Ant in a Room

Solution

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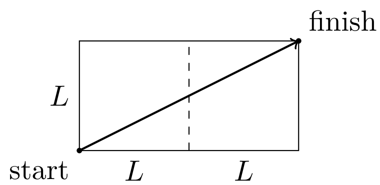
Let each edge of the room have length L. **The shortest walk has length $L\sqrt{5}$.**

Imagine cutting along some edges and laying the floor and one adjacent wall flat. Together they form a rectangle of dimensions $2L$ by L. The starting and finishing corners become opposite corners of this rectangle. Walk along its diagonal:

$$\text{length} = \sqrt{(2L)^2 + L^2} = L\sqrt{5}.$$

In the actual room, this route crosses the common edge of the floor and wall at its midpoint.



Why no other surface route is shorter

Here is a check that does not assume the ant uses only two faces. Temporarily take $L = 1$, and write the two opposite corners as $(0,0,0)$ and $(1,1,1)$.

The ant must eventually leave the three faces touching its starting corner and enter a face touching the finishing corner. At such a transition it crosses an edge having one coordinate 0 and another coordinate 1. After renaming the axes, that point is $(1,t,0)$ for some $0 \le t \le 1$.

Even a straight line through the room would need distance $\sqrt{1+t^2}$ to reach that point and distance $\sqrt{1+(1-t)^2}$ to finish. Walking on the surfaces cannot do better. The sum of these two distances is at least $\sqrt{5}$: they are the two pieces of a broken path across a 2-by-1 rectangle, whose straight diagonal has length $\sqrt{5}$. Equality occurs at $t = 1/2$, exactly as in our route.

The answer is a surface-walking distance. If the ant could fly straight through the room, the distance would instead be $L\sqrt{3}$.

History and sources: companion history PDF.