The Invisible Golden Snitch

READING LEVEL KIDS · EVERYONE · EXPERTS

The exact path of every possible Snitch and the corner of their curve: PROVED (written proof, independently re-derived); two chase results: PROVED under stated conditions; sample chases: COMPUTED for speed ratios 2, 3, 5 and 7; catching the Snitch exactly, at every speed ratio above 1: open. Not yet refereed.

proved in writing 4 · cited 1 · computed 1 · proved in writing; the program is not published here 1 · computed; the program is not published here 1 · open 1

What we actually checked: we worked out and proved the exact shape of the places a hidden Snitch could be while the chaser flies straight, and computed chases of pretend Snitches that finish at speed ratios 2, 3, 5 and 7, while whether the chaser can always win stays open and not yet refereed.

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1. The Invisible Golden Snitch

The Invisible Golden Snitch

The Snitch you cannot see

What we found

We worked out exactly where every possible Snitch is while Harry flies straight, and proved it: the places make an arrowhead with its sharp point at Harry. On a computer, Harry caught every one of lots of pretend Snitches when he was two, three, five or seven times as fast. Whether he can always win when he is just a little faster is still a mystery.

The question

Harry is looking for the Golden Snitch, and there is thick fog everywhere. He cannot see it at all.

He knows three things:

- The Snitch is exactly the same distance away from him, but he does not know in which direction.
- He can fly faster than the Snitch.
- The moment he moves, the Snitch flies straight away from him, as fast as it can.

The question

Can Harry fly a path that is sure to catch the Snitch, wherever it started?

This riddle comes from a maths channel called Don't Panic Math. Thank you for the question! It was a lot of fun to chase.

The question

Yesterday, today, tomorrow

Yesterday. People have been studying chases for almost three hundred years: ships chasing ships, dogs chasing rabbits. A famous trick says what to do if the thing you chase runs along a straight line: fly out in a spiral. Don't Panic Math asked a harder question. What if it runs away from you?

The question

Today. We worked out exactly where every possible Snitch is while Harry flies straight. Their places make a shape with a sharp point, like an arrowhead. Then we used a

computer to help Harry catch lots of pretend Snitches. It worked every time when Harry was two, three, five or seven times as fast. When he was only a little faster, the computer got stuck.

Tomorrow. Nobody knows yet whether Harry can always win when he is only a little faster. Maybe you will be the one to find out.

Play it in the playground

You need three or more friends and some chalk.

1. Draw a big circle on the ground. The Seeker stands in the middle with their eyes closed.
2. Everyone else is a Snitch. Each Snitch picks a spot on the circle.
3. When the Seeker takes a step, every Snitch takes one smaller step straight away from the Seeker. (Snitches take baby steps. Seekers take giant steps.)

Play it in the playground

1. The Seeker opens their eyes only at the end of each turn, to see if anyone is close enough to tag.

Try different paths. Walk straight. Walk in a spiral. Walk around the edge. Which path catches the most Snitches? Now make the Seeker's steps only a little bigger than the Snitches' steps. Is it still possible?

Why a spiral is not enough

Imagine every Snitch had to fly along its own straight road, starting from where Harry began. Then Harry could swirl outwards in a spiral, like water going down a drain, and cross every road. He would be sure to find it.

But this Snitch does not use a road. It flies away from wherever Harry is right now. When Harry moves, the Snitch bends its path to keep running away from him. So the spiral trick breaks.

[figure: A spiral that crosses every straight road out from the middle]

The arrowhead

Here is something we found and proved.

Suppose Harry flies in a straight line for a while. Think of every place the Snitch could be. At the start, those places make a circle. As Harry flies, the circle gets squashed into an arrowhead, with its sharp point right where Harry is.

The faster Harry is compared with the Snitch, the flatter the arrowhead gets. We found an exact rule for the angle of the point.

[figure: A circle of places turns into an arrowhead as Harry flies straight]

The chase along the edge

Next, Harry flies along the edge of the arrowhead, catching the closest Snitches one after another, a bit like eating a slice of pizza from the tip.

We tried this on a computer with hundreds of pretend Snitches. When Harry was two, three, five or seven times faster, he caught them all. When he was only a tiny bit faster, the computer's pretend chase fell apart before it finished, so we cannot tell yet who wins.

What nobody knows yet

Is there a path that catches the real Snitch every time, even when Harry is only a little faster? Nobody has shown that it can be done. Nobody has shown that it can't, either.

Here are some things you could try:

What nobody knows yet

- Play the playground game and draw the path that worked best.
- Ask: what if the Snitch could start anywhere inside the circle, not just on it?
- Ask: what if Harry only needs to get close, not exactly touch it?

If you find a clever path, we would love to hear about it.

Experts: the files and checks are here: verification guide.

We hope it helps others find more results and keeps their curiosity going. We'd love to collaborate with anyone.

Have an idea or a question? We'd love to hear it! Share it with a parent or guardian, and they can email it to us at hello@gocheckyourself.org.

Each result on its own page

- Proposition 1: the spiral against ships that run straight out
- Theorem 2: the exact path of a Snitch while Harry runs straight
- Theorem 3: the corner at the end of the opening run
- Result 4: the length of the curve at the end of the opening run

- Theorem 5: the tip law
- Theorem 6: the length balance, and capture for $\alpha > \pi + 1$ if a condition holds
- Remark 7: the sawtooth step, a heuristic
- Result 8: chases of sample Snitches with the exact motion
- Conjecture 9: point capture for $1 < \alpha \leq \pi + 1$

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