

# Instructions for Using the Model Program

The folder BB, which you have made by unzipping the file BB.zip, contains the following:

- This note
- A runnable java archive file BeesAndBats.jar for the model program
- A folder 'source' containing the program source code
- Pdfs of papers related to the program:
  - RE\_0\_8.pdf – the derivation of the Requirement Equation, a general statement of Bayesian optimal cognition
  - BB\_1\_6.pdf – describing the results of running the program
  - WH\_3\_6.pdf – describing evidence for wave storage of spatial information, in the central body of the insect brain and the mammalian thalamus

If you already use Java on your computer, start the model program by double-clicking the file BeesAndBats.jar, and then follow the instructions in the Help menu to run it. Typical help instructions are:

## Getting Started

### (1) Press 'Start', then 'Run'.

The bee moves across the space. As it moves, small circles with error bars show the estimated point positions, in its internal 3-D model of space. Lines of sight from the bee to the points are shown

### (2) Press 'Restart', then press 'Step' repeatedly.

The bee moves along the same track, in slow motion. See how the estimates converge to actual positions, and error bars get smaller.

### (3) Use the 'view rotate' slider.

This shows the space from different angles, to see the third dimension.

### (4) Press 'Start', choose 'cube' from 'Moving Shapes', then press 'Run'.

The corners of a cube appear. After a few steps, the cube starts to move. If the bee detects that the cube has moved, the corners of the cube turn red.

### (5) Choose 'Bat' from the 'Bee/Bat' menu, then repeat (1)

Instead of lines of sight, circles from echo-location are shown. (these depend on echo delay and Doppler shift)

### (6) Click on the coloured circle for a point

Recent lines of sight or echo circles to that point are shown

### (7) Click on the bee or bat

All lines of sight or echo circles disappear.

### (8) Click the 'Noisy' button

This shows the effect of memory errors on the accuracy of tracking

If you do not have Java on your computer, you will need to download and install a Java Runtime Environment (JRE), for instance from <https://www.oracle.com/uk/java/technologies/downloads/>. This automated installation takes about a minute. You will download a .exe installer program, and double-click it to install Java.

The folder 'Source' contains the program source code. You can import the code to a development environment such as Eclipse or IntelliJ, to modify or extend the program. The program uses the JAMA matrix libraries, and has no other external dependencies.