

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING: A CONVERSATIONAL APPROACH

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The engineering workflow you will use throughout this book

CHAPTER - 6

PART 5 · ≈ 40 MIN

Interrogate the AI & Transfer

Hand the same four missing frames to an AI. Whatever method it picks, audit it: what did it assume, what did it verify, did it label its estimates — and did it "recover" anything? Then take the workflow somewhere with no wheel at all.

5

Problem

›

Model

›

Compute

›

Analyze

›

Validate

›

Improve



Give the problem to the AI — and do not tell it how

PROMPT 1 · AS TYPED

"Four Tracker measurements are missing between $t = 0.066667$ s and $t = 0.108333$ s. Estimate the missing x -values and explain your method." + the ten-row Gap 1 excerpt (t , x only).

WHAT WE ARE WATCHING FOR

Not whether it gets -0.04315 . Whether it says WHAT it did, WHY that was reasonable here, what it CHECKED — and whether the four numbers come back marked as estimates or dressed as data.

The method is not prescribed on purpose. It may not pick a straight line.

SPECIMEN A · ONE BRANCH

"Assuming x varies linearly over this short interval, slope = 3.0818 m/s, so $x \approx -0.0432, -0.0175, +0.0082, +0.0339$ m. These are linear-interpolation estimates, not measurements."

SPECIMEN B · ANOTHER BRANCH

"The x data look sinusoidal with a period of about 0.65 s. Fitting $x = A \cos(\omega t + \phi)$ to the neighbouring points gives $x \approx -0.0433, -0.0175, +0.0084, +0.0342$ m." — different method, nearly the same numbers. Does that make either one verified?

Problem



Model



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Improve



Interrogate whatever method it chose

THE INTERROGATION

Ask these of the transcript in front of you — live or specimen. Write the answers down; "it didn't say" is an answer.

The list is the same for a straight line, a sinusoid, a polynomial or a circle. That is the point: a method you cannot interrogate is a method you cannot use.

Student role: CRITIC. AI role: ENGINEERING ANALYST.

1 · WHAT METHOD did it actually use?

2 · WHAT did it ASSUME about the bead between frames?

3 · WHAT did it actually VERIFY — anything?

4 · WHAT EVIDENCE supports the numbers it returned?

5 · Did it DISTINGUISH estimates from measurements?

6 · Which of ITS assumptions have WE already tested?

Known vs assumed: the AI KNEW six (t, x) pairs. Everything else — local straightness, periodicity, the same physical regime inside the gap — it ASSUMED.



Now give it x and y — same gap, same confidence?

PROMPT 2 · AS TYPED

"Now reconstruct both x and y for the missing times. Which coordinate do you trust more, and why?" + the ten-row excerpt with t, x, y.

SPECIMEN C · A TYPICAL FIRST ANSWER

"Applying the same linear interpolation to y: -0.3079 , -0.3078 , -0.3077 , -0.3075 m. Both reconstructions use the same interval and the same method, so their reliability should be similar."

Read that last sentence twice.

WHAT YOU KNOW THAT IT DOES NOT

You saw the y chord clip the bottom of the arc (Part 2). You saw the reconstructed point sag 5–8 mm inward on r(t) (Part 3). The same interval and the same method gave you DIFFERENT confidence — because local behaviour differs.

THE CHALLENGE TO PUT BACK

"Your y estimate is flat at -0.308 m while the measured points on both sides are heading lower. What in the data justifies equal confidence?" — and note whether it answers from the data or from the method.

Problem



Model



Compute



Analyze



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Improve



Give it the physics — including a number that is only nominal

PROMPT 3 · THE CONTEXT PROBE

"The bead is attached to a bicycle wheel. The nominal bead radius is approximately 0.3048 m. Reconsider your reconstruction and propose independent validation checks."

SPECIMEN D · WHAT A NUMBER CAN DO

"Using $x^2 + y^2 = 0.3048^2$, the corrected y values are -0.3017, -0.3043, -0.3047, -0.3029 m."

Compare with the MEASURED neighbours: $y = -0.3080$ m before the gap, -0.3074 m after. The "corrected" bead now jumps 6 mm UP into the gap. The context made the answer worse — confidently.

THE CHECK THE CLASS CAN RUN

r from the measured neighbours is ≈ 0.3156 and 0.3131 m — not 0.3048. Whoever forces the reconstruction onto the nominal radius is trusting a design dimension over the instrument that actually looked at the wheel. Ask the AI: "Does 0.3048 agree with the measured neighbours?"

**CONTEXT CAN HELP AI.
INCORRECT OR IMPRECISE CONTEXT CAN ALSO
MISLEAD IT.
THE ENGINEER MUST CHECK THE CONTEXT.**

Problem



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MODIFY

Ask it to revise — assumptions and checks first

IMPROVEMENT PROMPT · AS TYPED

"Before revising the answer, identify the data-based and physical assumptions behind your method, explain any conflict between the nominal context and the measured data, propose independent validation checks, and clearly label estimates."

THE LIVE MOMENT

If one prompt is run live in this Part, make it this one. Then compare Answer 1 (Prompt 1) with the revised answer side by side: what changed, and what caused the change — the physics, the challenge, or the request to label?

SPECIMEN E · A GOOD REVISION

Assumptions named: local linearity in x; y near an extremum so linearity is weak; approximately circular motion; the nominal 0.3048 m is a design value, not a measured one.

Conflict explained: neighbours imply $r \approx 0.313\text{--}0.316$ m about the Tracker origin, so the nominal radius is not the right constraint — use the neighbours' r .

Checks proposed: $r(t)$ continuity with the neighbours; chord vs neighbour trend for each coordinate; velocity continuity across the gap.

Revised y from the neighbours' $r \approx 0.314$ m: -0.3114 , -0.3139 , -0.3143 , -0.3125 m — LABELLED ESTIMATES. x kept.

Problem



Model



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“Did AI recover the missing measurements?”

NO.

The measurements are gone. Tracker never saw the bead in those four frames and nothing can make it have seen them. The AI — like your hand calculation, like Excel, like Python — produced ESTIMATES. Good ones, in x. Improved ones, in y. Still estimates.

AN ESTIMATE IS NOT A MEASUREMENT — LABEL IT. A polished table from an AI is the easiest place in engineering to forget this. The more fluent the answer, the more carefully you read the label.

Problem



Model



Compute



Analyze

**Validate**

Improve



BREAK THE AI — the audit, then the verdict

METHOD — what did it actually do?

ASSUMPTIONS — stated? justified from the data?

BOUNDING DATA — did it use the right neighbours?

PHYSICS — does the reconstruction respect the trajectory?

VISUALIZATION — does a zoomed plot support it?

LABELLING — estimates marked as estimates?

THE RESPONSE FORMAT

DECISION

ACCEPT · MODIFY · REJECT

+ EVIDENCE

what you looked at, and what it showed

+ WHAT WOULD CHANGE YOUR MIND

the observation that would flip your verdict

Expected: ACCEPT x (evidence: local straightness, r-check, physics) ·
MODIFY y (evidence: chord clips the arc; physics-corrected values) ·
REJECT any answer forced onto 0.3048 m.

Problem



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The handbook does not list your temperature

T (°C)	dynamic viscosity of water, μ (mPa·s)
20	1.0016
25	? ← the value you need
30	0.7972
40	0.6527

Tabulated values (CRC Handbook). Your process runs at 25 °C.

THE SAME FAILURE MODES

Wide table spacing · strong curvature between rows · the wrong bounding rows · a property that changes regime between them (a phase change) · a request outside the table.

FIND

the two tabulated rows that bracket 25 °C: 20 and 30

BRACKET

the requested value lies BETWEEN them — interpolation, not extrapolation

ESTIMATE

the chord: $\mu \approx (1.0016 + 0.7972)/2 = 0.8994$ mPa·s

VALIDATE

μ falls with T on a CURVE (faster at low T) — the chord sits above the curve; the estimate is slightly high. The handbook's own 25 °C row says 0.8900: the chord is 1 % high — small, and in the direction the curvature predicts

No wheel, no camera, no gap in time — and exactly the same workflow, the same assumption, and the same reason to check it.

Problem



Model



Compute



Analyze



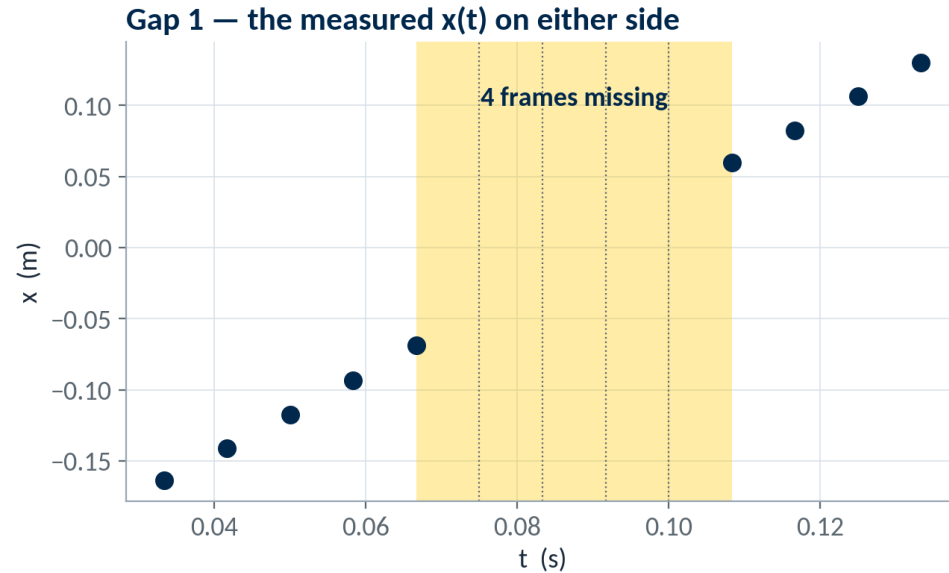
Validate



Improve

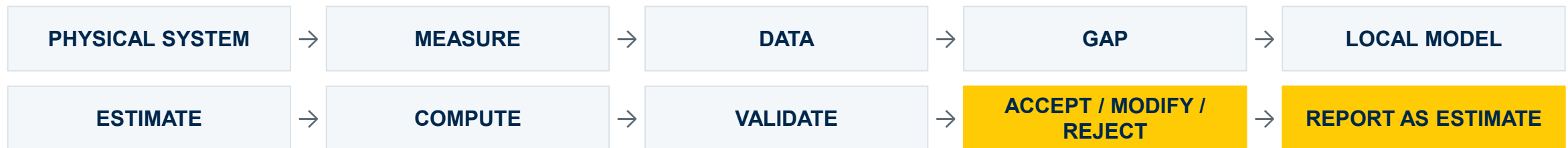


Can we reconstruct what we did not measure?



We can ESTIMATE it —

if we can justify the local model, validate the result with independent evidence, and report it as an estimate.



Overlay the course workflow: PROBLEM → MODEL → COMPUTE → ANALYZE → VALIDATE → IMPROVE. Chapter 6 was one full pass through it, on data instead of an equation.





Recover the Missing Data — this time the measurements are yours



Slow motion shows the motion the accelerometer turns into numbers, many times each second.

THE LAB IN ONE PASS

MEASURE Your phone becomes the accelerometer: phyphox records 20 s of the beam ringing down. Export to Excel — your own data are the evidence.

INTERPOLATE Program 1 withholds measurements near a peak and near a zero crossing. Straight line between the neighbours — the same equation as Gap 1.

COMMIT → REVEAL You type the prediction first. Only then does the program show what the sensor actually measured.

DECAY Program 2 repeats it on the $|\text{peak}|$ envelope, then fits $A(t) = A_0 e^{(-\lambda t)}$ — the door into Chapter 7.

VALIDATE Compare prediction with measurement and explain the difference. A prediction made after reveal is not a prediction.

MEASURE › ACQUIRE › INSPECT › INTERPOLATE › COMMIT › REVEAL › VALIDATE

Problem

Model

Compute

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