

# Prediction using Bayesian Networks

Inge Becht

University of Amsterdam

October 1, 2012

- Will I be moving to a new apartment?
- Considering a 2 year span
- Some more probable events and some less probable

# Creating the network

- What causes me to move?
  - Change in income
    - lower
    - higher
  - House gets unlivable
  - Noisy neighbours
  - etc.
- And what causes these things?

- How to represent money gain, money loss or money income that stays the same?
  - Creating multiple boolean nodes that are dependent of eachother
  - Creating a node with multiple values(not boolean)
- Can noisy OR be implemented?
  - Probably not all the time!

# Models compared

Con: we now have  $2^3$  probabilities in regards to moving, from which some aren't even possible combinations.

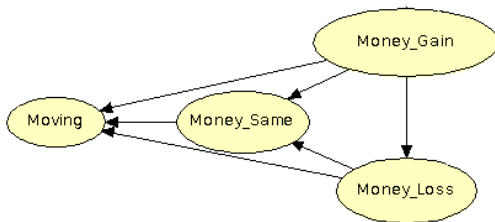


Figure: Using booleans to represent money.

## Models compared (2)

Now only 3 probabilities to consider

Con: How can Noisy OR be used?

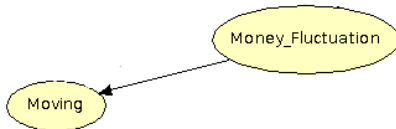


Figure: Money fluctuation represented as 3 nodes.

# The final network: Moneygain

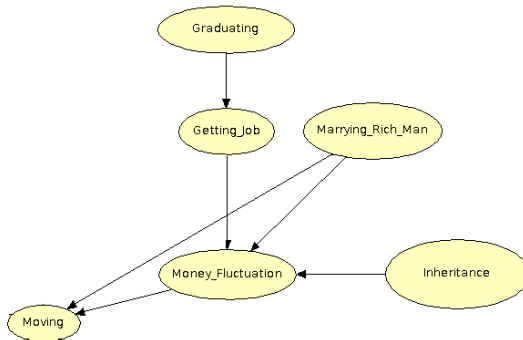


Figure: Money dependencies

# The tables(1)

|   | $\mu(\textit{Graduating})$ |
|---|----------------------------|
| 1 | 0.8                        |
| 0 | 0.2                        |

Table: Chance of graduating

|   | $\mu(\textit{Marrying\_rich\_man})$ |
|---|-------------------------------------|
| 1 | 0.01                                |
| 0 | 0.99                                |

Table: Chance of marrying rich man



# The tables(2)

|   | $\mu(Inheritance)$ |
|---|--------------------|
| 1 | 0.1                |
| 0 | 0.9                |

Table: Chance of inheritance

| Graduating | $\mu(Job)$ | $\mu(\neg Job)$ |
|------------|------------|-----------------|
| 1          | 0.8        | 0.2             |
| 0          | 0.2        | 0.8             |

Table: Chance of graduating

# The tables(3)

| M | I | G | $\mu(\text{more})$ | $\mu(\text{same})$ | $\mu(\text{less})$ |
|---|---|---|--------------------|--------------------|--------------------|
| 0 | 0 | 0 | 0.1                | 0.6                | 0.3                |
| 0 | 0 | 1 | 0.8                | 0.2                | 0                  |
| 0 | 1 | 0 | 0.3                | 0.4                | 0.3                |
| 1 | 0 | 0 | 0.9                | 0.1                | 0                  |
| 0 | 1 | 1 | 0.8                | 0.1                | 0.1                |
| 1 | 0 | 1 | 1                  | 0                  | 0                  |
| 1 | 1 | 0 | 0.9                | 0.1                | 0                  |
| 1 | 1 | 1 | 0.99               | 0.01               | 0                  |

Table: Probability of money fluctuation

# The final network: Noisiness

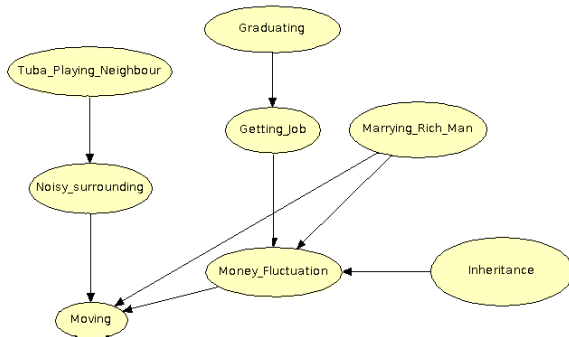


Figure: Noisiness dependencies

# The tables

|   | $\mu(Tuba\_neighbour)$ |
|---|------------------------|
| 1 | 0.02                   |
| 0 | 0.98                   |

Table: Chance of tuba playing neighbour

| Tuba | $\mu(Noise)$ | $\mu(\neg Noise)$ |
|------|--------------|-------------------|
| 1    | 0.98         | 0.02              |
| 0    | 0.5          | 0.5               |

Table: Chance of noise

# The final network: Unlivability

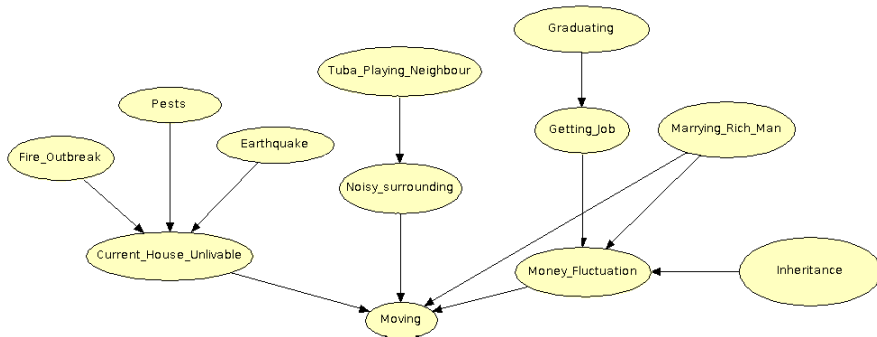


Figure: Unlivable dependencies

# The tables

|   | $\mu(\textit{Fire})$ |
|---|----------------------|
| 1 | 0.01                 |
| 0 | 0.99                 |

Table: Chance of fire

|   | $\mu(\textit{pest})$ |
|---|----------------------|
| 1 | 0.2                  |
| 0 | 0.8                  |

Table: Chance of pests

|   | $\mu(\textit{Earthquake})$ |
|---|----------------------------|
| 1 | 0.3                        |
| 0 | 0.7                        |

Table: Chance of Earthquake

- Not all elements are considered (More variables possible when considering money gain)
- How to implement noisy OR in case of 3 possible values instead of boolean?
- Using noisy OR to indicate house livability seems to work very well

# noisy OR implemented

E = Earthquake, P = Pest, F = Fire, U = Unlivable conditions

| E | P | F | $\mu(U)$ | $\mu(\neg U)$                 |
|---|---|---|----------|-------------------------------|
| 0 | 0 | 0 | 0        | 1                             |
| 0 | 0 | 1 | 0.6      | 0.4                           |
| 0 | 1 | 0 | 0.8      | 0.2                           |
| 1 | 0 | 0 | 0.001    | 0.999                         |
| 0 | 1 | 1 | 0.92     | $0.4 * 0.2 = 0.08$            |
| 1 | 0 | 1 | 0.6004   | $0.999 * 0.4 = 0.3996$        |
| 1 | 1 | 0 | 0.8002   | $0.999 * 0.2 = 0.1998$        |
| 1 | 1 | 1 | 0.92008  | $0.4 * 0.2 * 0.999 = 0.07992$ |

Table: Probability of Unlivable conditions arising



# Probability of moving

- probability of moving is dependent of money fluctuation, noisiness of surroundings, livability of house and if I will be getting married
- 24 different combinations of events
- Problematic pairs like Marrying rich man and Low income occur

# The table

| Marrying | Unlivable | Noisy | Money | $\mu(Moving)$ | $\mu(\neg Moving)$ |
|----------|-----------|-------|-------|---------------|--------------------|
| 0        | 0         | 0     | L     | 0.7           | 0.3                |
| 0        | 0         | 0     | S     | 0             | 1                  |
| 0        | 0         | 0     | H     | 0.7           | 0.3                |
| 0        | 0         | 1     | L     | 0.5           | 0.5                |
| 0        | 0         | 1     | S     | 0.1           | 0.9                |
| 0        | 0         | 1     | H     | 0.7           | 0.3                |
| 0        | 1         | 0     | L     | 0.8           | 0.2                |
| 0        | 1         | 0     | S     | 0.85          | 0.15               |
| 0        | 1         | 0     | H     | 0.9           | 0.1                |
| ...      | ...       | ...   | ...   | ...           | ...                |
| 1        | 0         | 1     | H     | 0.9           | 0.1                |
| 1        | 1         | 0     | L     | 0.9           | 0.1                |
| 1        | 1         | 0     | S     | 0.95          | 0.05               |
| 1        | 1         | 0     | H     | 0.95          | 0.05               |
| 1        | 1         | 1     | L     | 0.9           | 0.1                |
| 1        | 1         | 1     | S     | 0.99          | 0.01               |
| 1        | 1         | 1     | H     | 1             | 0                  |

# Chance of moving

- Chance of moving: 54.6
- Seems somewhat low given the probability distribution
  - Only 57 percent chance of earning more
  - Most of the nodes are biased towards reasons to move
  - But are very small chances of happening
- More nodes (that are more relevant) could give a more accurate result of moving probability

- Chance of moving given tuba playing neighbours and earning more: 73.61
- Chance of moving given pests and earning the same: 56.63
- Chance of getting a job given moving and earning the same: 40.82
  - Seems a bit much...
- Chance of graduating when not getting a job: 50