Visualizing Scalars, Vectors, and Tensors

Data Objects in Space

Objects in Two & Three Dimensional Space

Data Objects can contain n-dimensional information.

For visualization, information must be projected onto 1, 2, or 3 dimensional space.
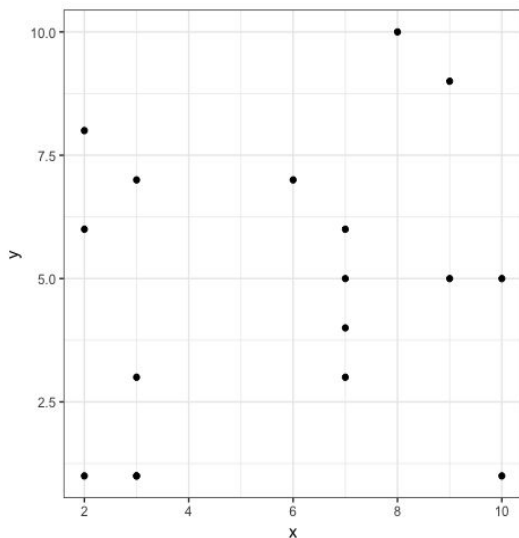
Each data entry is represented as a point in space.

Each point may contain extra dimensions of information, in addition to its position.
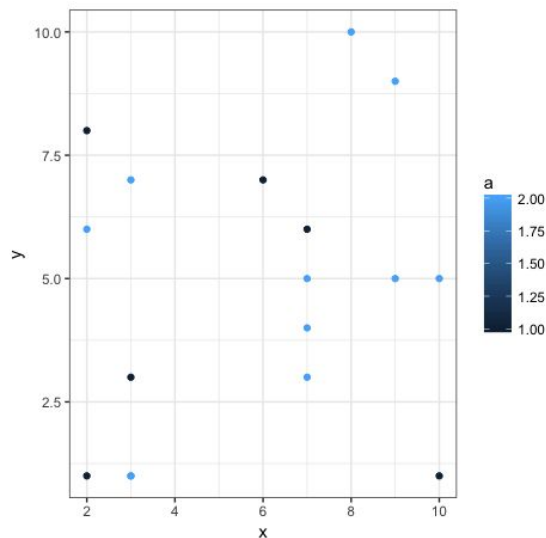
Objects in Two & Three Dimensional Space
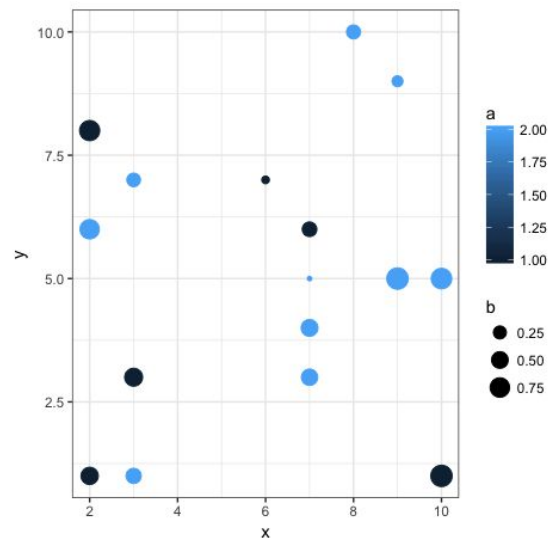
E.g. Data Objects in 2-Dimensional Space

2 total dimensions:
2-d position

3 total dimensions:
2-d position +
'a' dimension

4 total dimensions:
2-d position +
'a' + 'b' dimensions

Scalars

Scalars

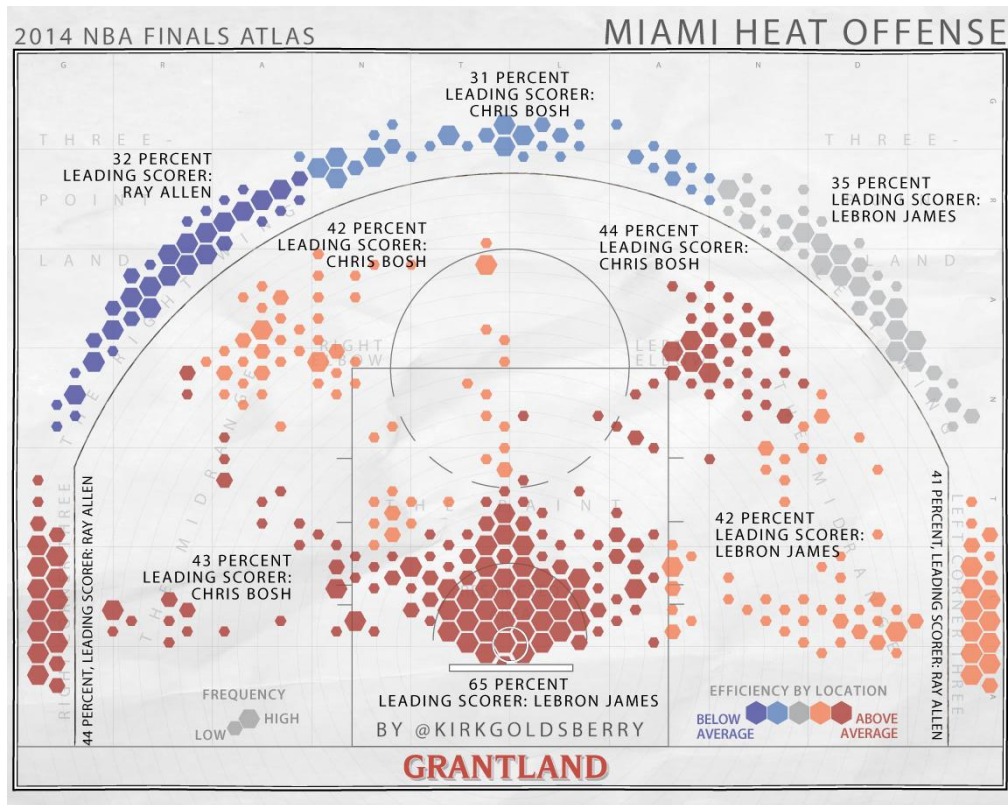A data object that contains information about only magnitude.

Scalars are quantitative data types that are typically continuous variables.

A scalar quantity has a one-dimensional visual representation at each point in space.
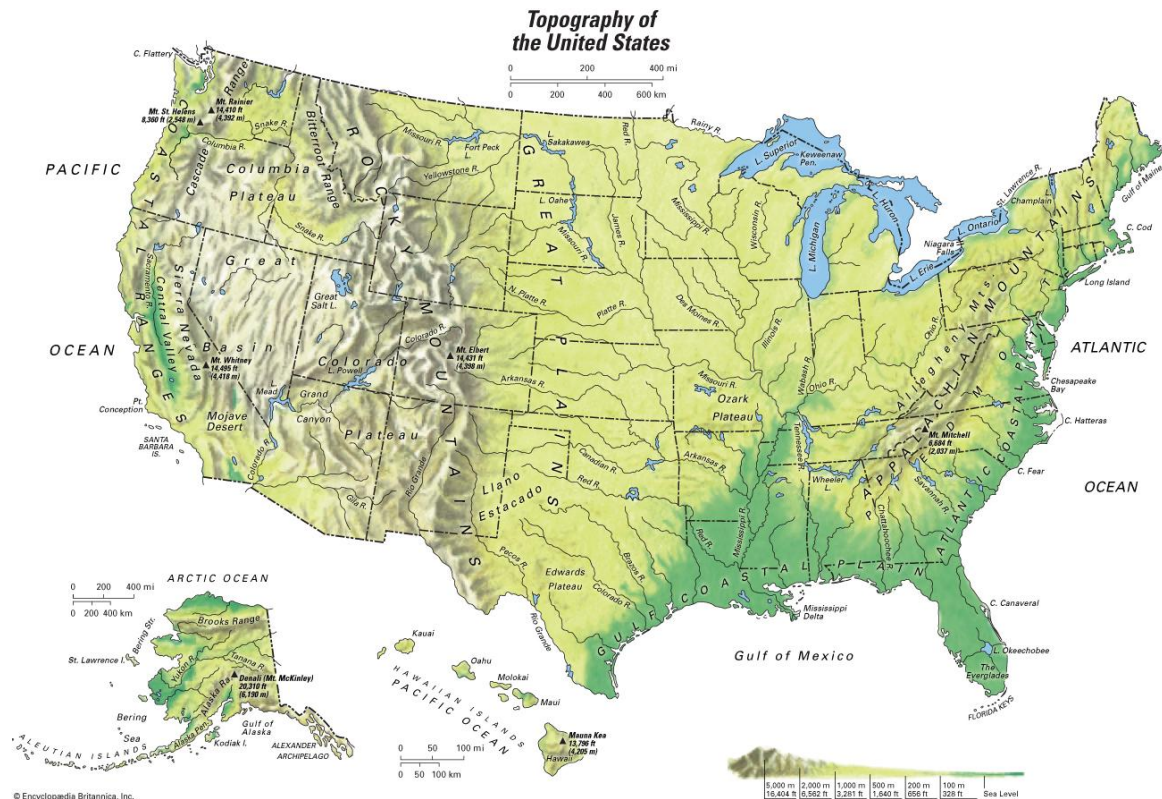
Examples of scalar data variables:

- Temperature
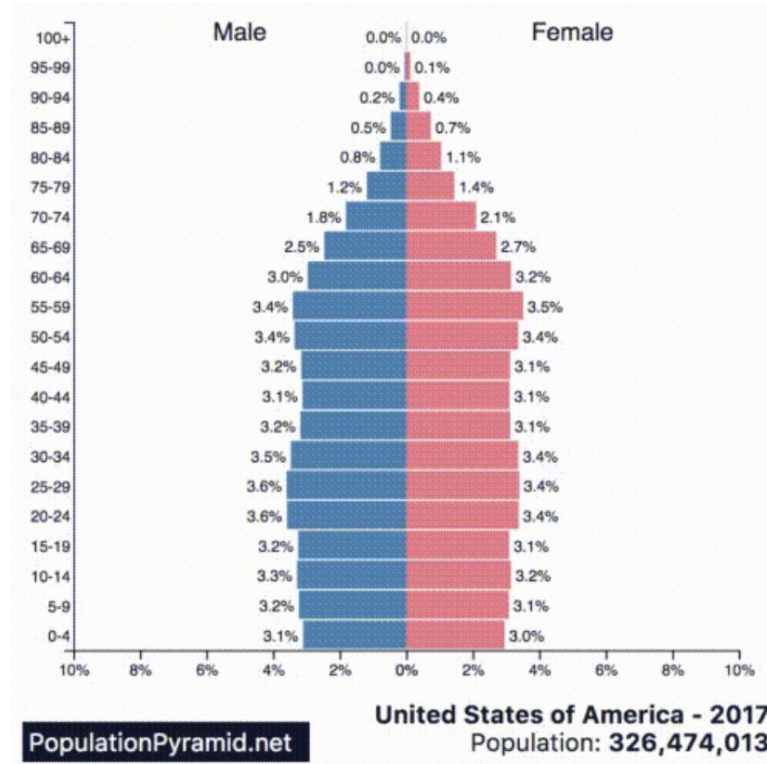- Area
- Speed
- Density

Scalars: Visual Examples
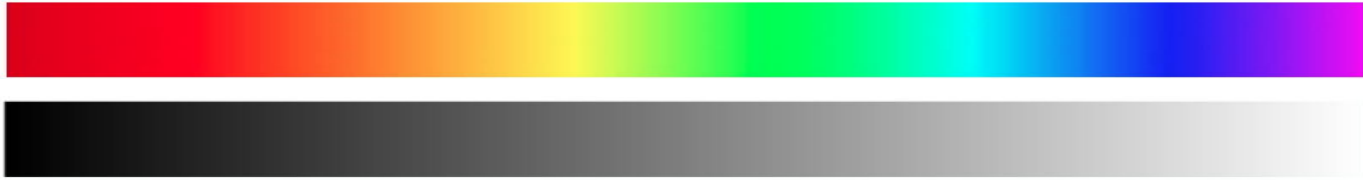
Scalars: Visual Examples

Topography of the United States

Scalars: Visual Examples

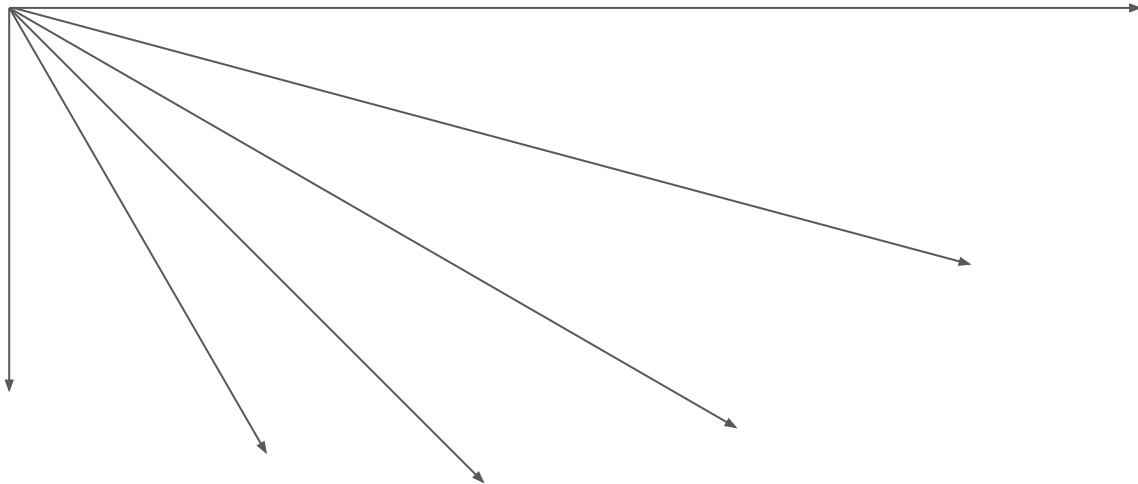# Scalars: Visual Variables Used

1. Color
   a. Hue
   b. Luminance

2. Size
   a. Area
   b. Length

Vectors

Vectors

Vectors

A data object that contains information about magnitude and direction.
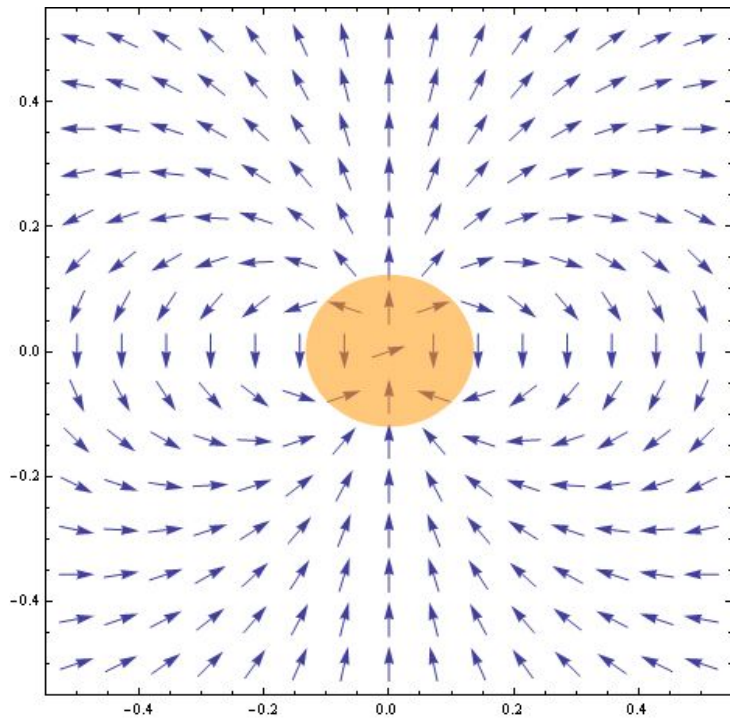
Vectors are quantitative data types that are typically continuous variables.

A vector quantity has a two-dimensional visual representation at each point in space.

Examples of vector data variables:

- Velocity (Speed + Direction)
- Force

Vectors: Visual Examples

Vectors: Visual Examples

Wind Vector Map: http://hint.fm/wind/

Vectors: Visual Variables Used

1. Color
   a. Hue
   b. Luminance
2. Size
   a. Area
   b. Length
3. Orientation

Tensors

Tensors

Tensors are the generalized data object that scalars and vectors fit into.

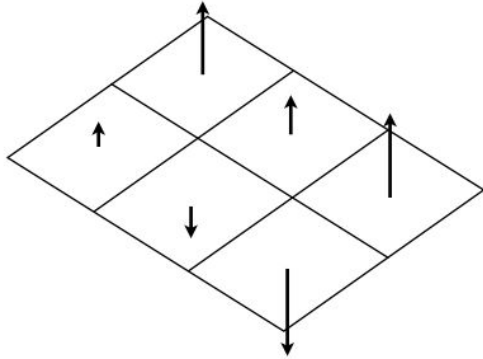Scalars: Rank 0 Tensors
Vectors: Rank 1 Tensors
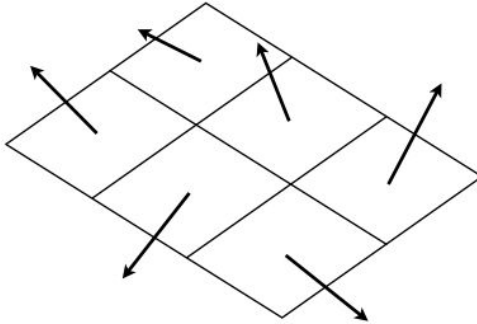Matrices: Rank 2 Tensors
Higher-Dimensional Objects

Typically in tensor visualization (non scalar/vector), a tensor quantity has a >two-dimensional visual representation at every point in space.
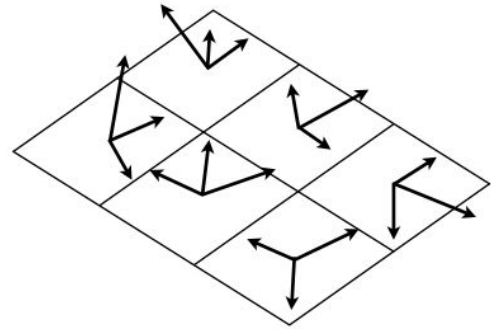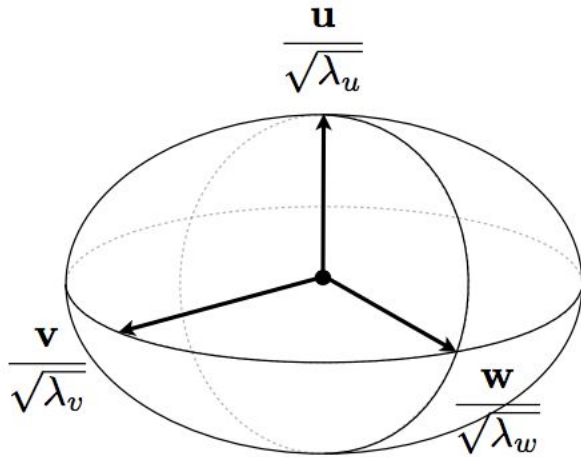
Tensors

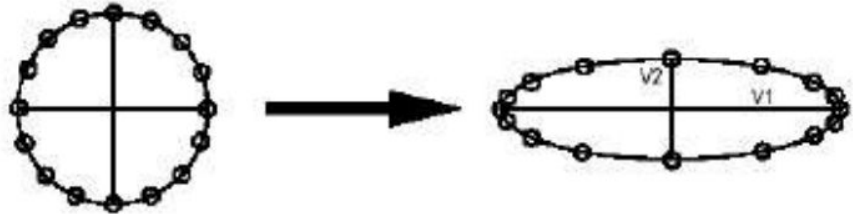**Scalar field**

Vector field

Tensor field (Rank 2)
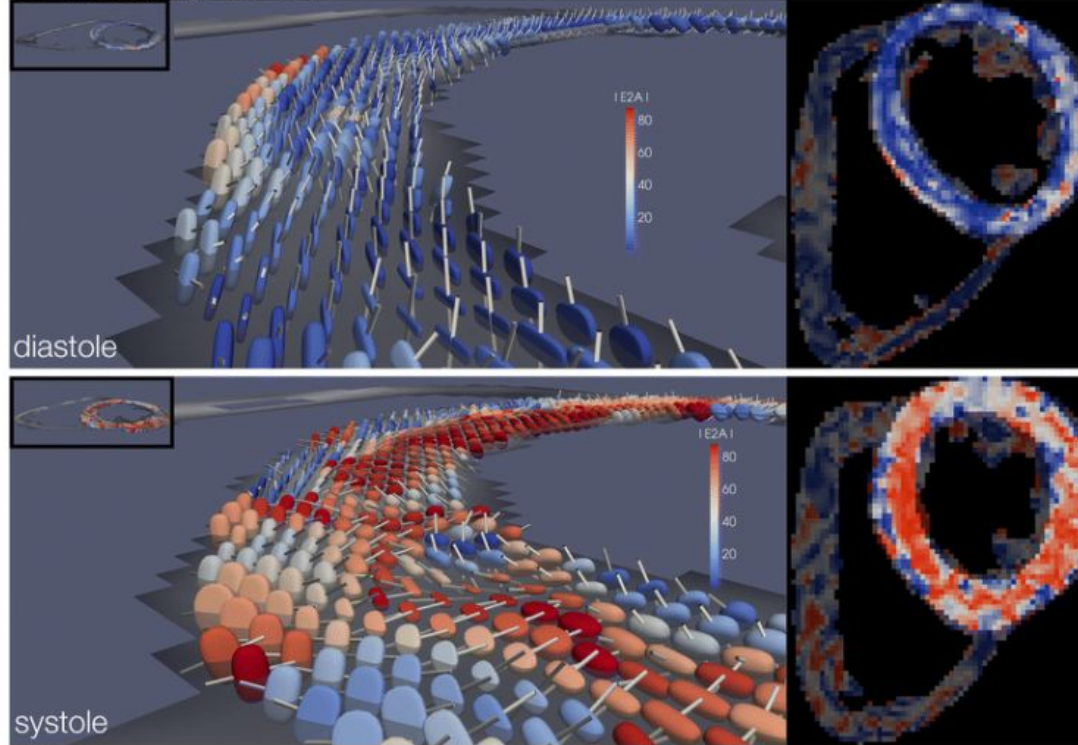
Tensors: 'Common' Visualization Methods

Ellipsoid Glyphs

Hyperstreamlines
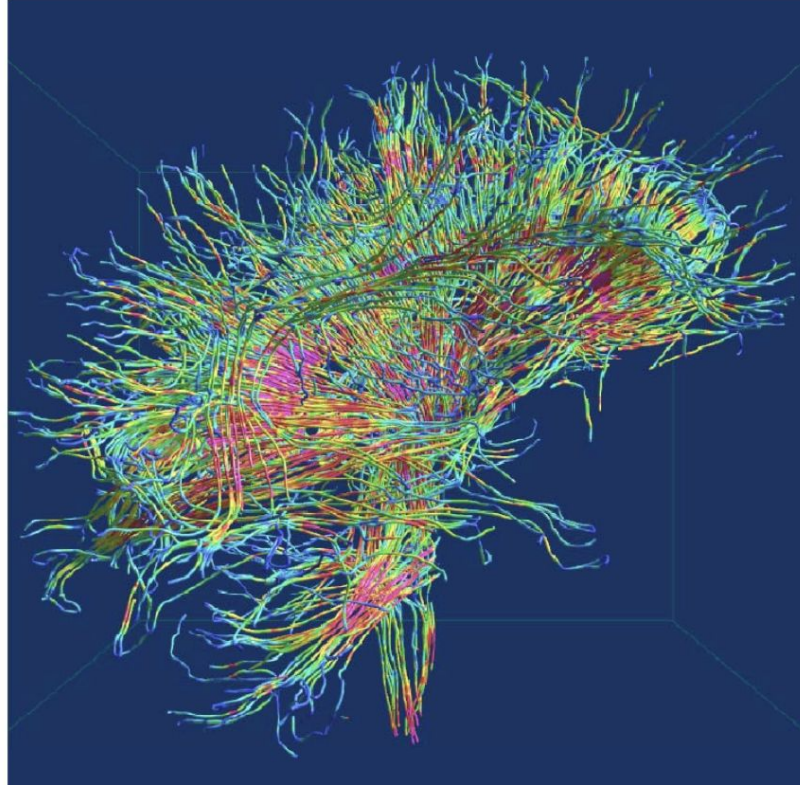
Tensors: Visual Examples (Ellipsoid Glyphs)

Tensors: Visual Examples (Hyperstreamlines)

Tensors: Visual Examples

https://youtu.be/wvsE8jm1GzE?t=18s

Scalars and Vectors in R