# Assignment 2

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| Type | Assignment |
| Materials | |
| Reviewed | ☐ |

## Solution to the Monty Hall problem, by using GeNIe

You are confronted with three doors A, B, and C. Behind exactly one of the doors there is \$10 000. The money is yours if you choose the correct door. After you have made your first choice of door but still not opened it, an official comes in. He works according to two rules:

1. He starts by opening a door. He knows where the prize is, and he is not allowed to open that door. Furthermore, he cannot open the door you have chosen. Hence, he opens a door with nothing behind.

2. Now there are two closed doors, one of which contains the prize. The official will ask you if you want to alter your choice (i.e., to trade your door for the other one that is not open).

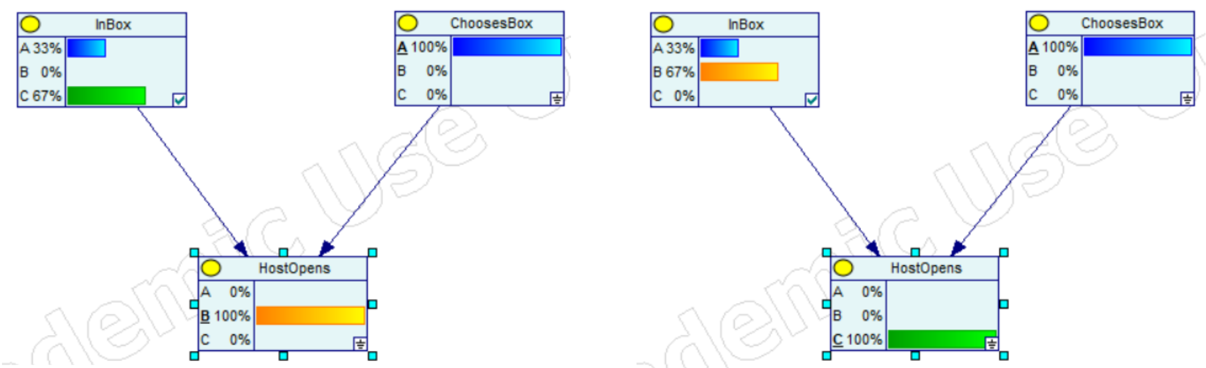
The model created (a box is the same as a door):

- The node ‘InBox’ has a 1/3 probability of being A, 1/3 being B and 1/3 being C
- The node ‘ChoosesBox’ has a 1/3 probability og being A, B or C, but in the analysis, this will be set to one specific choice.
- The node ‘HostOpens’ is the probability of the host opening a box based on which box the prize is in, and what box you choose initially. If you choose the wrong box, the host is limited to choosing between 1 box, which results in a 100% probability of the host opening this box. If you initially choose the correct box, the host can choose between 2 boxes to open, each with a probability of 1/2 to be opened by the host. This is the probability-table for ‘HostOpens’:

| InBox | A | | | B | | | C | | |
|---|---|---|---|---|---|---|---|---|---|
| ChoosesBox | A | B | C | A | B | C | A | B | C |
| A | 0 | 0 | 0 | 0 | 0.5 | 1 | 0 | 1 | 0.5 |
| B | 0.5 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0.5 |
| C | 0.5 | 1 | 0 | 1 | 0.5 | 0 | 0 | 0 | 0 |

Analysis:

- We see that when you choose a box  initially, and the host opens a box, there is always a 67% probability of winning if you switch box, no matter which box the host opens:
    - if you choose A, and the host opens B, there is a 67% probability of the prize being in box C
    - if you choose A, and the host opens C, there is a 67% probability of the prize being in box B
    - this is also the case when you choose B or C initially
- **Based on this, we have proven that there is always a higher probability of winning if you switch boxes after the host have opened one of the boxes.**




Intuition:

One way to think intuitively on this problem is that initially, there is a 67% probability of you being wrong, and when the host opens a door there is still a 67% probability of you being wrong, because you being wrong only depends on your guess and where the prize is. However, when the host ‘removes’ one of the boxes, the 67% is distributed over 1 box, in stead of the initial 2 boxes. So there is a 67% probability of the prize being in the other remaining box.