Q: It appears that a discrete vector is an easy concept: it’s simply an arrow that extends from one point in space to another point in space—right?

A: Good heavens NO! Although this is sometimes a valid description of a vector, most of the time it is not.

In most physical applications, a discrete vector describes a quantity at one specific point in space!
Remember the arrow representing a discrete vector is **symbolic**. The length of the arrow is **proportional** to the magnitude of the vector quantity; it generally does **not** represent a physical length!

\[ |\mathbf{F}| = 2.0 \text{ Newtons} \]

For example, consider a case where we apply a **force** to an **electron**. This force might be due to gravity, or (as we shall see later) an electric field. At any rate, this force is a **vector** quantity; it will have a **magnitude** (in Newtons), and a **direction** (e.g., up, down, left, right).

The force described by this vector is applied **at the point** in space where the electron (a very small object) is located. The force does **not** “extend” from one point in space near the electron to another point in space near the electron—it is applied to the electron **precisely** where the electron is located!

**Q:** Well OK, but you also implied my vector definition was **sometimes** valid—that a vector can extend from one point in space to another. When is this true?
A vector that extends from one point in space (point $a$) to another point in space (point $b$) is a special type of vector called a directed distance!

The arrow that represents a directed distance vector is more than just symbolic—it’s length (i.e., magnitude) is equal to the distance between the two points!

Note the direction of the directed distance vector $\vec{R}_{ab}$ indicates the direction of point $P_b$ with respect to point $P_a$.

Thus, a directed distance vector is used to indicate the location (both its distance and direction) of one point with respect to another.
It is imperative that you understand this concept—whereas all directed distances are vectors, most vectors are not directed distances!

For example, the vectors below are all examples of directed distances.

\[ \mathbf{R}_1 \]
\[ \mathbf{R}_2 \]
\[ \mathbf{R}_3 \]
\[ \mathbf{R}_4 \]
\[ \mathbf{R}_5 \]

Q: What the heck do these vectors tell us??

A: The location of some of your hometowns!

These directed distances represent the direction and distance to towns in Kansas, with respect to our location here in Lawrence.
For example:

a) Newton is 150 miles southwest of Lawrence.
b) Olathe is 30 miles east of Lawrence.
c) Fort Scott is 100 miles south of Lawrence.
d) Marysville is 100 miles northwest of Lawrence.
e) Goodland is 350 miles west of Lawrence.

The location of each town is identified with both a distance and direction. Therefore a vector, specifically a directed distance, can be used to indicate the location of each town.

Typically, we will use directed distances to identify points in three-dimensions of space, as opposed to the two-dimensional examples given here.