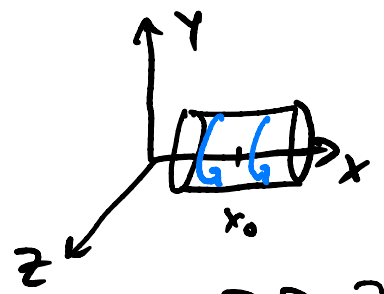


3D case:

Rotation about x-axis: $R_x(\theta)$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \cos \theta - z \sin \theta \\ y \sin \theta + z \cos \theta \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta & 0 \\ 0 & \sin \theta & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$



Rotation about y-axis: $R_y(\theta)$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \cos \theta + z \sin \theta \\ y \\ -x \sin \theta + z \cos \theta \\ 1 \end{bmatrix} = \begin{bmatrix} \cos \theta & 0 & \sin \theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Rotation about z-axis: $R_z(\theta)$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos \theta & -\sin \theta & 0 & 0 \\ \sin \theta & \cos \theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

2D version embedded in 3D
 \Rightarrow rotation still happens in x-y plane.

★ All rotation directions above follow the right-hand rule.

- Make a fist with your right hand
- point your thumb along the $(+)$ rotation axis
- $(+)$ rotation θ is in the direction that your fingers curl.

Project 3: Linear Regression

Goal Beyond just "looking" at data in a scatter plot, we want to quantify relationships between 2+ variables

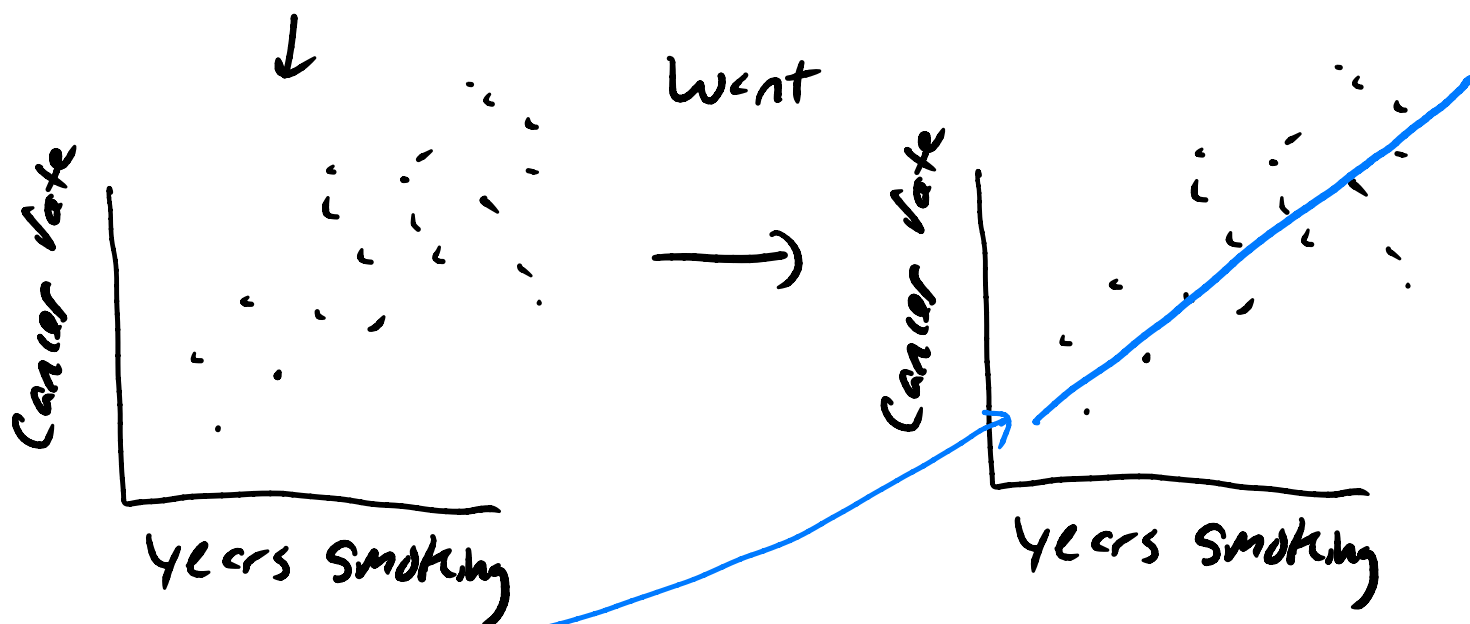
And the strength of association.

is Cancer associated with - smoking?
- drinking?
- old age?

- weak?
- Strong?
- unrelated?

raw data

=



regression: curve fit to data that tolerates error in measurement and noise