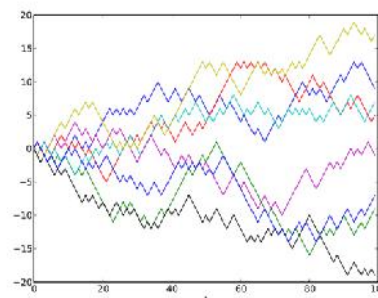


Ratcliff, 1978

- Diffusion model suggests that evidence builds gradually towards one of a number of outcomes
- Ratcliffe had data from a monkey saccade experiment
 - SRT behavioural data
 - SC single cell recording
- A diffusion model was built on behavioural data to predict SRT and accuracy of saccade
- And then tested on the single cell data from SC
 - Evidence accumulation from the model matched increase in activity in SC cells
 - The nearer the model was to a decision, the greater the firing rate
- Is it the behavioural data or the neural data that make this such a great paper?
- Perhaps both?
- Actually, its that you can integrate both together in a model/framework

First, a random walk

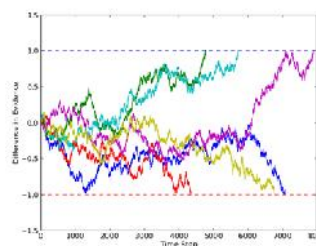
- also called drunkard's walk in
- Is a type of random search or exploration over time
- Searching physical space, but also other abstract spaces, like 'evidence'
- At every time step, randomly move some distance along possible dimensions
- Incorporated as starting point or an element of some models
 - Eg eye movements in visual search



A number of random walks in one dimensional space

Diffusion model

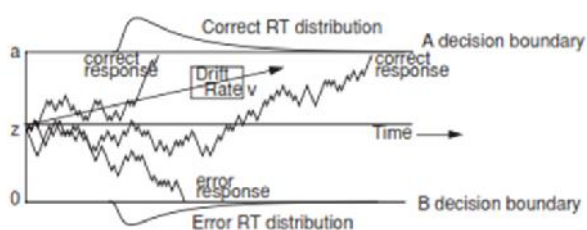
- AKA accumulator model, threshold model
- At its simplest, we could model one or more random walks that stop when they pass one or more thresholds
- And these thresholds represent possible outcomes
 - Decisions
 - Saccade directions
 - Responses
- The model makes predictions on time, choice and accuracy



Multiple walks can represent multiple possible choices or targets. Assumes evidence and noise accumulate separately for each option

What parameters are missing?

- At every time step we can add
 - **Noise** in a random direction (random walk)
 - **Signal (or drift rate)** about the correct 'direction'
- The **threshold** (or boundary) is the value that the walk must reach for a decision or a response to be made
 - Threshold **shift** can be made in response to correct or incorrect responses to reflect an adjustment of threshold

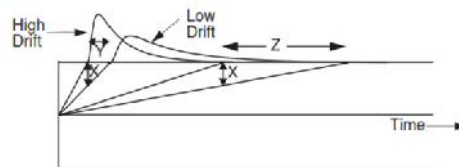


Review, Ratcliff and McKoon, 2008

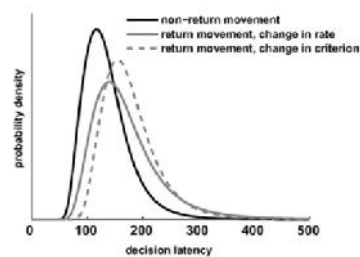
- Single model explains reaction times and error rates
- Generative: can produce response distributions
- Replicates positive skew of most RT distributions
- Drift rate can vary across trial and across subject
 - Often chosen from one or more random distributions
- Bias can be modelled as shift in starting point
- **Parameters of the model represent aspects of cognitive processing, and can change as we manipulate experiment parameters**
- Ratcliff version: for single stage decisions less than 1500ms only
- Signal can represent
 - Size of target
 - Amount of practice on a memory task
 - Attention or cuing
- Noise can represent
 - Number of distracters
 - inhibition

tweaks

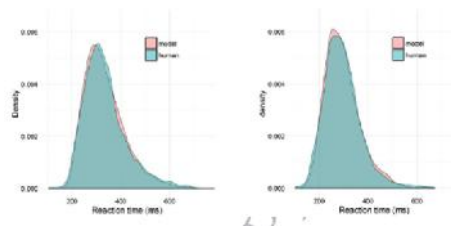
- Trial by trial adjustment of threshold criteria shift
 - Correct answers make us more liberal
 - Incorrect answers make us more conservative
- Different parameters change different quartiles of the distribution
 - For example, the same shift in drift rate (X) will have a larger impact on the tail end (Z) of the distribution than on the leading edge (Y)
- Other variants, including EZ diffusion model of RT
 - Wagenmakers, 2008
 - Linear Ballistic Accumulator

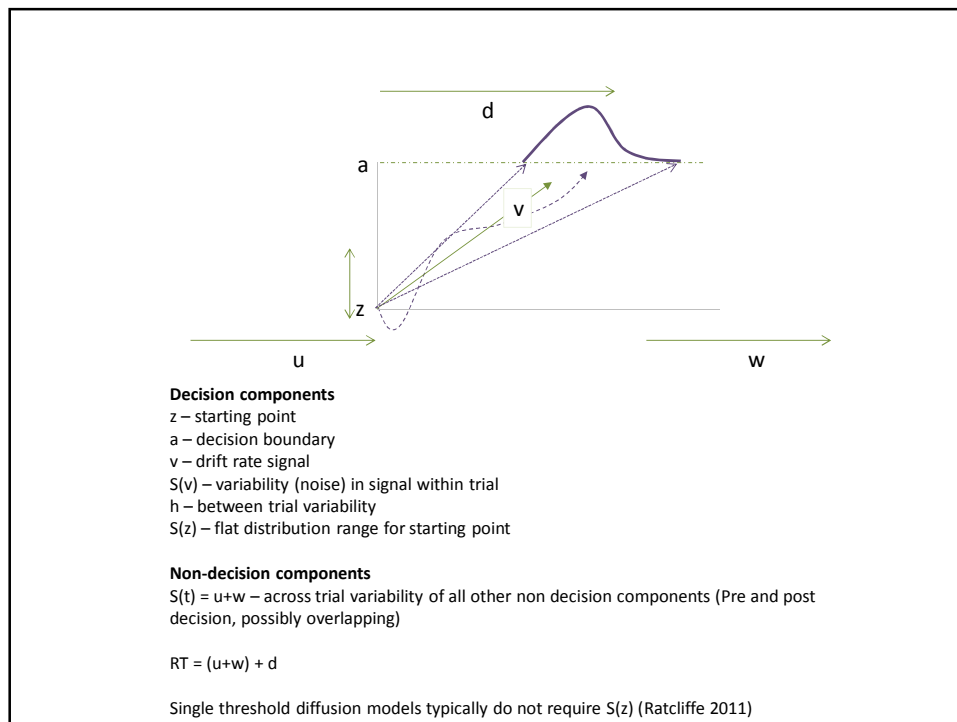


Ludwig et al 2009



MacInnes 2016



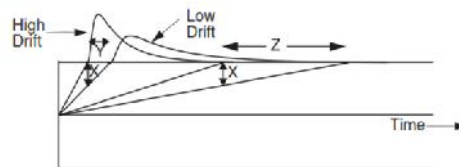


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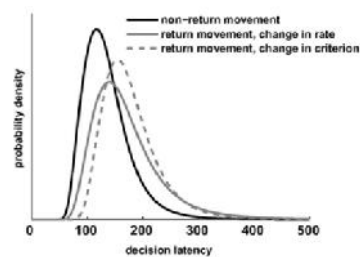
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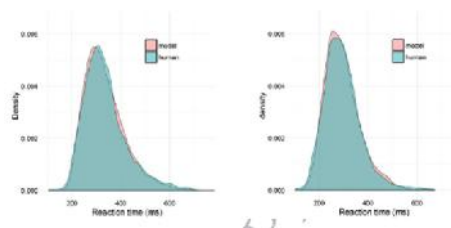
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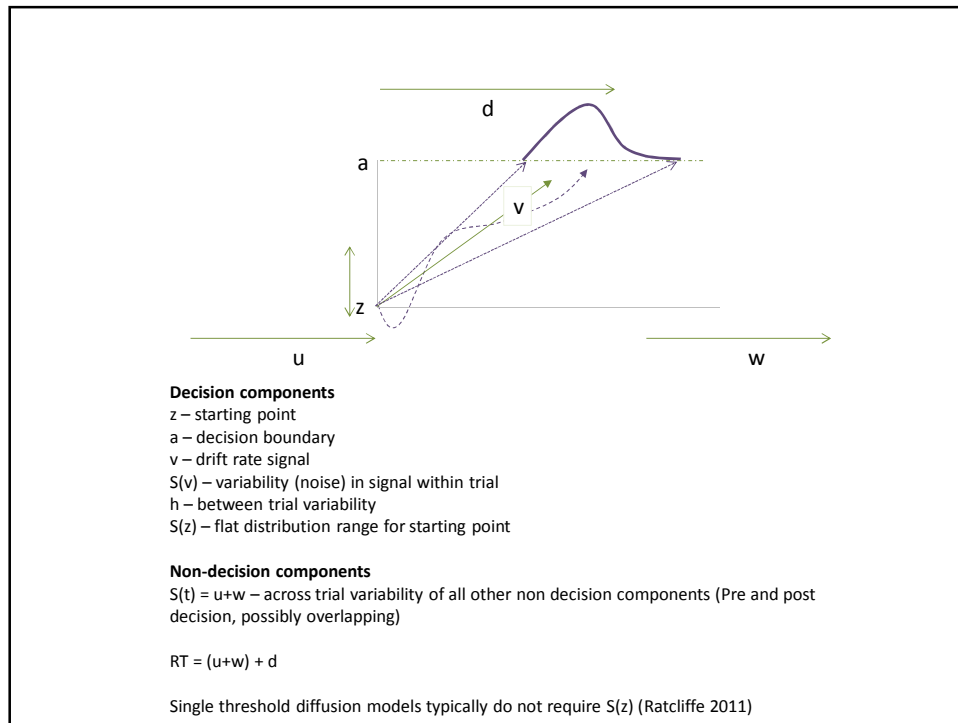


Ludwig et al 2009



MacInnes 2016





- Brains are grown, not built...
- The case for machine learning in computational modelling
- An example

Search for common : Genetic algorithms

- Primarily a search algorithm
- Search for best combination of parameters when there are too many combinations for 'brute force' search
- Requires some measure 'best'
 - Fitness function/heuristic

<http://www.youtube.com/watch?v=HgWQ-gPlvt4>

http://rednuht.org/genetic_walkers/

<https://www.youtube.com/watch?v=KjOtNMQxxXo>

Generation x

- What are the key parameters and variables of your model?
 - Define the possible range of values they could take
 - Begin with 50(?) random models, each one possible combination of values
 - This is generation one
1. Test each model of the current generation against some fitness function
 2. Selection: Keep the top 20(?) winning models
 3. Mutate or crossover an additional 20
 4. Add a new set of 10 random models
 5. Return to step 1 as new generation

Generation	N	N+1
Mutate	ARTY	ARKY
Splice	ARTY, GLGS	ARGS, GLTY
Merge	ARTY, GLGS	ARTYGLGS
Random	ARTY, GLGS	EWCF, JYTE

Notes:

Merge is only possible if you allow new generations of different length
Elitism is simply keeping some of the best in a generation 'as is'