

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING: A CONVERSATIONAL APPROACH

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The engineering workflow you will use throughout this book

CHAPTER - 6

PART 1 · ≈ 15 MIN

The Measurement Disappears

A bead on a spinning wheel, a slow-motion camera, and a table of numbers with holes in it. Chapter 5 ended by promising that the engineer's f would arrive as DATA. Here it is.



Problem

Model

Compute

Analyze

Validate

Improve

What can we know about something we did not measure?

Commit to a first answer before we look at anything — nothing · something · it depends. On what?

Problem

›

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CONTENTS OF CHAPTER 6:

Chapter 5 asked: can the hunt read the map while it runs? **Chapter 6 asks:** when the information is a table of measurements with holes in it, what can we responsibly say about the holes?

1

The measurement disappears

A real bicycle wheel · Tracker turns motion into a table · four frames go missing · predict before calculating



2

Build it, fill it

The straight line is a model you proposed · slope → interpolation equation · one cell by hand, then Excel · the same gap in y



3

Check it with physics

What the spreadsheet does not know · an $r(t)$ continuity check · ACCEPT x, MODIFY y · three kinds of evidence



4

Automate it, guard it

How far can a straight line be trusted · interpolation vs extrapolation · Python for four times · two guardrails · a program that runs and is wrong



5

Interrogate the AI & transfer

BREAK THE AI: method, assumptions, evidence, context · "did AI recover the measurements?" · a handbook table · the bridge to Chapter 7



Course spiral: Ch 3 — how much can a number be trusted · Ch 4 — trap an unknown with a bracket · Ch 5 — spend the slope · Ch 6 — reason from measured data. Prediction before computation, as always.



A bead on a spinning wheel — what moves, and what could we measure?

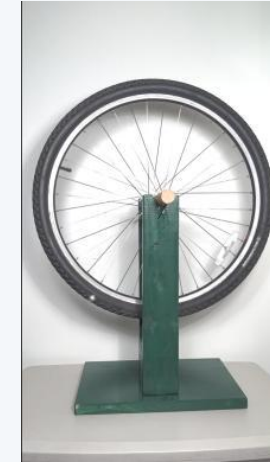


THE APPARATUS

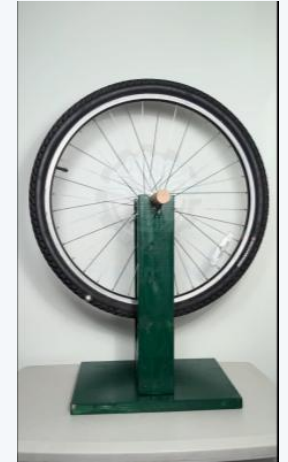
Front bicycle wheel on a wooden V-notch stand. A $\frac{1}{2}$ -in silver bead is fixed near the tire rim, nominally 12 in ≈ 0.3048 m from the spindle. The wheel is spun by hand and filmed.

THE CAMERA

Normal speed 30 fps and slow motion 120 fps. At 120 fps one frame every $1/120$ s ≈ 0.00833 s — the clock behind every number in this chapter.



slow motion · 120 fps



normal · 30 fps

Ask: What is moving? What could we measure? If a camera records this, what information does it actually hand us?

Spin the wheel. Watch the bead. Notice the wooden post in front of the wheel — it will matter in about four minutes.

Problem

›

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›

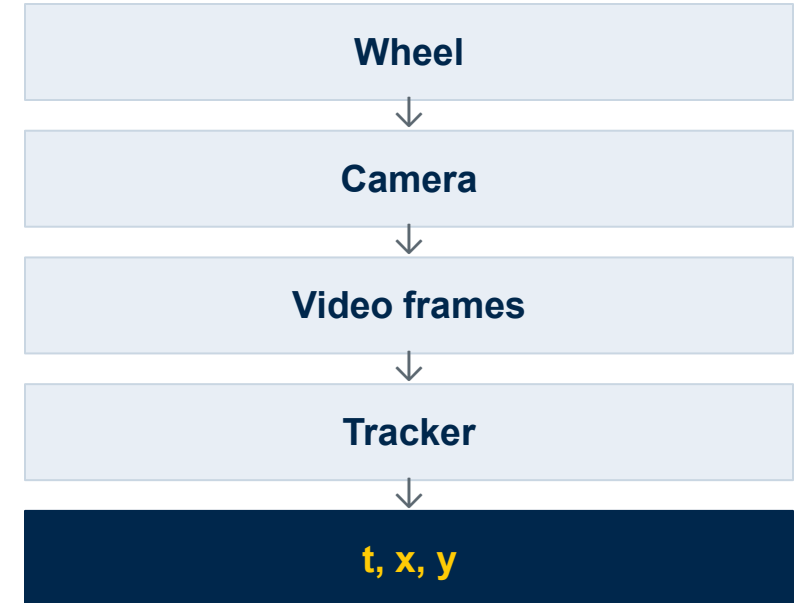
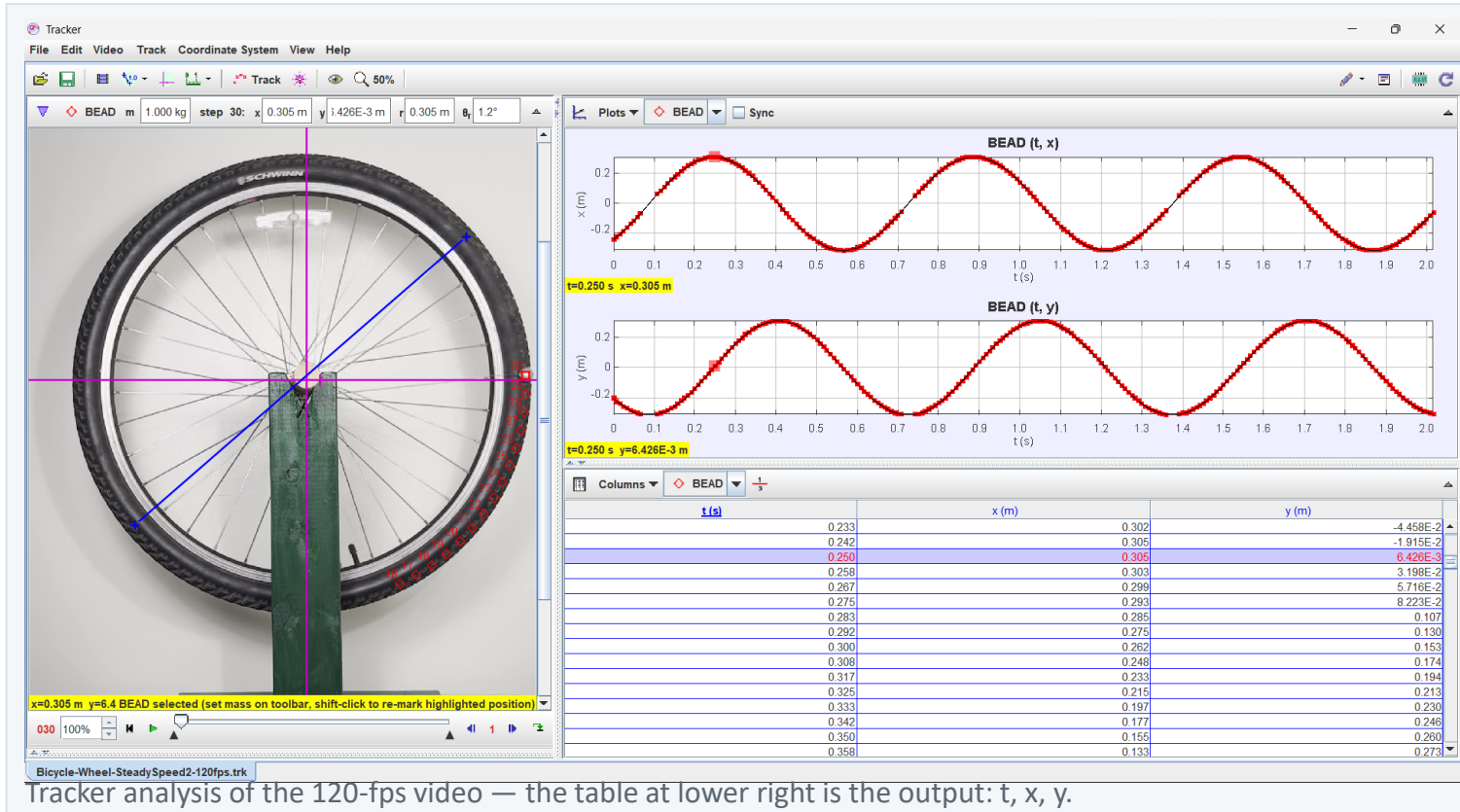
Validate

›

Improve



Physical motion becomes a table of numbers



Two columns, $x(t)$ and $y(t)$, one row every 1/120 s. Nothing in the table says "circle."

Tracker does not give us motion. It gives us measurements of motion — a number, at an instant, with a clock attached. Everything that follows is about what those numbers can and cannot tell us.

Problem

Model

Compute

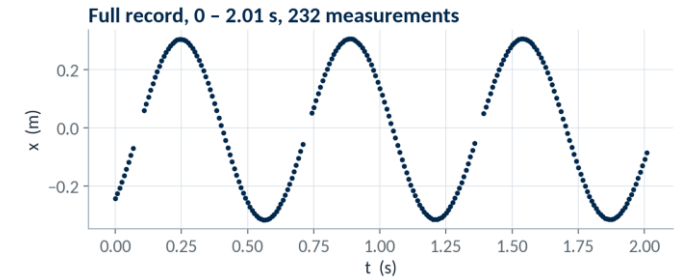
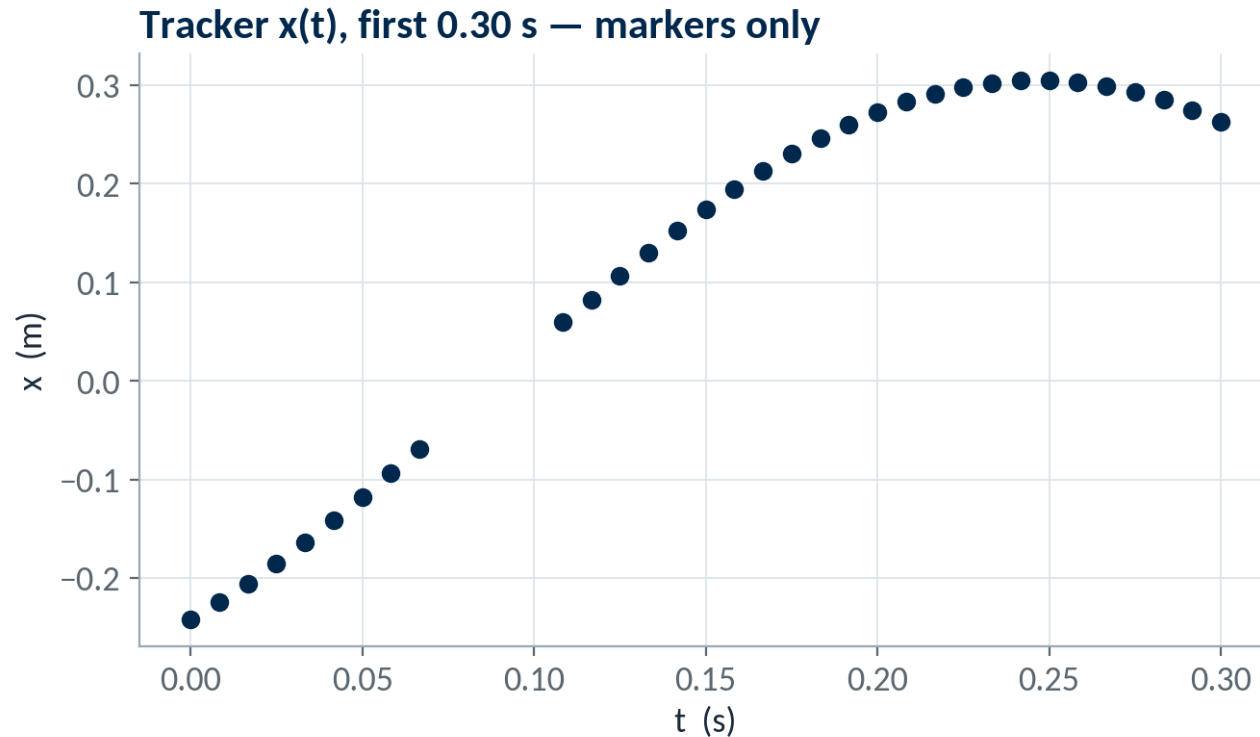
Analyze

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Improve



Something happened. What do you notice?



LOOK FIRST

Markers only — no line has been drawn between the points. Every marker is a frame Tracker could see the bead in.

Say what you see. Then say what you do not see.

Between 0.067 s and 0.108 s there are no markers. Four frames — $1/30$ of a second — in which Tracker has no measurement at all.

Problem



Model



Compute



Analyze



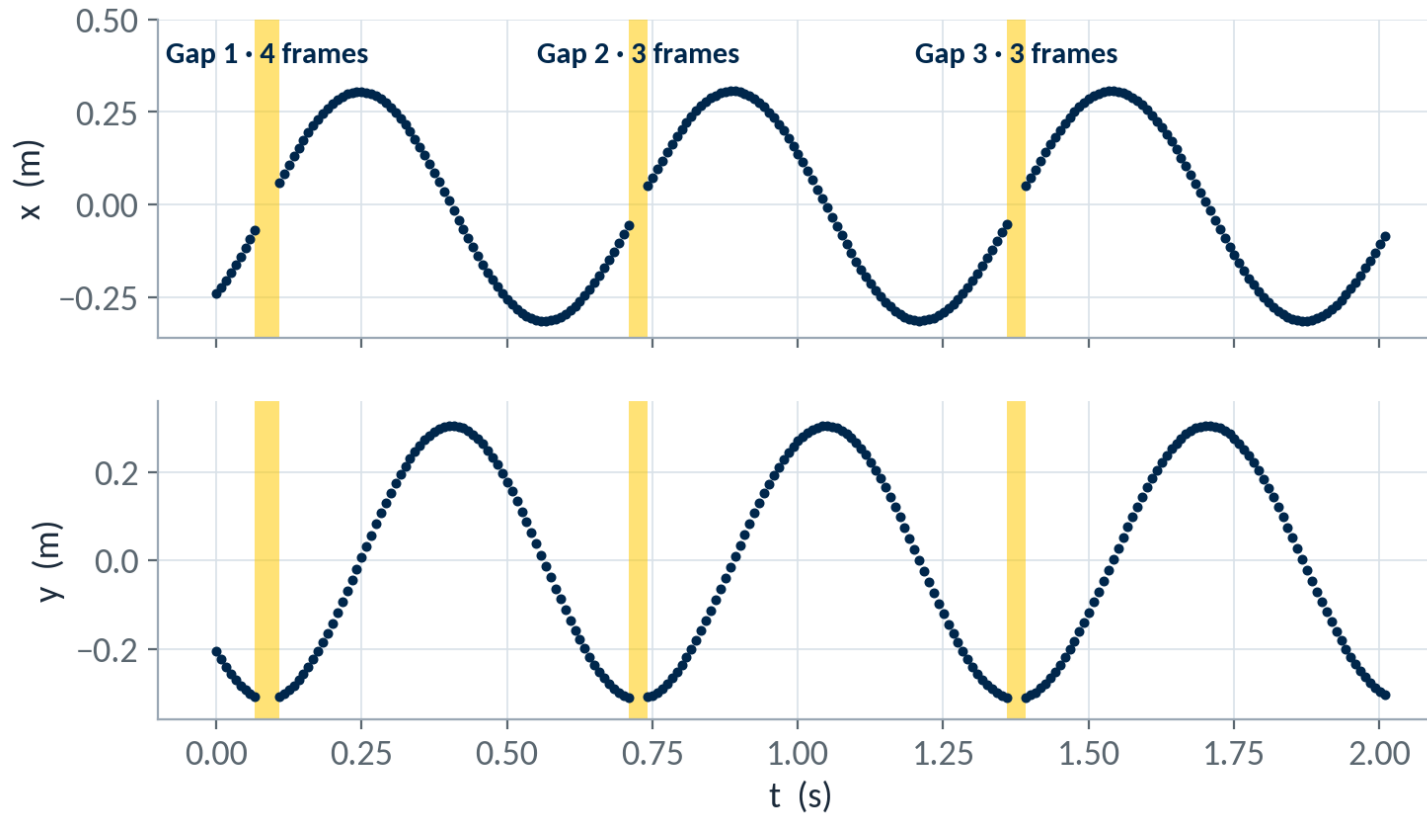
Validate



Improve



Tracker has no measurements here. Did the bead stop moving?



VOTE FIRST

The bead stopped · the bead kept moving ·
the camera stopped · something got in the way.

One sentence of evidence for your vote.

THE REVEAL

Three gaps — 4, 3 and 3 frames — and every one of them sits at the bottom of the wheel, once per revolution. The bead passes behind the wooden post. Tracker cannot see what the post hides.

THE PHYSICAL SYSTEM CONTINUED. THE MEASUREMENT DISAPPEARED. The data are shaped by how we measured — the gaps are systematic, not random.

Problem



Model



Compute



Analyze



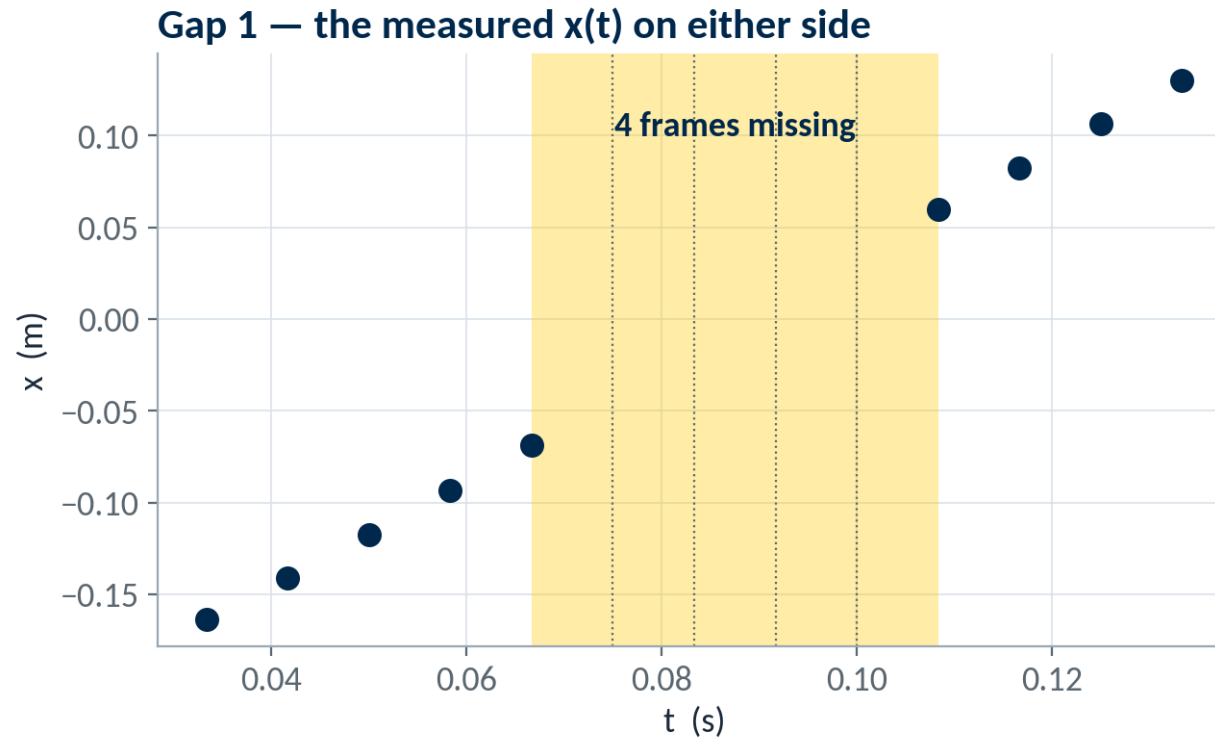
Validate



Improve



Four missing frames. Can we reconstruct what happened while we could not measure it?



t (s)	x (m)	status
0.050000	-0.117594	MEASURED
0.058333	-0.093531	MEASURED
0.066667	-0.068832	MEASURED
0.075000		MISSING
0.083333		MISSING
0.091667		MISSING
0.100000		MISSING
0.108333	+0.059576	MEASURED
0.116667	+0.082395	MEASURED
0.125000	+0.106590	MEASURED

INTERPOLATION estimating a value between known data points. Not recovering it. Not measuring it. Estimating it — from what was measured on either side.

Problem



Model



Compute



Analyze



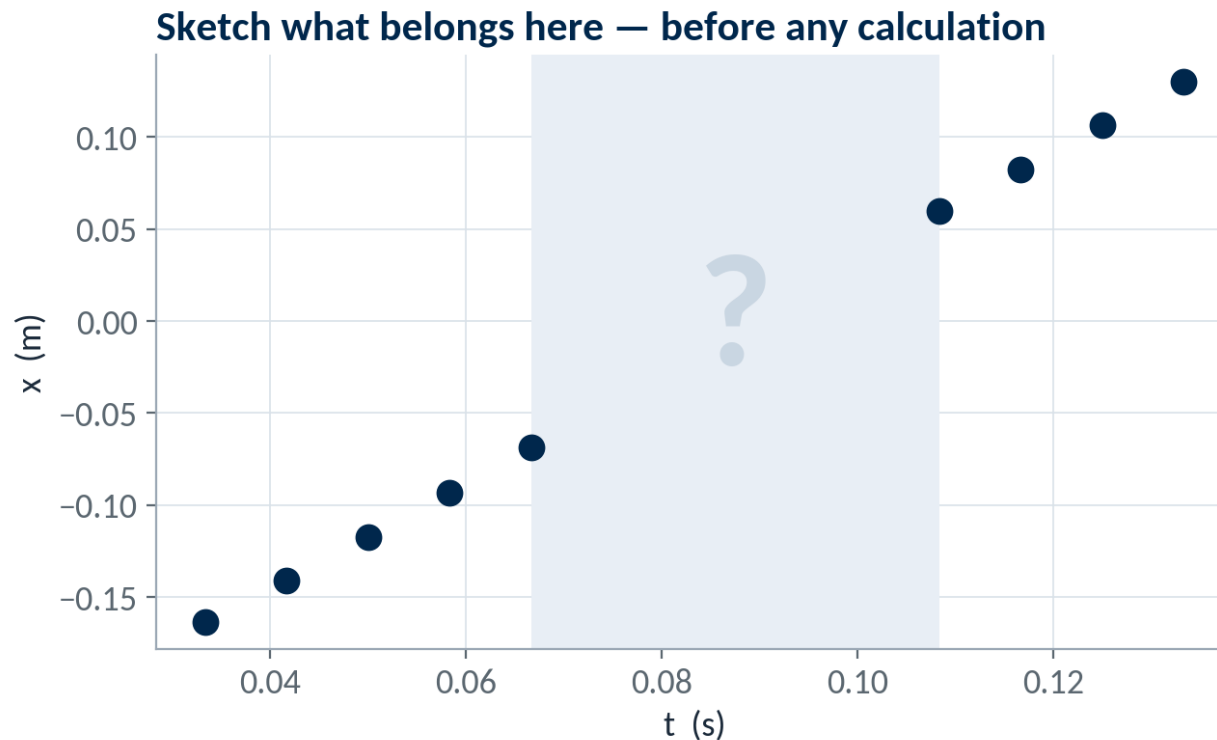
Validate



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PREDICT



Sketch the missing part of $x(t)$ on your own paper. Do not calculate anything.

Then answer in one sentence: what **SHAPE did you assume the bead's x followed while nobody could see it — and why that shape?**

Straight line? Gentle curve? Something else?
Commit before we discuss.

Whatever you drew, you just made an assumption about the physics. Part 2 gives that assumption its name.

Problem



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