ModelTypes

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Stone Model

$$x(t+1) = x(t) + v \times dt + \sqrt{(dt)} \times s \times N(0,1)$$

Where x is the decision variable, v is the drift rate, dt is the step size, s is the standard deviation of the noise, $N(0,1)$ denotes the normal distribution.

A correct response is made when $x(t+1) > a_{upper}$ and an incorrect response when $x(t+1) < a_{lower}$. The decision time is identified at time t. The total reaction time is estimated as a sum of the decision time and a non decision time that is also estimated from the RTs. The non decision time is thought to reflect processes such as stimulus encoding and motor initation time.

Results from the stone model

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## [1] "Vanilla diffusion model with no bells and whistles"
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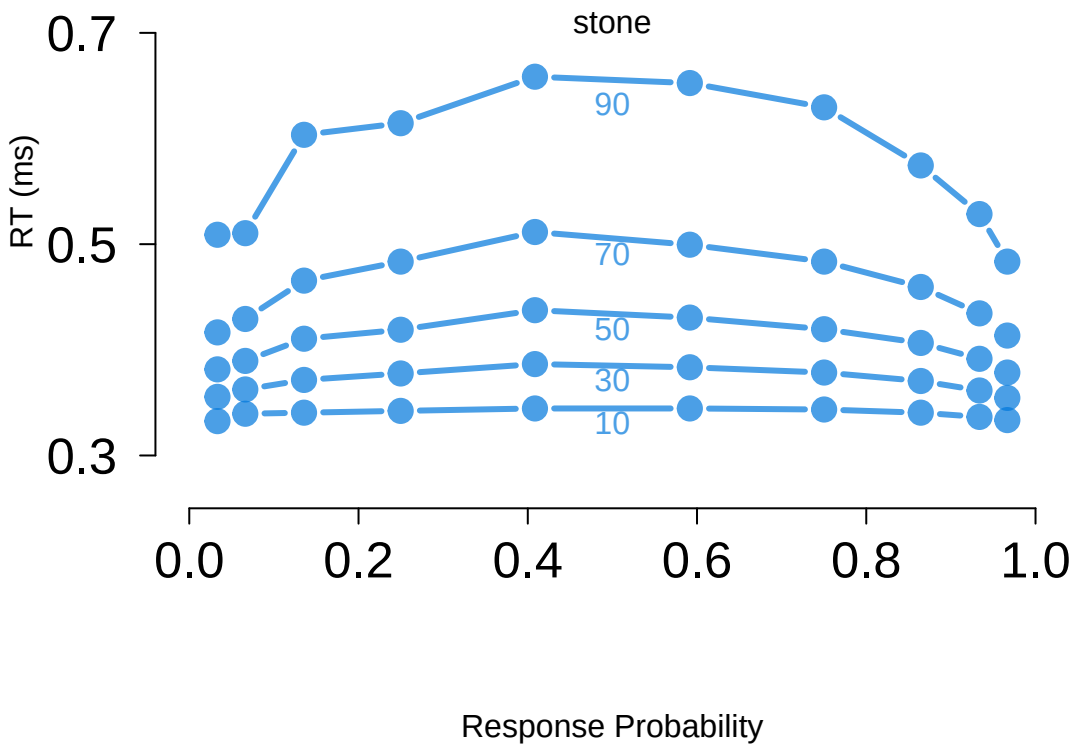


Stone UGM model

In the Urgency "gating"" model that Cisek and collaborators have proposed, there is no integration of evidence instead the input evidence is low pass filtered and then multiplied by an urgency term that increases with time. Note, without a low pass filter, multiplication of instantaneous evidence by the urgency signal would lead to excessive noise especially in the later time points. So Cisek and collaborators argue that the sensory evidence is low pass filtered (time constants of either 100 or 200 ms are used).

Implementation of this uses the exponential smoothing average approach that can be used for discrete smoothers.

x_0 is the initial evidence for each choice which is also the baseline state of the process. Again assume input drift rate is v and there is additive noise which again is appropriately scaled. Then the pair of governing equations for the UGM model are as follows. The current evidence that is used for making a decision is a weighted sum of past evidence with the present evidence.

$$\alpha = \frac{\tau}{\tau + dt}$$
$$E(t) = \alpha \times E(t-1) + (1-\alpha)(v \times dt + \sqrt{dt} \times s \times N(0,1))$$

When alpha is zero, there is no filtering, however when alpha is 100 ms (and dt is 1 ms), then the previous evidence is weighted by 0.99 and the new evidence by 0.01.

The current decision variable at time t is now given as

$$u(t) = (intercept + \beta t)$$
$$x(t) = E(t) \times u(t)$$

In classical models the intercept is set to be zero and beta to be 1.

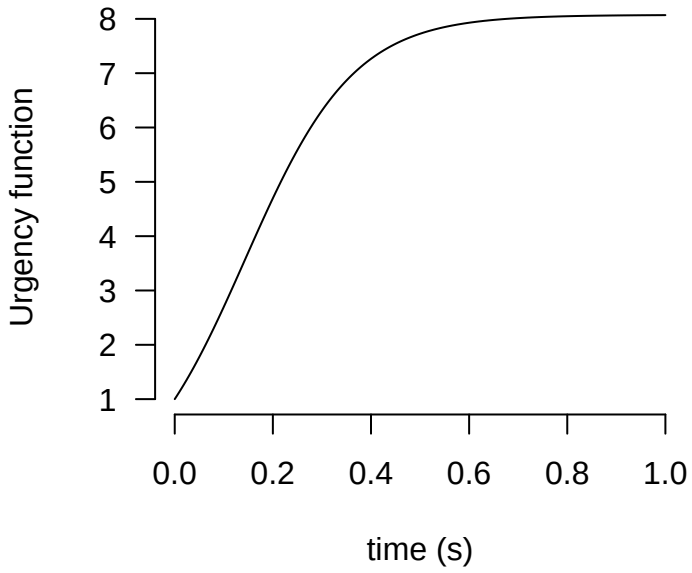
Stone Urgency Model

The philosophy of the stone urgency model contains elements of the urgency gating model and the classical stone model except that there is no low pass filtering of the input evidence. Instead, the input evidence is multiplied by the urgency signal and then accumulated over time.

$$E(t) = (v \times dt + \sqrt{dt} \times s \times N(0,1))$$
$$x(t) = x(t-1) + E(t) \times u(t)$$

Both the input stimulus and the noise are multiplied by the urgency signal which can take on many forms. An elegant 3 parameter form with two scaling factors (s_x, s_y) and a delay (d) was proposed by Jochen Ditterich (2006).

$$S_1(t) = exp(s_x(t-d));$$
$$S_2(t) = exp(-s_x d);$$
$$gamma(t) = \frac{s_y S_1(t)}{1 + S_1(t)} + \frac{1 + (1 - s_y) S_2(t)}{1 + S_2(t)}$$



Models of Decision Making

List of available models

Model	Description	Name in model list	Uses C Function Name	Involves Urgency
stone	Vanilla drift diffusion model for decision-making originally developed by stone (1960)	stone	stone	No
stoneEta	Drift diffusion model with variability in the drift rates. Drift rate variability is drawn from a normal distribution.	stoneEta	stoneEta	No
stoneEtaVarTer	Drift Diffusion Model with variability in the drift rates and variability in the residual time that is thought to reflect sensory and motor processing delays	stoneEtaVarTer	stoneEta	No

Model	Description	Name in model list	Uses C Function Name	Involves Urgency
stoneEtaVarBaseVarTer	Drift Diffusion Model with variability in the drift rates, variability in the baseline state before evidence comes in and variability in the residual time that is thought to reflect sensory and motor processing delays	stoneEtaVarBaseVarTer	stoneEtaVarBase	No
ratcliff	Ratcliff model that involves variability in the baseline starting point and in the drift rate	ratcliff	ratcliff	No
stoneEtaDitterich				

Using this toolbox.

This toolbox is an attempt by us (Chand and Guy) to provide the legions of researchers interested in various models of decision-making a simple and easily used toolbox for analysis of RT and discrimination accuracy behavior in decision-making tasks. The architecture of the toolbox is very simple. The choosing of which model to run and the lower and upper parameters and the

We assume that there is a reasonable working knowledge of R and C.

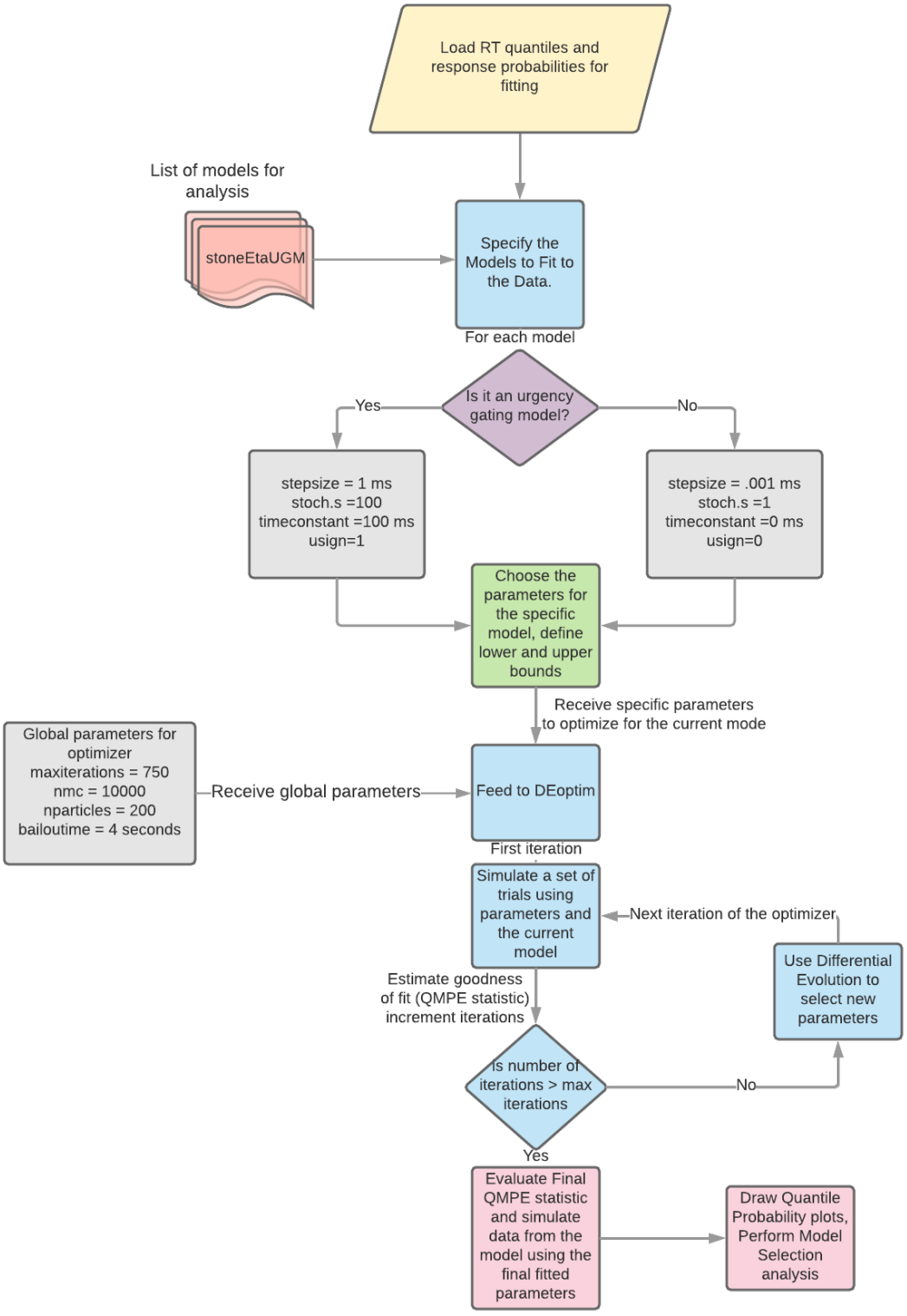

Load RT quantiles and response probabilities for fitting
List of models for analysis
stoneEtaUGM
Specify the Models to Fit to the Data.
For each model
Is it an urgency gating model?
Yes
No
stepsize = 1 ms
stoch.s =100
timeconstant =100 ms
usign=1
stepsize = .001 ms
stoch.s =1
timeconstant =0 ms
usign=0
Choose the parameters for the specific model, define lower and upper bounds
Receive specific parameters to optimize for the current mode
Global parameters for optimizer
maxiterations = 750
nmc = 10000
nparticles = 200
bailoutime = 4 seconds
Receive global parameters
Feed to DEoptim
First iteration
Simulate a set of trials using parameters and the current model
Next iteration of the optimizer
Use Differential Evolution to select new parameters
Estimate goodness of fit (QMPE statistic) increment iterations
Is number of iterations > max iterations
No
Yes
Evaluate Final QMPE statistic and simulate data from the model using the final fitted parameters
Draw Quantile Probability plots, Perform Model Selection analysis

Figure 1: