Newton's Laws

- **Newton's 1st Law (Same as Galileo's law of inertia): No force => no acceleration.**

"An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by a force."

$$\vec{F} = 0 \quad \Rightarrow \quad \vec{v} = const$$

- **Newton's 2nd Law:**

"Force equals mass times acceleration"

$$\vec{F} = m\vec{a}$$

- **to be continued…**

Unit of force is called Newton (N)

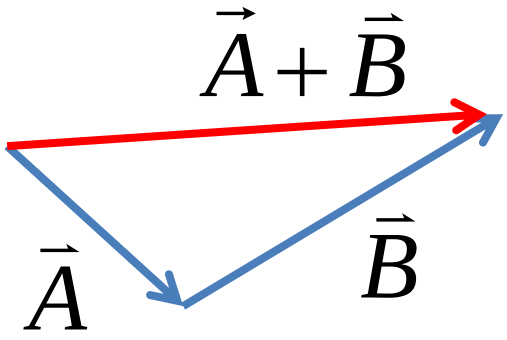
$$1N = 1\frac{kg \cdot m}{s^2}$$

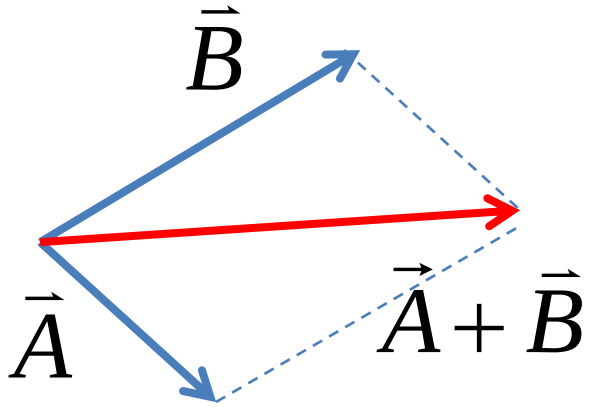
Adding vectors

Forces are vectors! There are two ways of thinking about **vectors**:

- **Geometrically,** vector is a directed line segment. It has direction and magnitude.
- **Algebraically,** vectors can be written as a list of numbers: their X, Y and Z components. For instance (3,4,-5).

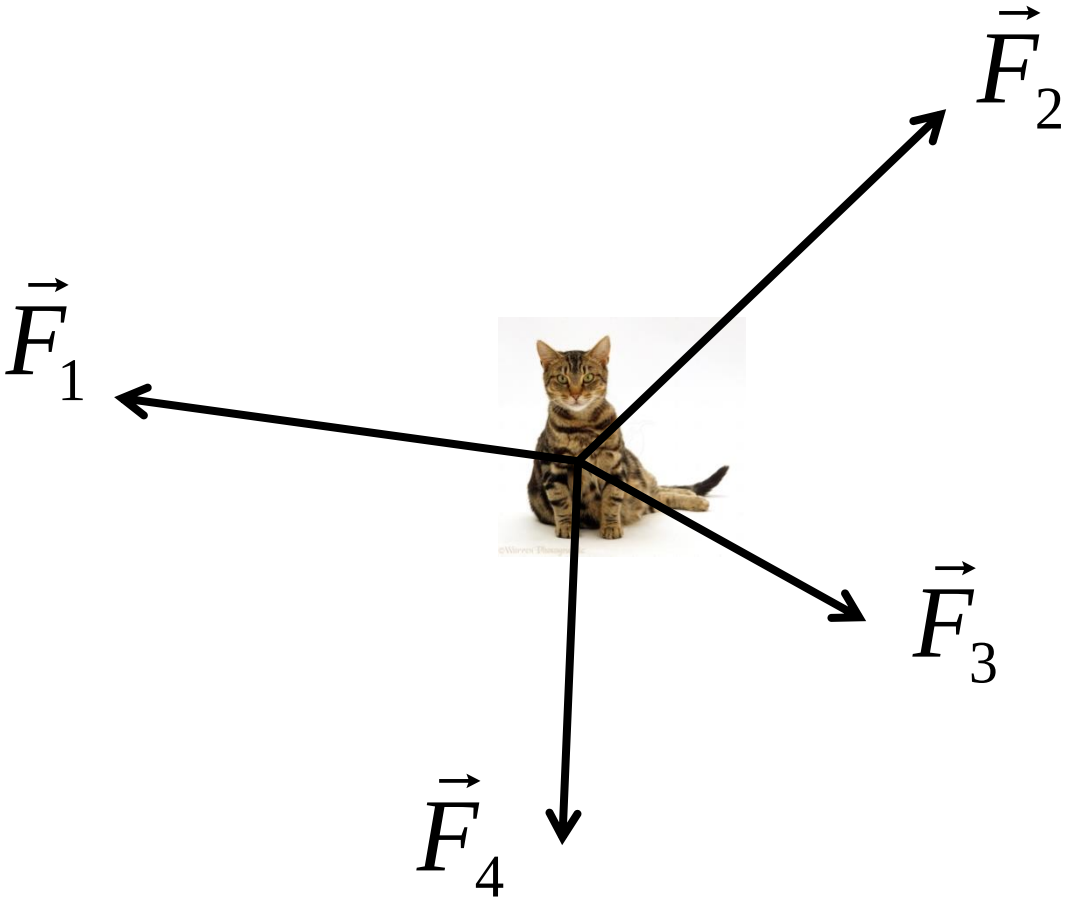
To add vectors A and B geometrically. you can use "triangle" or "parallelogram "rules:

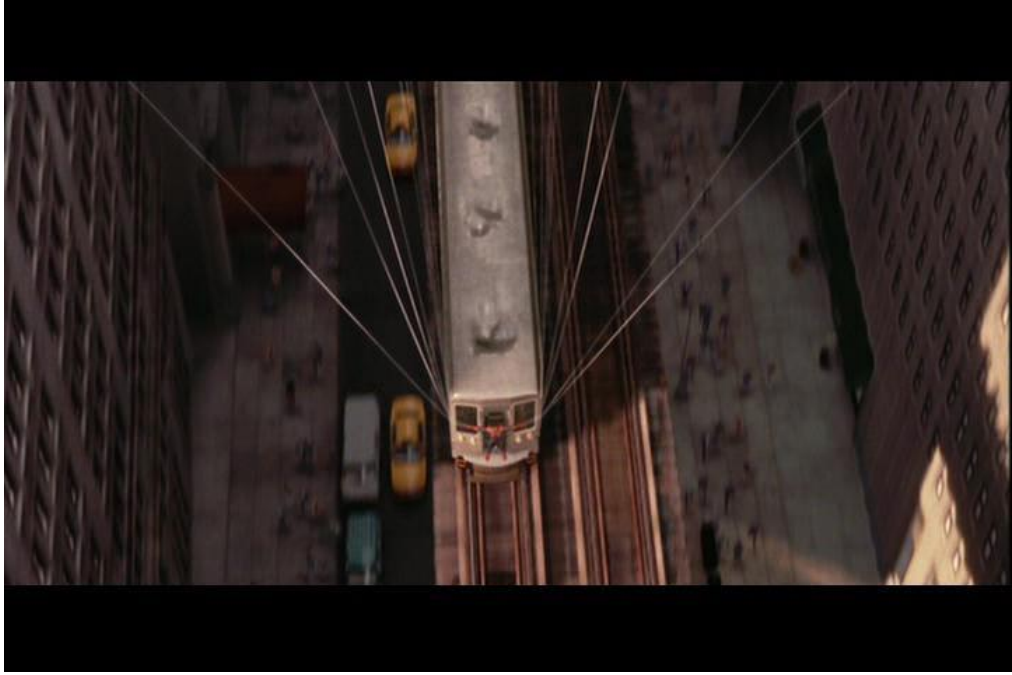




Homework 9

Problem 1.
Find the total force acting on a cat (graphically)





Problem 2

In the movie Spiderman 2, Peter Parker aka Spiderman manages to stop the train by using his web. (search youtube for "**Peter Stops The Train!"** clip). It takes t=45s of screen time. The initial speed of the train is approximately v=80 km/hr (you'll need to convert to m/s!).

Find the average acceleration of the train, and the force that Spiderman can hold. This force is of strategic importance for any villain: you can see from the video that the superhero is close to his limit. Mass of the NYC subway train (full of people) is 300,000kg.