# Vectors

## Direction and magnitude

### Geometry and Graphics:

* Vectors are extensively used to represent geometric entities such as points, lines, and shapes.
* Direction of a vector determines the orientation or orientation change;
* magnitude determines the scale or size of the object being represented.

For example: in 3D graphics, vectors are used to represent the direction of light sources, the orientation of objects, and the magnitude of scaling or translation operations.

### Physics Simulations:

* Representing physical quantities such as force, velocity, and acceleration.
* Direction of a vector indicates the direction of the physical quantity (e.g., the direction of motion);
* magnitude represents the strength or intensity of the quantity (e.g., the speed of an object).

Crucial for accurately modelling and simulating real-world phenomena in computer-generated environments.

### Navigation and Mapping:

* Vectors represent the direction and distance between two points on the Earth's surface.
* Direction of a vector indicates the heading or direction of travel;
* magnitude represents the distance to be covered.

For example: navigation systems can calculate optimal routes, provide turn-by-turn directions, and estimate arrival times.

Vectors are essential for navigation and mapping applications, such as GPS systems.

### Data Representation:

* Vectors are used to represent features, patterns, and relationships in data.
* Direction of a vector represents the relationship between different data points;
* magnitude reflects the strength or importance of that relationship.

By analysing vectors, algorithms can identify patterns, make predictions, and derive insights from complex datasets.

### Robotics and Motion Planning:

* Vectors are used for motion planning and control in robotics.
* By representing the direction and magnitude of movement using vectors, robots can navigate through complex environments, avoid obstacles, and reach desired destinations.

Vectors are also used to calculate trajectories, velocities, and accelerations, enabling precise and efficient motion control.