Psychophysics and Noninvasive Methods: MATLAB diffusion model exercises

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There are two functions you need for the exercises and they are both uploaded to ILIAS: `DiffusionModel.m` and `DiffusionModelDemo.m`.
Make sure you download both functions and add them to your path/and or have them in your working directory. For the exercises you will only need to call `DiffusionModelDemo`. If you want to understand the diffusion model algorithm, however, you should try and understand the function `DiffusionModel.m`

Preliminary exploration

Play with the constant named

```
NUMBER_OF_RUNS
```

at the top of the function `DiffusionModelDemo`. For large values ($\geq$ 10.000) the results you obtain are fairly stable, but take a longish time (depending on the speed of your laptop, obviously). Start with small values of 100 or 1000 and repeatedly execute the function to find a reasonable value for you. On my MacBook a value of 10.000 results in processing times of about 5–6 seconds, which I deem to be reasonable. If your laptop and patience allows it, 10.000 should be the minimum.

1 Q1: Percent correct and RTs for a symmetric diffusion process

For a symmetric diffusion process, what drift rates do you need for ...

1. 94% correct? What is the mean RT?
2. 82% correct? What is the mean RT?
3. 65% correct? What is the mean RT?
4. 51% correct? What is the mean RT?

Hint: Simply change `x` in the call `DiffusionModelDemo(x)`.

2 Q2: Slow errors

Start with a symmetric diffusion process and drift rate = 2:
`DiffusionModelDemo(2)`.
You should get 88–89% correct and 0.20–0.21 s mean RT. Now generate slow errors, i.e. ensure that in Fig. 3 the red histogram is shifted to the right relative to the green histogram. For a SD of the drift rate variance of 1, you should obtain around 0.19-0.20 s for the correct answers and 0.22-0.23 s for the errors: `DiffusionModelDemo(2, 1)`. Note the variability in Fig. 4. What you should see, too, is that the "observer" now is only 85% correct—which drift rate is needed to get the observer back to 88-89% correct? What is the mean RT? Separate for correct and wrong answers?

3 Q3: Fast errors

Again start with a symmetric diffusion process and drift rate = 2:
`DiffusionModelDemo(2)`.
You should—as before—get 88-89% correct and 0.20-0.21 s mean RT again. Now generate fast errors, i.e. ensure that in Fig. 3 the red histogram is shifted to the left relative to the green histogram. For a SD of the starting point rate variance of 0.17, you should obtain around 0.19 s for the correct answers and 0.15-0.16 s for the errors: `DiffusionModelDemo(2, 0, 0.17)`. Note the variability in Fig. 5. What you should see, too, is that the "observer" now is only 85–86% correct—which drift rate is needed to get the observer back to 88-89% correct? What is the mean RT? Separate for correct and wrong answers?

Take-home message: Thus using the diffusion model we can generate three observers with 88-89% correct, either with errors and correct responses taking equally long, with slow errors via the drift rate variability and fast errors via the starting point variability.

4 Q4: Speed-accuracy trade-off

Play with the speed-accuracy trade-off: A drift-rate of `2` yields 88-89% correct, if the variability parameters are both set to `0`. Play with the constant

```
UPPER_BOUND
```

in `DiffusionModelDemo`.
WARNING: Do not set the value too high, otherwise the diffusion process "never" reaches the boundary, and you wait and wait and wait .... Increasing it from "1" to "2" increases the mean RT from 0.20-0.21 s to 0.49-0.50 s, i.e. the simulations already take more than twice as long (and the observer is now around 98% correct). What upper bound gives you roughly 65% correct? How short is the RT now? Compare with the RTs for 65% correct you found in the first exercise for a symmetric diffusion process.

5 Solutions

5.1 Q1

1. 94% correct? What is the mean RT? [2.70 / 0.17 s]
2. 82% correct? What is the mean RT? [1.50 / 0.22 s]
3. 65% correct? What is the mean RT? [0.60 / 0.26 s]
4. 51% correct? What is the mean RT? [0.05 / 0.27 s]

5.2 Q2

Drift rate 2.3 / mean RT 0.19 s / mean RT for correct answers 0.18 s / mean RT for wrong answers 0.22 s

5.3 Q3

Drift rate 2.4 / mean RT 0.17 s / mean RT for correct answers 0.17 s / mean RT for wrong answers 0.13–0.14 s

5.4 Q4

Upper bound 0.29 / mean RT 0.03 s