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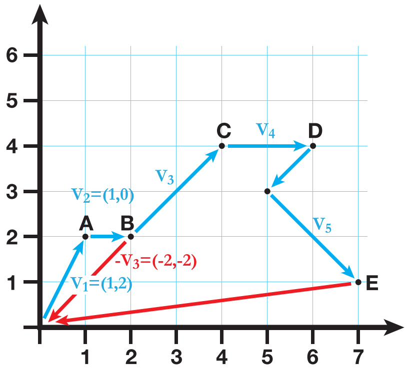
How do insects find their way home?

When insects go foraging, they zoom off from their nest in complex zig-zag paths. How do they manage to find their way back home? And how do they manage to do so along a straight path?

The main mechanism, used by most animals, involves a little geometry. Look at the zig-zag path shown in blue in the diagram. It's a sequence of arrows, known as **vectors**.



Moving along vector v_1 from the nest to point A is the same as moving one step to the right and two steps up, so we can represent the vector v_1 as a pair of numbers $v_1=(1,2)$. Similarly, we can write the vector v_2 from A to B as $v_2=(1,0)$. Now let's add the two vectors as follows:

$$v_3=v_1+v_2=(1,2)+(1,0)=(1+1,2+0)=(2,2).$$

And now take the negative of the resulting vector v_3:

$$-v_3=(-2,-2).$$

The new vector $-v_3$ (taking two steps to the left and two steps down) points from point B straight back to the nest! The same is true if we add any number of successive vectors and then take the negative: we always get a vector pointing from our current location back to the nest. So to know our way back home, we don't even need to remember all the vectors we travelled along – we simply need to add the current one to the last total.

Biologists believe that insects have innate mechanisms to determine orientation and distance, which help them represent each step in a foraging path by something akin to the vectors we have explored here. Neural processing enables them to add vectors as they go along, so they always know how to get back home quick! And insects are not the only ones – the technique explored here is sometimes called **dead reckoning** and it has been known to sailors for a long time.

With this technique small errors in measuring and adding up vectors can accumulate as the insect goes along. Insects then use other mechanisms to correct these errors, for example comparing what they see now to what they remember the world looking like from the nest. Scientists make extensive use of vector mathematics to model these other mechanisms too.

Vectors are extremely useful for all things geometrical, for example, they are used in computer generated movies to describe the geometry of virtual worlds. But they are also essential in physics and engineering, where they are used to describe forces: the direction of a vector indicates the direction the force is acting in and its length indicates the magnitude of the force. Apart from being an arrow, a vector can also be regarded as an array storing pieces of information – two pieces in our example – and in this capacity vectors are central to computer science, enabling your search engine to come up with millions of results in a split second.

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