Introdução à programação computacional:
MATLAB e Python

Bruno L S Bedo

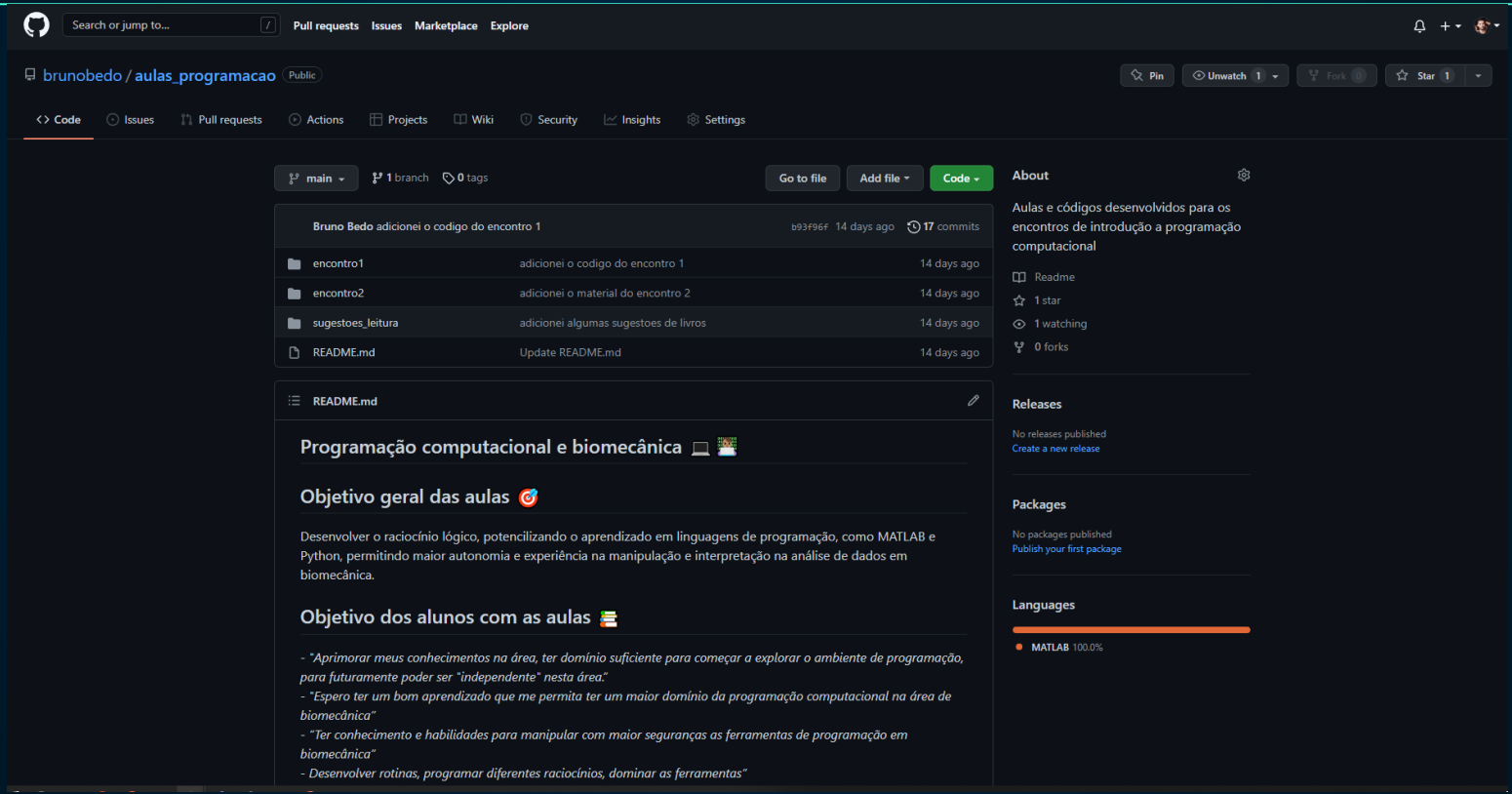
Encontro 7

Posturografia baseada em plataforma de força

brunosbedo@gmail.com
@brunobedo

https://www.github.com/brunobedo/aulas_programacao

GITHUB



OBJETIVO DA AULA

- Compreender quais variáveis trabalharemos (tempo)
- Carregar dados de uma plataforma de força
- Calcular do centro de pressão
- Calcular variáveis no domínio do tempo (Duart et. al., 2010)
- Exportando resultados

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Revisão sobre posturografia baseada em plataforma de força para avaliação do equilíbrio

Revision of posturography based on force plate for balance evaluation

Marcos Duarte[1], Sandra M. S. F. Freitas[2]

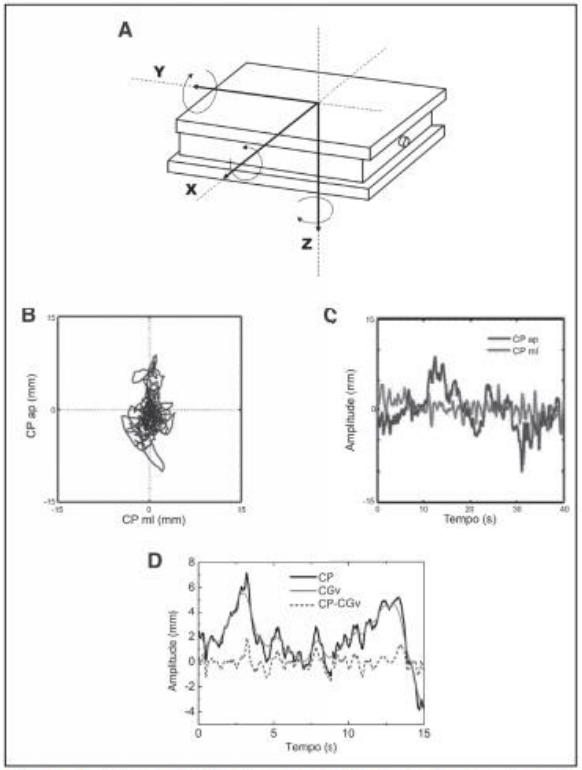

Figura 1. Representação de uma plataforma de força e eixos de medida (A) e exemplos do estatocinesigrama (B) e do estabilograma (C) de um indivíduo na postura ereta quieta por 40 segundos. Exemplo de trajetórias do CP, CGv e da diferença entre CP e CGv, CP-CGv, na direção ântero-posterior (ap) durante a postura ereta quieta de um indivíduo.

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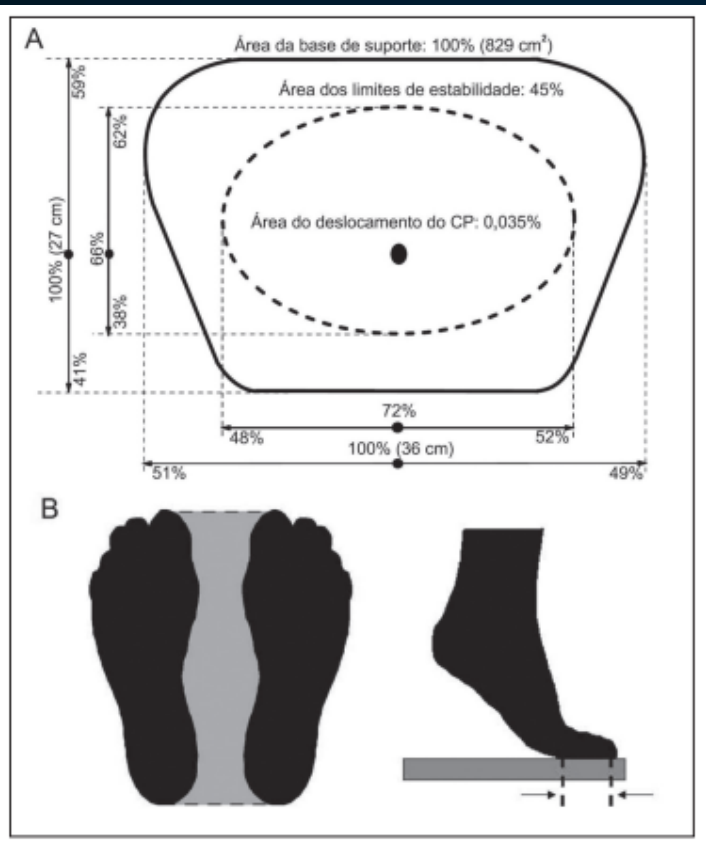

Figura 2. Em A, base de suporte média (linha contínua), elipse representando os limites de estabilidade média (linha tracejada) e média das elipses que descreve a oscilação do CP durante a postura ereta quieta por 40 s. N=13. Adaptado de Duarte e Zatsiorsky[23]. Em B, relação do posicionamento dos pés: separados e nas pontas dos pés com o tamanho da base de suporte e a área de deslocamento do CG.

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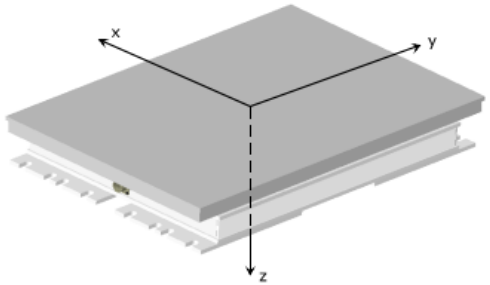
Cálculo do centro de pressão



Coordinate system for load measurements
The center of the coordinate system is at the inner corner of the arm block with y-axis forward, x-axis to the left (pointing inwards looking from behind), and z-axis downward.

CALCULATION OF THE POINT OF APPLICATION OF FORCE AND COUPLE

A load system acting on a treadmill belt can be completely described by the six load components (i.e. the three force and three moment components) calculated from the ***Force and signal scale factors*** equation. Alternatively, the same information can be given as the three force components, the point of application of the force vector (x_p, y_p), and a couple (sometimes also referred as "torque" or "free moment") acting on the force plate. The point of application of the force and the couple are calculated from the force and moment components as:

$$x_p = \frac{-h \cdot F_x - M_y}{F_z}$$

$$y_p = \frac{-h \cdot F_y + M_x}{F_z}$$

$$T_z = M_z - x_p \cdot F_y + y_p \cdot F_x$$

Force and Couple equation

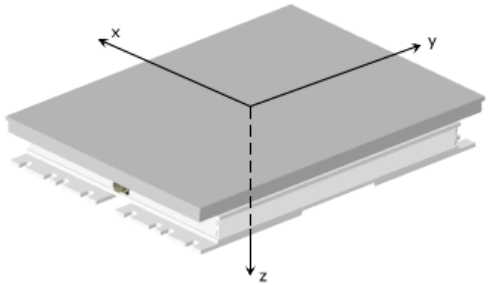
Where x_p and y_p are the coordinates of the point of application for the force (i.e. center of pressure) on the treadmill belt; h is the thickness above the top surface of any material covering the force plate (see the ***Coordinate system*** figure, above), and T_z is the couple acting on the force plate. Note that the thickness h, shown in the figure on the next page, is to be entered as a positive number in the ***Force and Couple*** equation above.

Cálculo do centro de pressão

To calculate the point of application of the force, the ***Force and Couple equation*** is used. Assuming there is a 5 mm covering on the top surface of the transducer, then h = 0.005 m. The coordinates of the Center of Pressure will be:

$$x_p = \frac{(-0.005)\cdot(-145.0)+17.3}{714.8} = 0.025\,\text{m}$$

$$y_p = \frac{(-0.005)\cdot(223.5)+92.9}{714.8} = 0.128\,\text{m}$$



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Cálculo do centro de pressão

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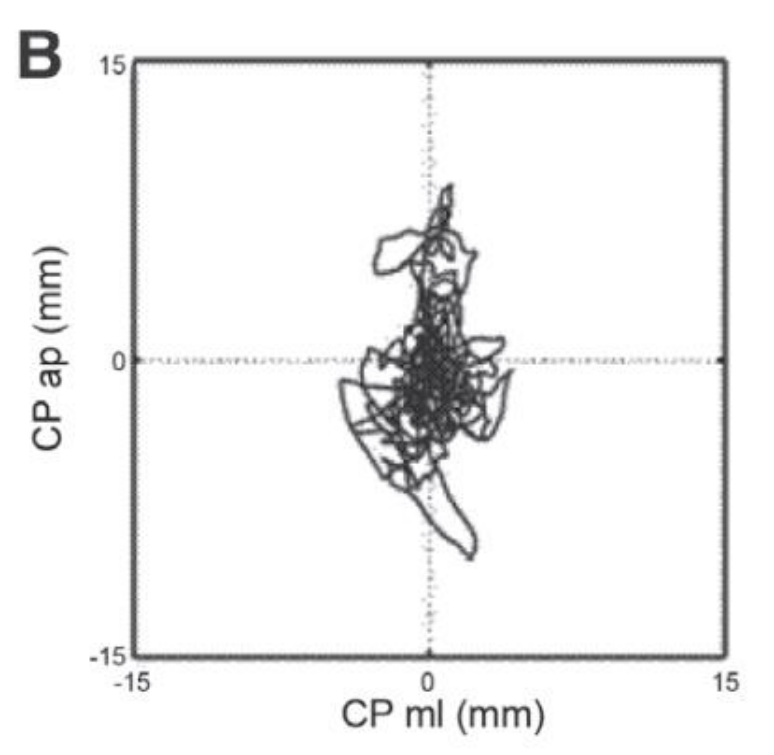
Variáveis

Tabela 1. Variáveis para análise global do centro de pressão (CP), suas descrições e rotinas para o cálculo usando o ambiente de programação Matlab.

Variável	Descrição	Rotina Matlab
Deslocamento da oscilação total, DOT	'Tamanho' ou comprimento da trajetória do CP sobre a base de suporte	DOT=sum(sqrt(CPap.^2+CPml.^2));
Desvio-padrão	Dispersão do deslocamento do CP da posição média durante um intervalo de tempo	SDap=std(CPap); SDml=std(CPml);
RMS ('Root Mean Square')	Mesmo resultado para RMS e desvio-padrão, se o sinal do CP tem média zero	RMSap=sqrt(sum(CPap.^2)/length(CPap)); RMSml=sqrt(sum(CPml.^2)/length(CPml);
Amplitude de deslocamento do CP	Distância entre o deslocamento máximo e o mínimo do CP para cada direção	AdCPap=max(CPap) - min(CPap); AdCPml=max(CPml) - min(CPml);
Velocidade média (VM)	Determinação de quão rápidos foram os deslocamentos do CP	VMap=sum(abs(diff(CPap)))*freq/length(CPap) VMml=sum(abs(diff(CPml)))*freq/length(CPml)
Área	[vec,val]=eig(cov(CPap,CPml)); Área=pi*prod(2.4478*sqrt(svd(val)))	
Velocidade média total (VMT)	VMT=sum(sqrt(diff(CPap).^2+diff(CPml).^2))*freq/length(CPap)	

Deslocamento da oscilação total (DOT)

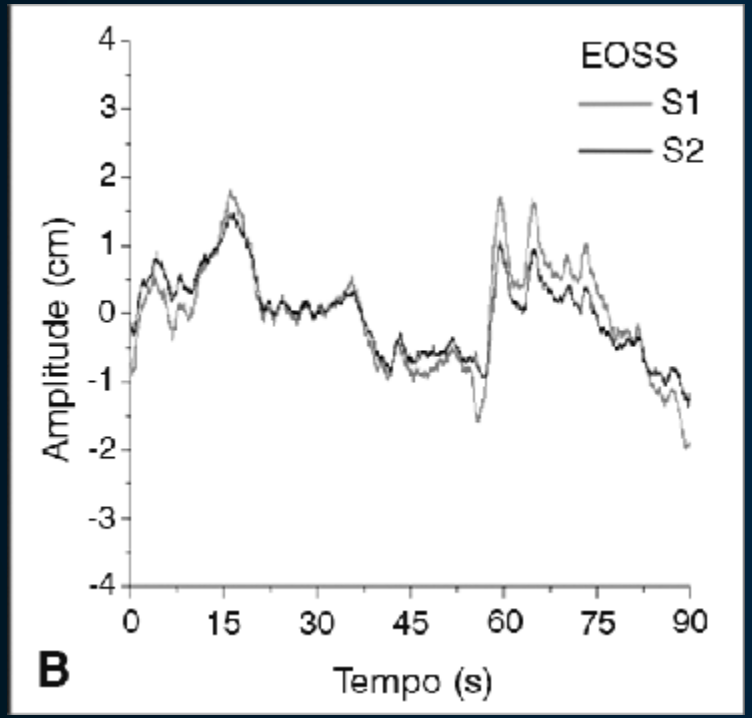


‘Tamanho’ ou comprimento da trajetória do CP sobre a base de suporte

```
DOT=sum(sqrt(CPap.^2+CPml.^2));
```

Duarte, Marcos, and Sandra MSF Freitas. "Revision of posturography based on force plate for balance evaluation." *Brazilian Journal of physical therapy* 14.3 (2010): 183-192

Desvio-padrão



Dispersão do deslocamento do CP da posição média durante um intervalo de tempo

```
SDap=std(CPap);
SDml=std(CPml);
```

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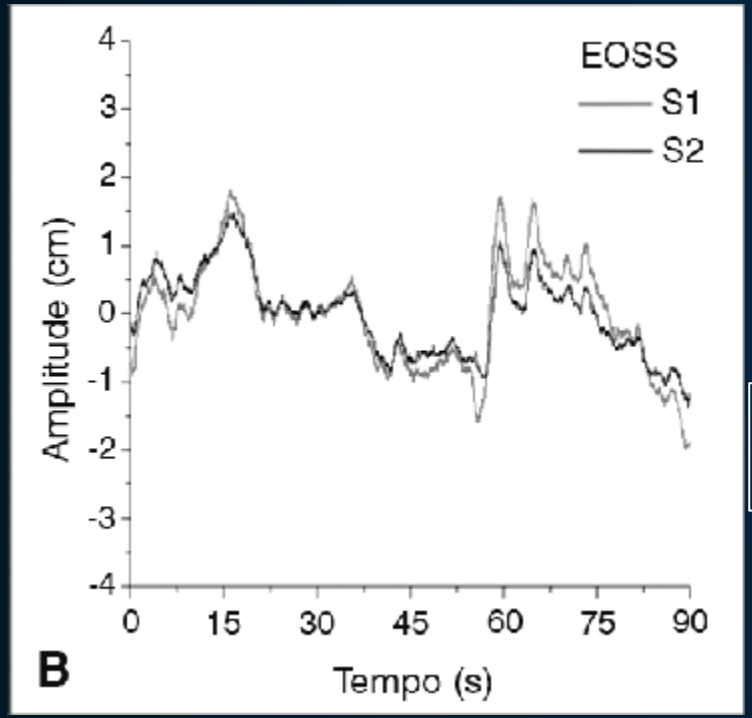
RMS (‘Root Mean Square’)



Mesmo resultado para RMS e desvio-padrão, se o sinal do CP tem média zero

```
RMSap=sqrt(sum(CPap.^2)/length(CPap));
RMSml=sqrt(sum(CPml.^2)/length(CPml);
```

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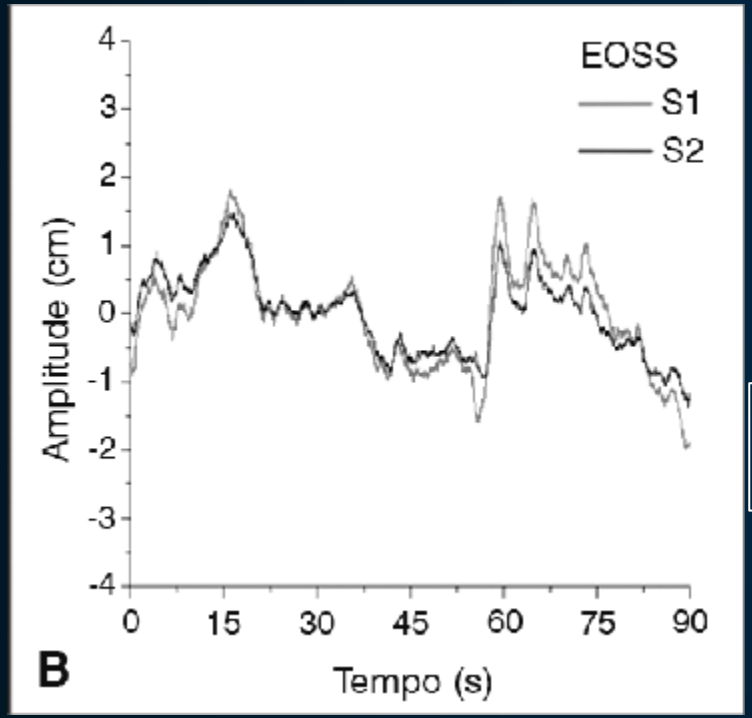
Amplitude de deslocamento do CP



Distância entre o deslocamento máximo e o mínimo do CP para cada direção

```
AdCPap=max(CPap) - min(CPap);
AdCPml=max(CPml) - min(CPml)
```

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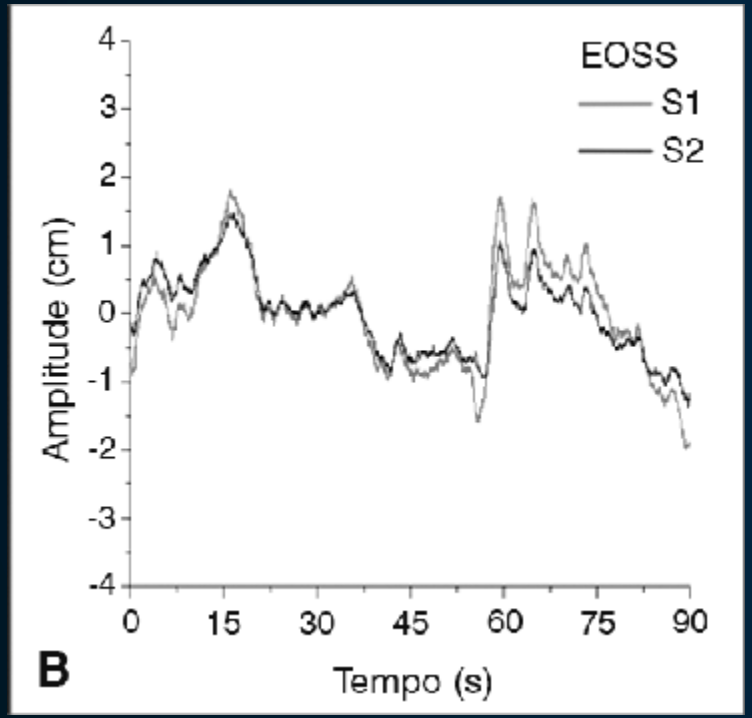
Velocidade média (VM)



Determinação de quão rápidos foram os deslocamentos do CP

```
VMap=sum(abs(diff(CPap)))*freq/length(CPap)

VMml=sum(abs(diff(CPml)))*freq/length(CPml)
```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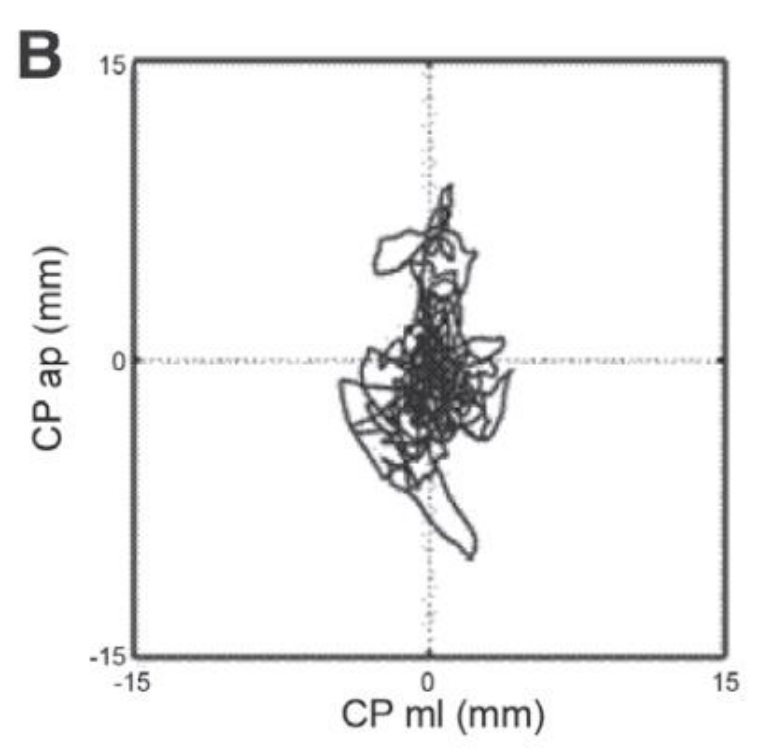
Área

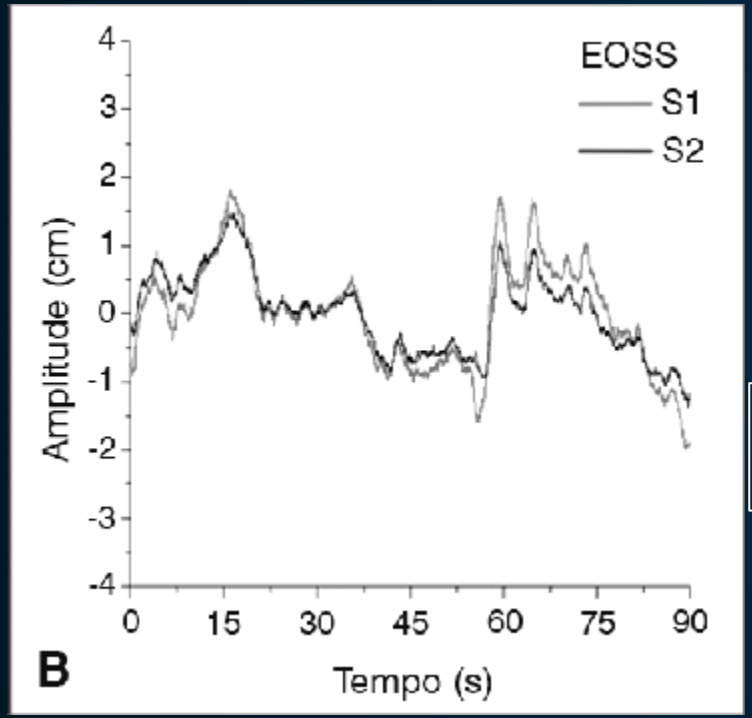


Como vocês definiriam?

```
[vec,val]=eig(cov(CPap,CPml));
Área=pi*prod(2.4478*sqrt(svd(val)))
```

Duarte, Marcos, and Sandra MSF Freitas. "Revision of posturography based on force plate for balance evaluation." *Brazilian Journal of physical therapy* 14.3 (2010): 183-192

Velocidade média total (VMT)



Como vocês definiriam?

```
VMT=sum(sqrt(diff(CPap).^2+diff(CPml).^2))*freq/length(CPap)
```

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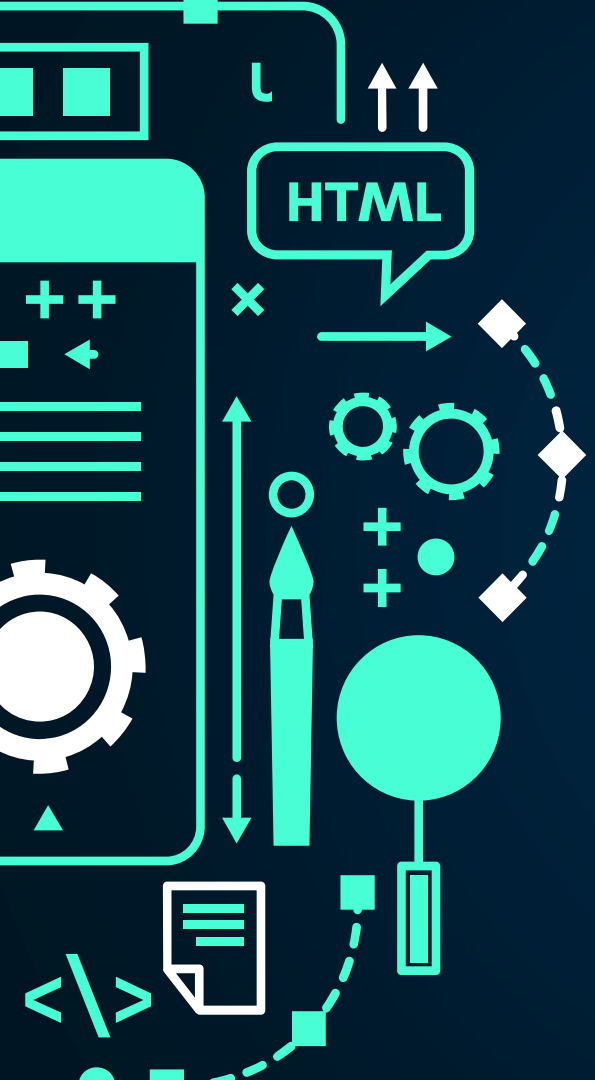

OBRIGADO

Does anyone have any question?

brunosbedo@gmail.com
@brunobedo