Functions, array axes, and planar trajectories — review sheet

Use this after attempting the worked examples and practice. Explain each claim in words before calculating.

Key ideas

- A function exposes an input–output contract.
- Return values can feed later calculations.
- Loops make repeated index meanings visible.
- Name every axis before broadcasting or reducing.
- A rotation uses matrix multiplication and preserves lengths.
- A threshold is a declared decision rule, not a scientific truth.

Common errors and repairs

Treat the final array axis as time automatically. Here the final axis is coordinates; time is axis 1.

Divide a batch by a duration array with no axis reasoning. Align durations as (1, intervals, 1).

Call every norm an observed path speed. It is the magnitude of average velocity over sampled intervals.

Retrieve without your notes

- What shape follows time differencing of (8,10,2)?
- Which of $>$ and $>=$ includes equality?
- What remains invariant under a rigid rotation?

Readiness check

- Write and test a function with inputs, a return value and a declared invalid-input case.
- Trace a loop and a strict comparison at its boundary.
- Label trial, time and coordinate axes in a three-dimensional NumPy array.
- Compute interval-average velocity components and their magnitudes with explicit broadcasting.
- Use a matrix rotation and check that it preserves displacement lengths.