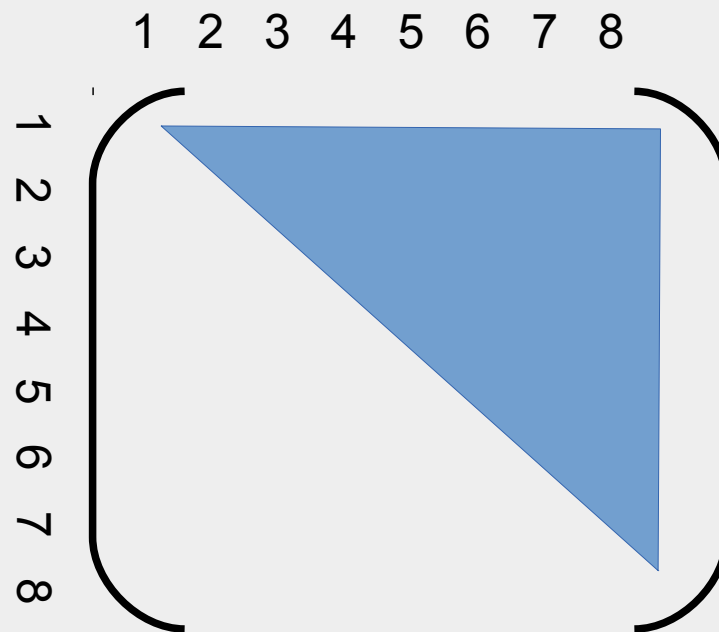


Distâncias  
espaciais

# Como aleatorizar?



Distâncias  
genéticas



Distâncias  
espaciais

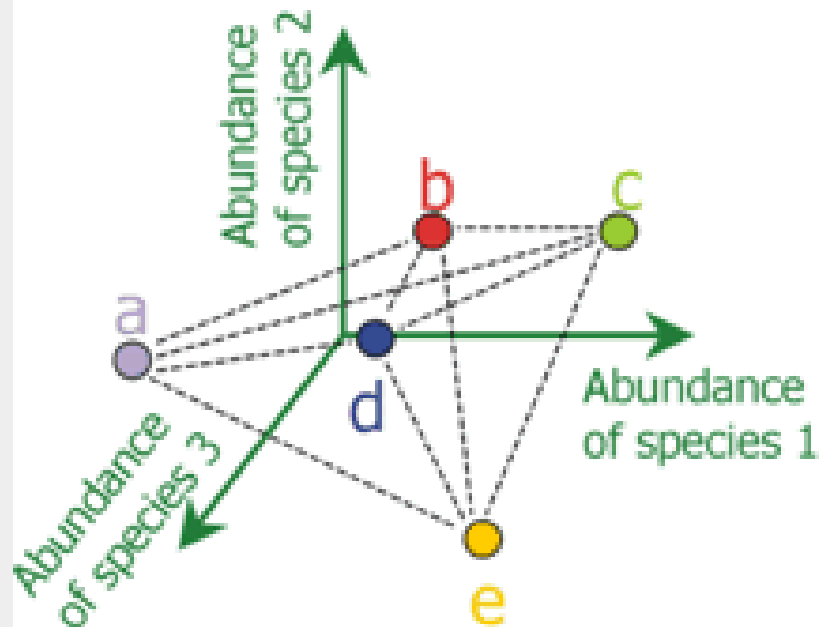
# Teste de Mantel

**Correlação entre  
duas matrizes,  
calculando a  
significância por  
aleatorizações**



# Teste de Mantel

Biological space

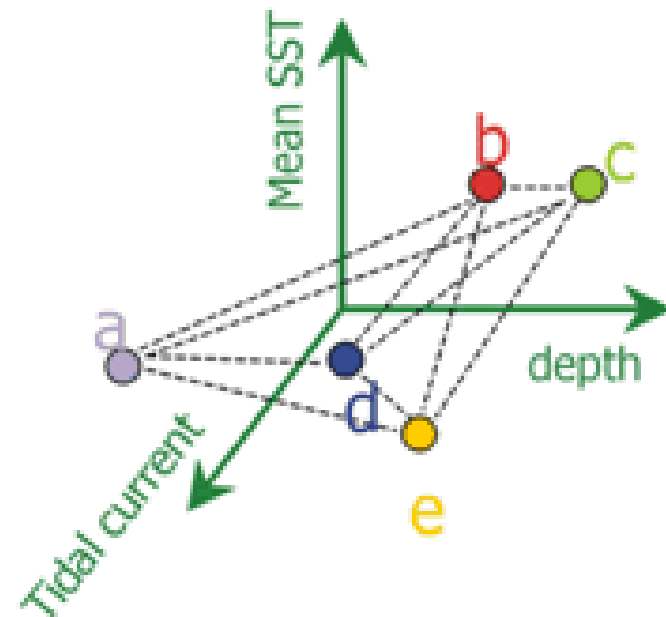


Pair-wise distance matrix

b	.1			
c	.2	.4		
d	.8	.3	.3	
e	.6	.4	.1	.3
	a	b	c	d

Compute the correlation

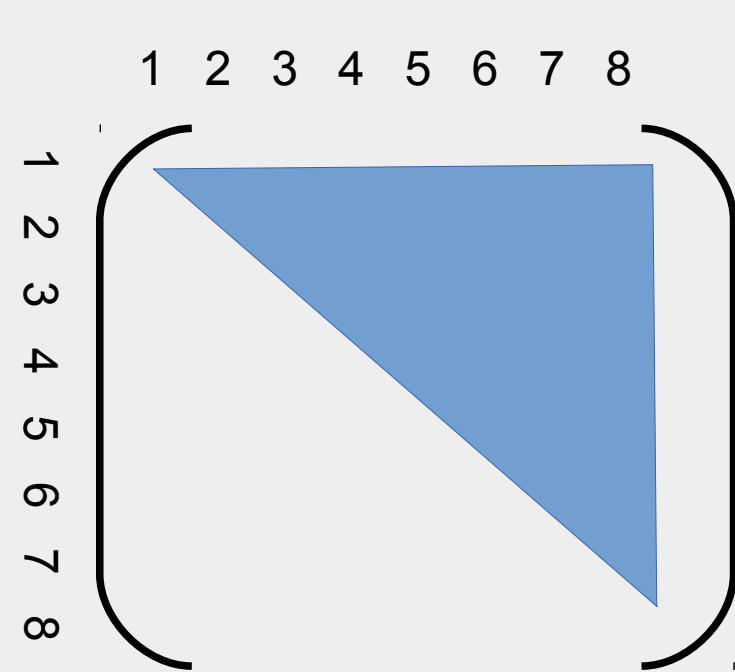
Environmental space



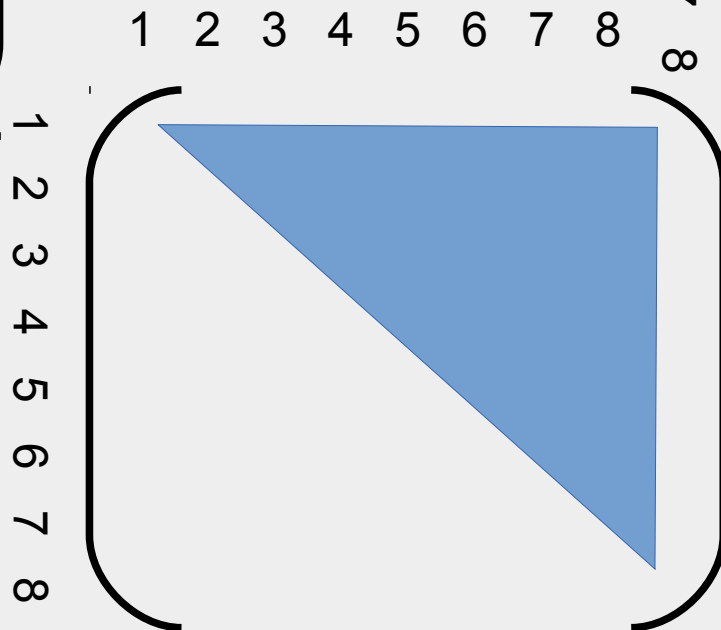
Pair-wise distance matrix

b	.2			
c	.2	.3		
d	.9	.2	.3	
e	.5	.4	.1	.2
	a	b	c	d

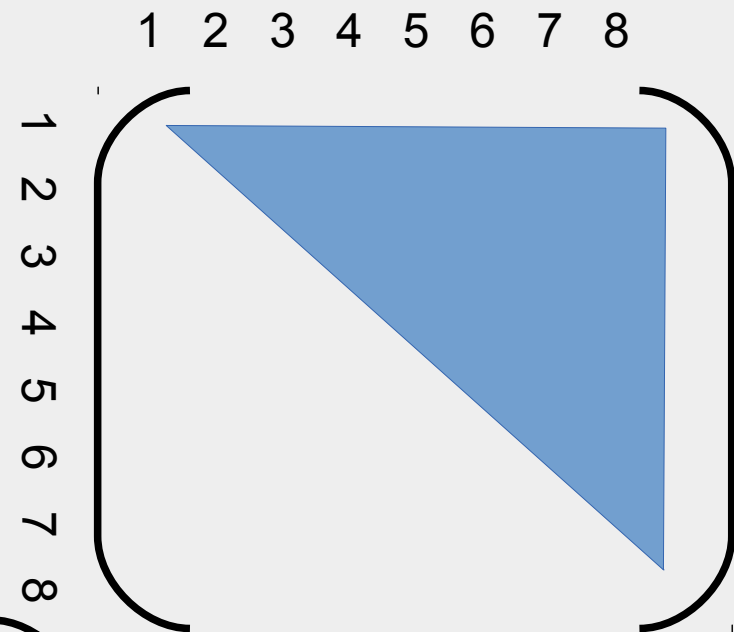
# Relação entre três matrizes de distância



Distâncias  
genéticas



Distâncias  
ambientais

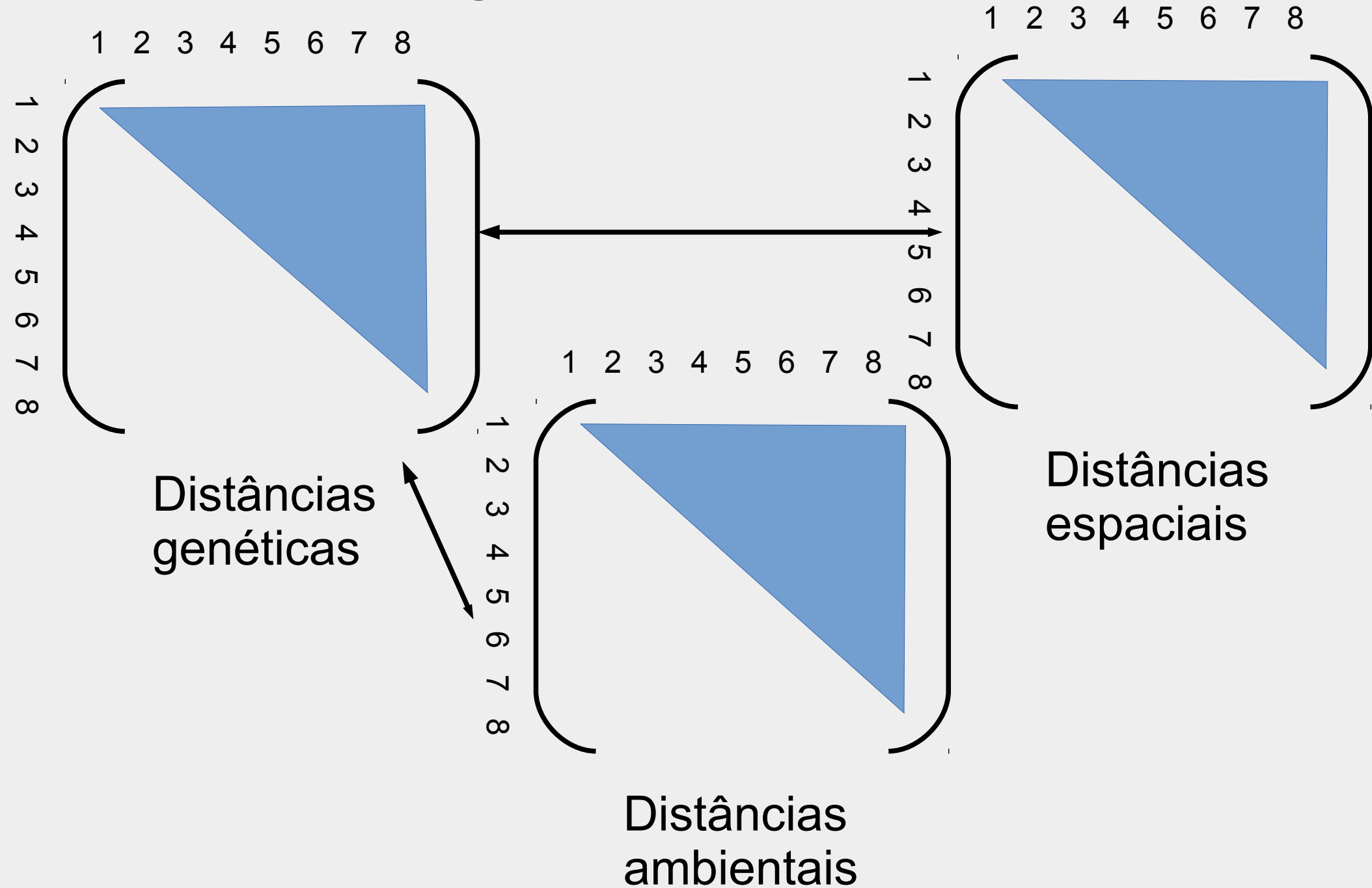


Distâncias  
espaciais

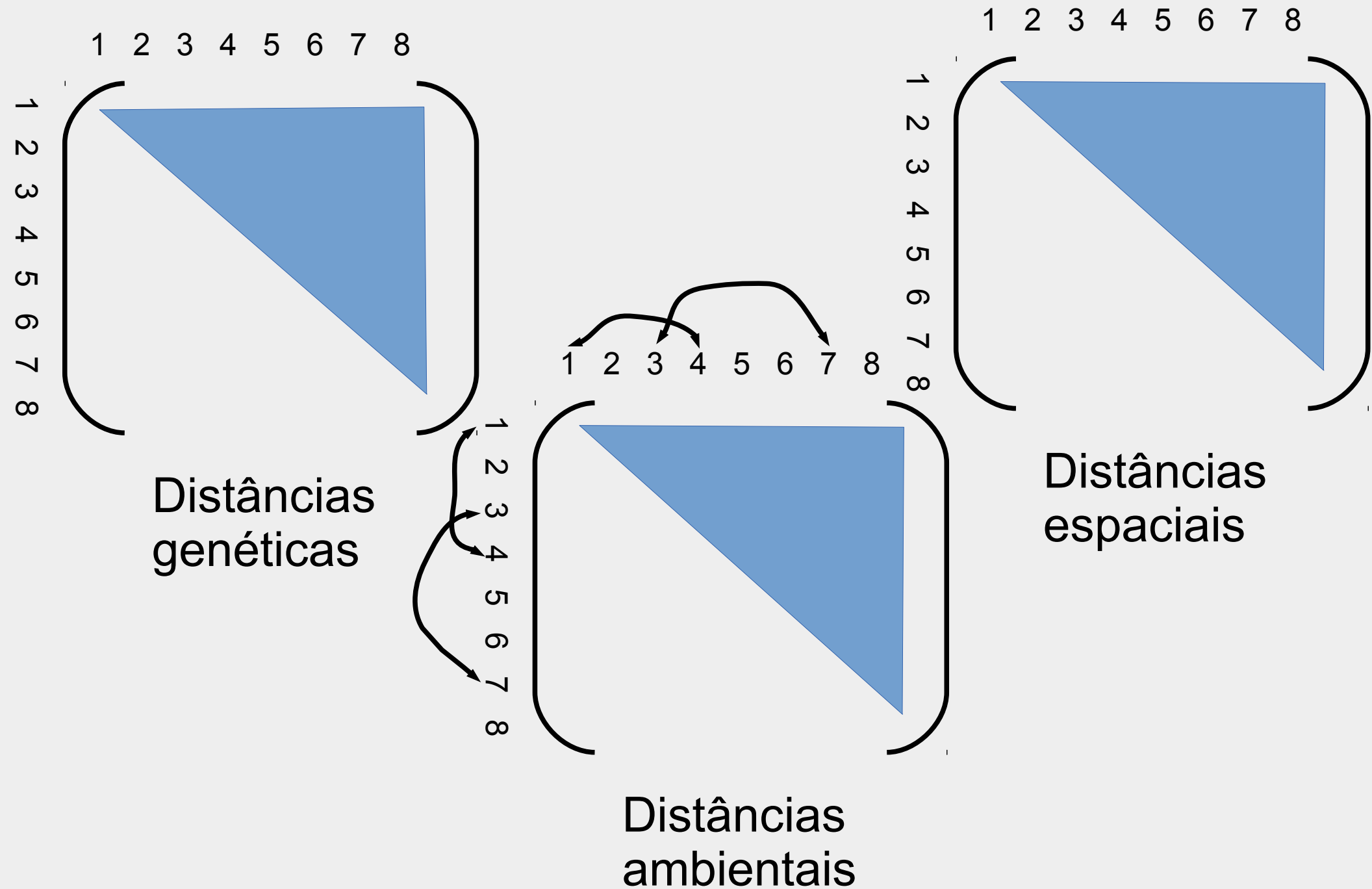
# Relação entre três matrizes de distância

Plantas em **ambientes parecidos** (distância ambiental pequena) são **parecidas geneticamente?**

# Regressão múltipla



# Aleatoriza a matriz de interesse



# PERMANOVA

**Permutational  
Multivariate  
Analysis of  
Variance**

# PERMANOVA

*Austral Ecology* (2001) **26**, 32–46

A new method for non-parametric multivariate analysis of variance

MARTI J. ANDERSON

*Centre for Research on Ecological Impacts of Coastal Cities, Marine Ecology Laboratories A11,  
University of Sydney, New South Wales 2006, Australia*

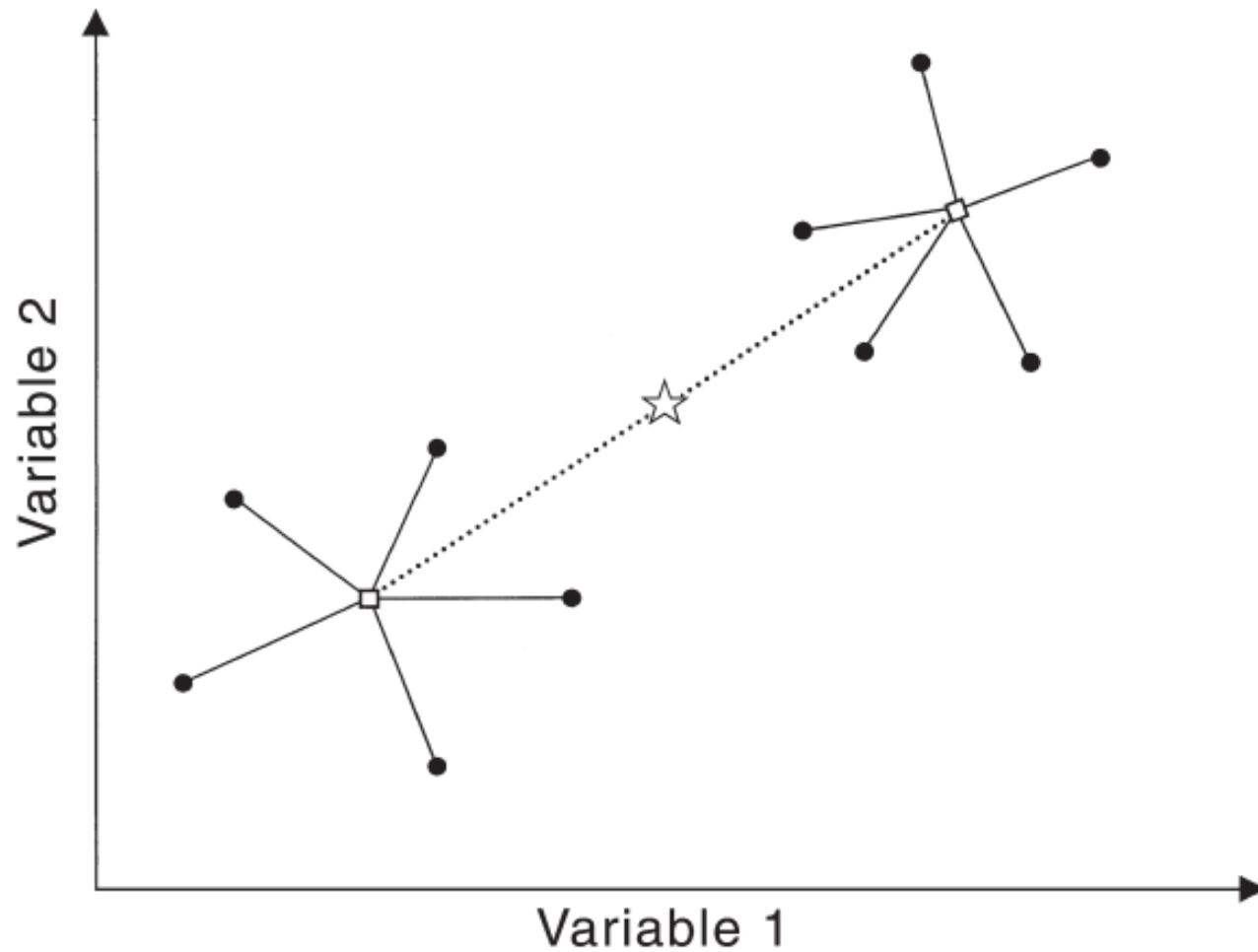
# PERMANOVA

Como funciona  
uma ANOVA  
univariada?



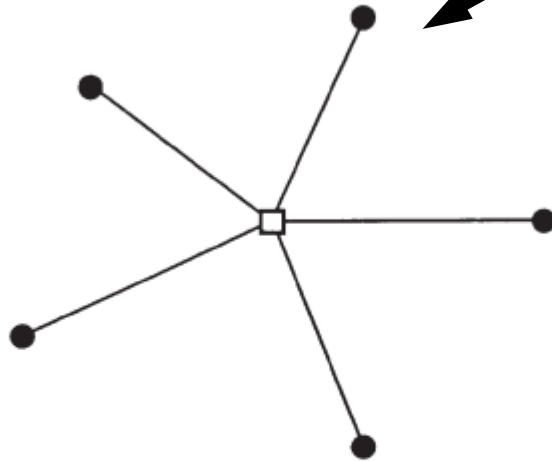
# Estatística de teste

# Estatística de teste

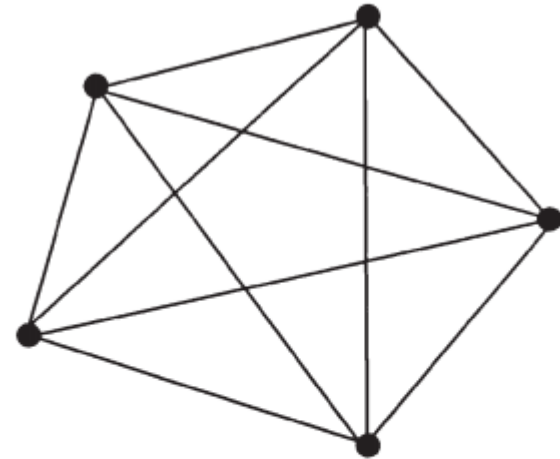


$$\frac{\Sigma Distâncias_{dentro}}{\Sigma Distâncias_{entre}}$$

# Estatística de teste

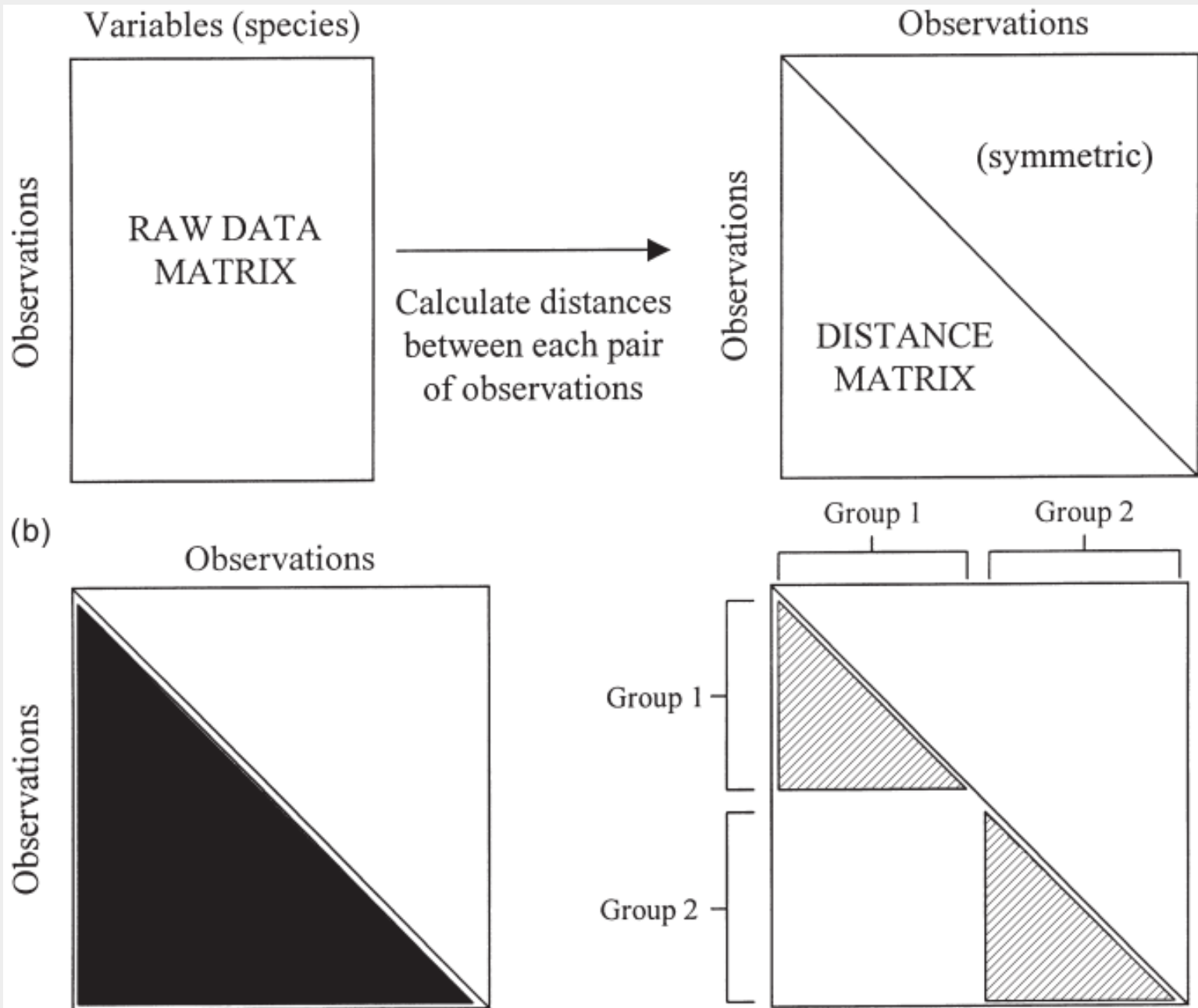


Distances from points  
to their group centroid

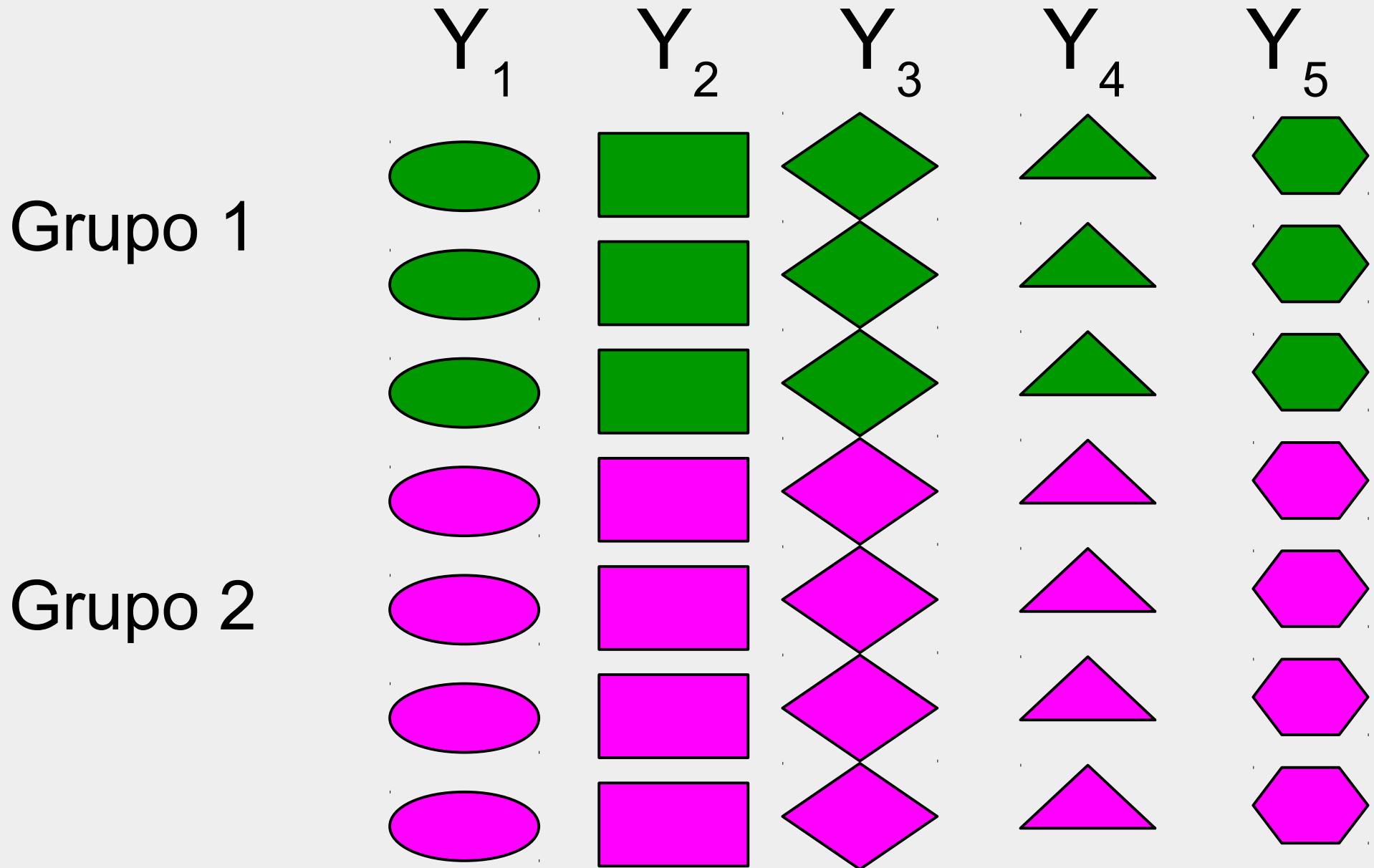


Inter-point distances

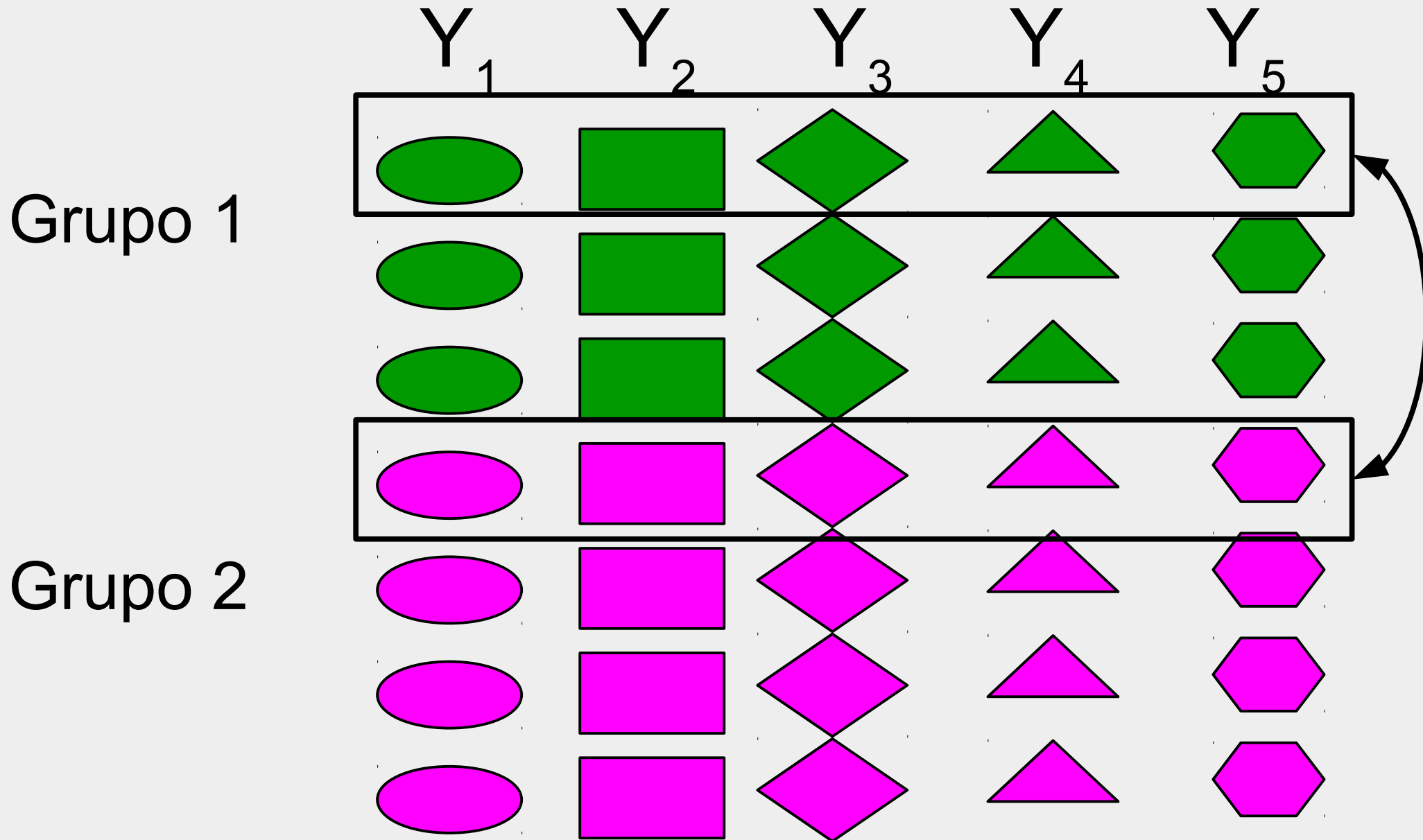
# Estatística de teste



# Como aleatorizar?



# Como aleatorizar?

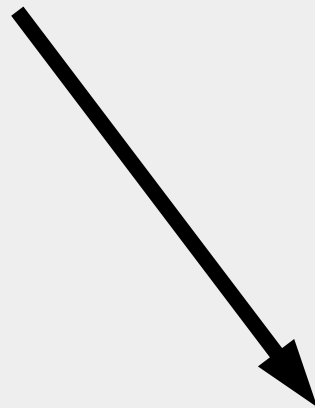


# Premissa

**As observações são  
intercambiáveis se a  
 $H_0$  for verdadeira**

# Premissa

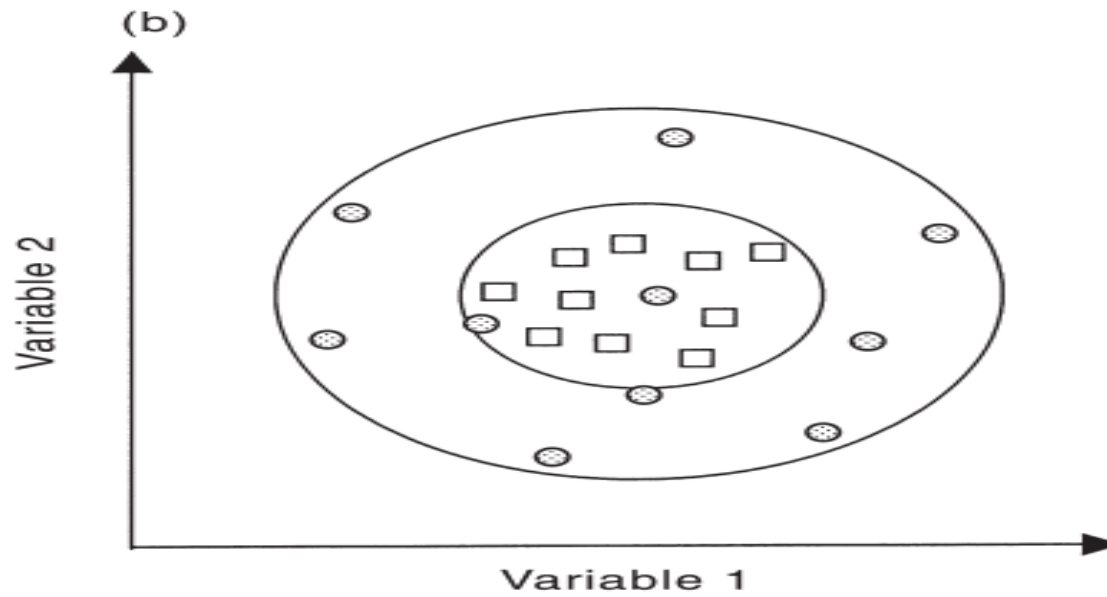
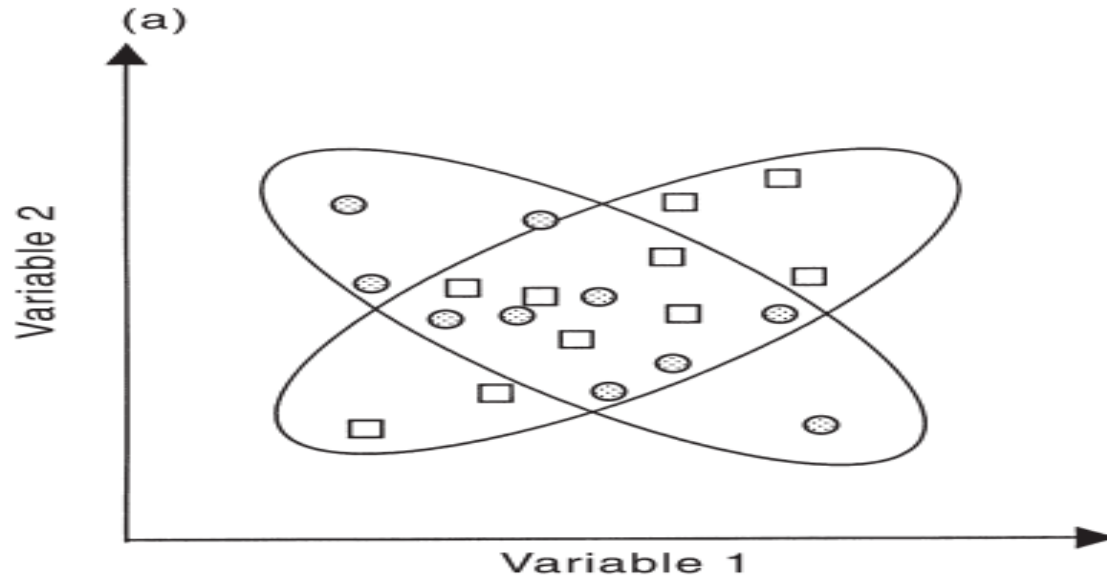
**As observações são  
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**Vêm de  
distribuições  
similares**



# Premissa



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