Visual discrimination is a two-stage process

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What process underlies discrimination?

Three discrimination tasks

- Orientation
  - Clockwise of vertical?

- Localization
  - Left or right?

- Direction
  - Clockwise of vertical?

Decision variable: \( E = \log \frac{P(\theta > C)}{P(\theta < C)} \)
- If \( E > 0 \), say “Clockwise”
- If \( E < 0 \), say “Counter Clockwise”

Accuracy depends on the magnitude of \( E \), which depends on signal-to-noise ratio (SNR):
\[
\Delta' = \frac{\Delta \theta}{\sigma}
\]

Drift-diffusion model (DDM)

Momentary evidence \( E(t) \)
Decision variable accumulates evidence
\[
D(t) = \sum_1^t E(t)
\]

Evidence accumulates until
- \( D(t) \) reaches a decision boundary
- task forces process to terminate

Accuracy and RT depend on \( D \) and hence on SNR

Prediction of DDM for RT: \( \Delta \) and \( \sigma \) interact

Model (Drift-diffusion + Population code)

- 36 orientation-selective neurons
- Poisson firing rates
- Decoded via Bayesian inference
- Decode every 50 ms

Experiment 1:
- Orientation, location and direction discrimination;
- 5 contrast/coherence levels (\( \sigma \))
- 3 \( \Delta \theta/\Delta x \) levels, all interleaved
- Instructions: Respond quickly but maintain 95% accuracy

Simulation (DDM prediction)

Experiment 1: Example Data – Orientation discrimination

DDM prediction fails:
No interaction of \( \Delta \) and \( \sigma \) (parallel fits)

Mean RT (s)

Transformed contrast / coherence

Experiment 2: Results

Expt. 2: Results

5% Coherence
25% Coherence

Response cue delay (s)

Contribution

Discrimination is a two-stage process:
(1) Estimate, then
(2) Decide

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