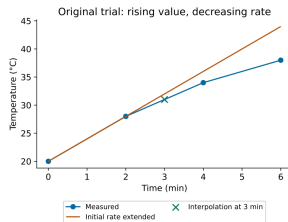


Science: data representation and defensible extrapolation

Original skill preparation; versioned source scope

Method and conditions



- A rate of change compares output change with the matching input interval.
- Tables; units; slopes; interpolation versus extrapolation.

Worked method 1

Read and reason

A rate of change compares output change with the matching input interval.

$r = \Delta T / \Delta t = (32 - 28) ^\circ\text{C} / (4 - 2) \text{ min} = 2 ^\circ\text{C} / \text{min}$. A rising temperature can have a falling rate. Read units before calculating.

Original context 1

Read and reason

Original hypothetical research summary — A cooling sleeve A laboratory team tests sleeves intended to reduce a small sensor's temperature during operation. All sensors start at 22°C. Temperature is measured after ten minutes of use with the same power setting, room conditions and measuring instrument. Sleeve A costs 4 units, B costs 7 units, and an unsleeved sensor is the control.

Original context 2

Read and reason

The design brief requires a cost no greater than 5 units and a final temperature no greater than 35°C. Lower temperature alone is not the only design criterion. Experiment 1 uses identical sensors and records three independent trials per sleeve. Final temperatures in °C are: control 41,42,43; A 33,34,35; B 30,31,32.

Original context 3

Read and reason

The team resets the starting temperature and checks the sensor charge before each trial. They report the means and the full observed ranges. The ranges describe these trials, not every future result. The team has not yet measured sleeve durability. Experiment 2 investigates thickness for material A. Each sleeve has the same length and fit; thicknesses are 1,2,3 mm.

Original context 4

Read and reason

Mean final temperatures are 38,34,32°C respectively. All other stated conditions match Experiment 1. Changing thickness also changes material quantity, so a future design review must measure costs instead of assuming they stay at 4 units. A student proposes testing a 3-mm sleeve in material B against a 1-mm sleeve in material A to identify thickness's effect.

Original context 5

Read and reason

This comparison would change two factors at once. Two original models explain the observed temperature pattern. Model P says final temperature depends only on thickness, regardless of material. Model Q says both thickness and material matter; at equal thickness it predicts that material B produces a lower final temperature than A under the same conditions.

Original context 6

Read and reason

Both models predict lower final temperatures as thickness rises over the tested 1–3 mm interval. A decreasing trend alone therefore cannot separate them. Experiment 3 tests new A and B sleeves, each 2 mm thick, in matched conditions. Mean final temperatures are A 34°C and B 31°C.

Original context 7

Read and reason

The measuring instrument's stated resolution is 0.1°C , and the team checks its calibration with a reference. Repeated trials would still be needed to characterise variability and rule out other differences in manufacture. The result conflicts with P's material-independence prediction and is consistent with Q's direction; it is not proof that Q is the only possible explanation.

Original context 8

Read and reason

A separate time series for one sensor with sleeve A records temperatures 22,28,32,34°C at 0,2,4,6 minutes. These observations show warming with successively smaller two-minute increases. No measurements beyond six minutes are supplied in this series.

Original context 9

Read and reason

A proposal to continue the first interval's slope to twelve minutes is a model assumption that later measurements may contradict, not a reading from the table.

Attempt 1.1

Read and reason

For the separate time series, calculate the three average two-minute warming rates. Describe temperature and rate separately.

Reasoning 1.1

Read and reason

$r_1 = (28 - 22)/2 = 3$, $r_2 = (32 - 28)/2 = 2$, $r_3 = (34 - 32)/2 = 1$, all in $^{\circ}\text{C}/\text{min}$.

Temperature rises throughout, while these interval-average rates decrease. This does not specify every instantaneous rate.

Attempt 2.1

Read and reason

Estimate temperature at minute 3 by linear interpolation. Extend the first interval's slope to minute 6 and compare with the actual measurement.

Reasoning 2.1

Read and reason

$T(3) = 28^{\circ}\text{C} + [(3 - 2)/(4 - 2)](32 - 28)^{\circ}\text{C} = 30^{\circ}\text{C}$. First-slope model gives
 $T(6) = 22^{\circ}\text{C} + (3^{\circ}\text{C}/\text{min})(6 \text{ min}) = 40^{\circ}\text{C}$, above the observed 34°C . Constant early rate is inconsistent with the whole series.

Attempt 3.1

Read and reason

Is a minute-12 value read from these data or extrapolated? Explain why a graph with a rising curve does not establish indefinite constant-rate warming.

Reasoning 3.1

Read and reason

It is extrapolated beyond 0–6 minutes. A rising curve can flatten, and the measured average rates already decline. Predicting minute 12 needs a stated model and additional evidence; temperature direction alone does not fix rate or long-term behaviour.

Transfer and limits

Read and reason

Tables; units; slopes; interpolation versus extrapolation.

Check yourself

Read and reason

Close the worked reasoning. Explain why the method fits the final transfer task, reconstruct its conclusion, and state a condition that would change your answer. Then check the full reasoning in the reference.