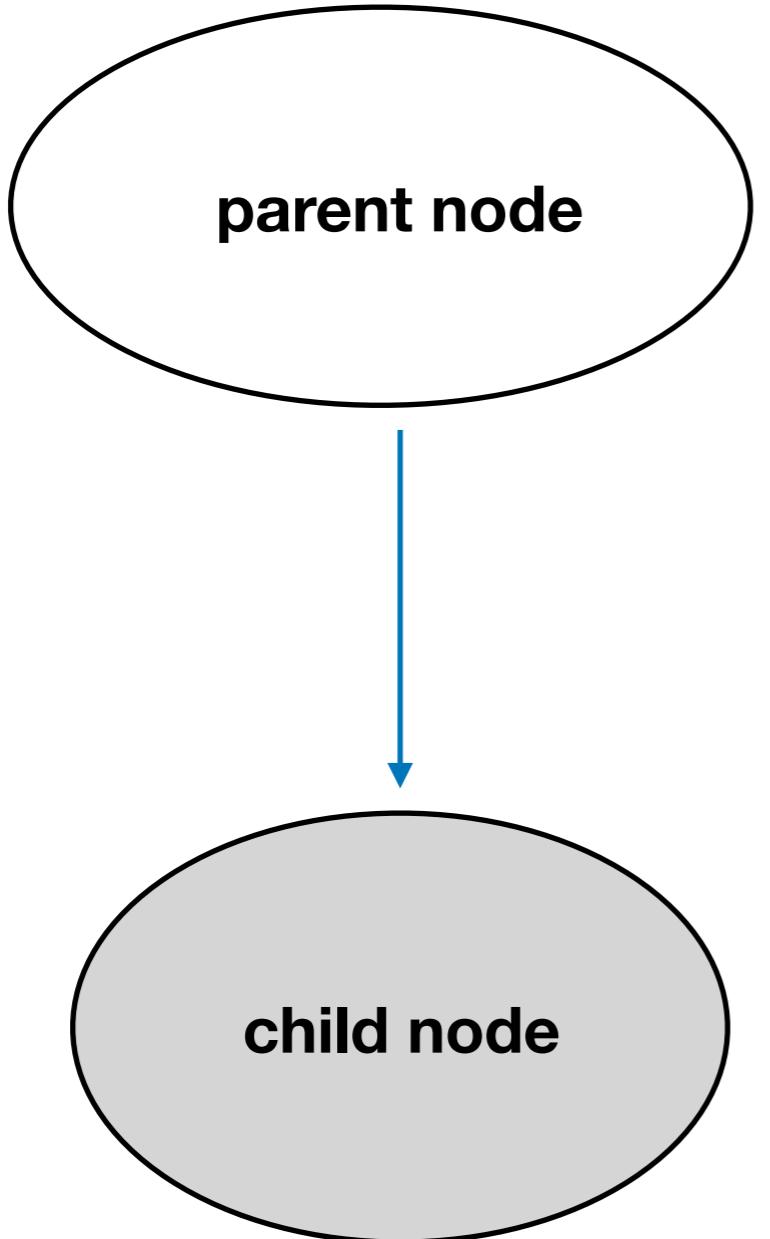


Evaluating Bayesian Networks

using agent-based modelling



**Someone is nervous for
a presentation**



**Someone is
watching too much
Youtube
beforehand**

Someone is nervous for
a presentation

	nervous	not nervous
	0.9	0.1
nervous		
not nervous		

Someone is
watching too much
Youtube
beforehand

nervous	too much Youtube	not (too much youtube)
TRUE	0.75	0.25
FALSE	0.2	0.8

**Someone is nervous for
a presentation**

Bayes Law

**Someone is
watching too much
Youtube
beforehand**

Someone is nervous for
a presentation

Bayes Law

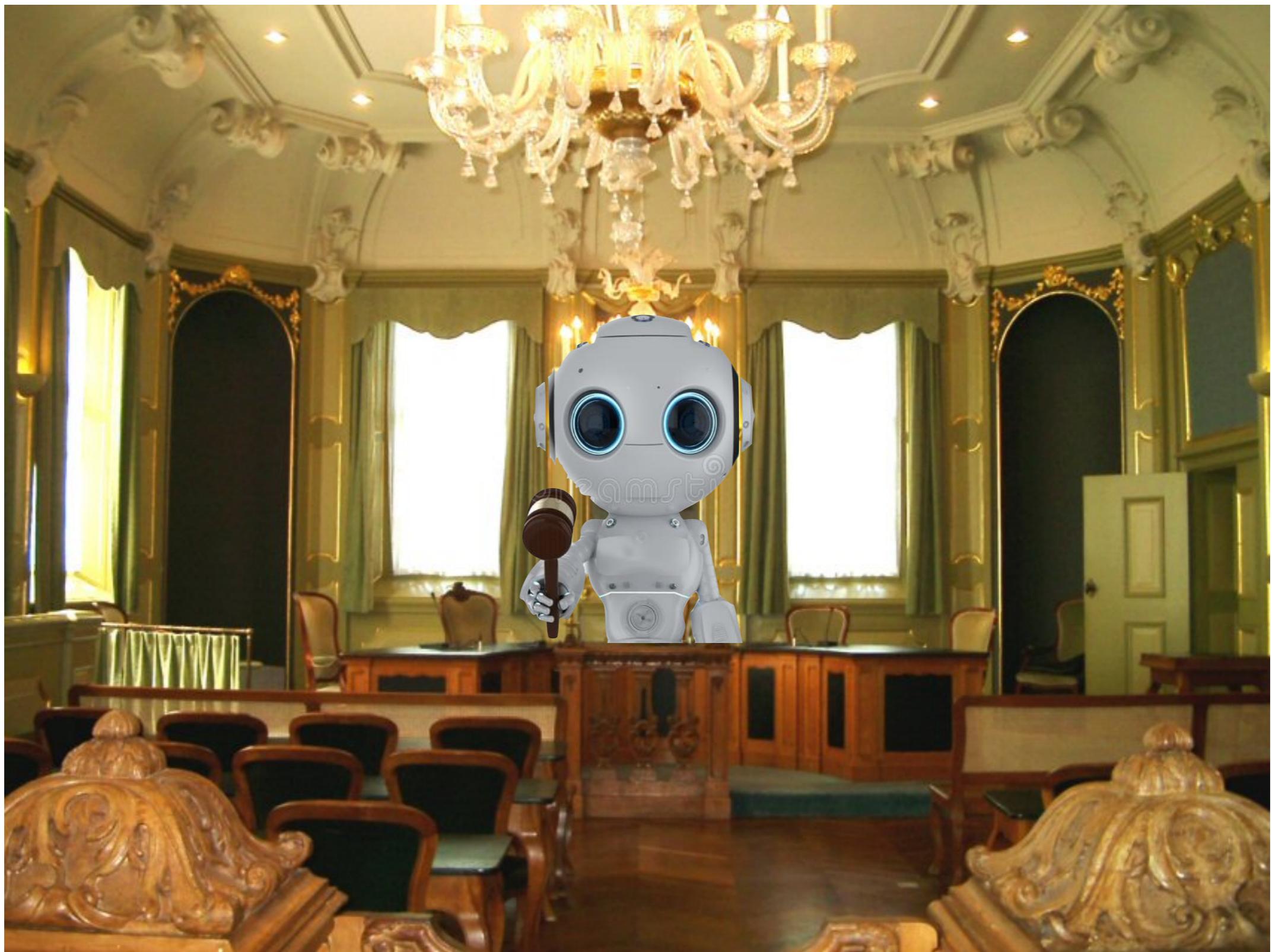
Someone is
watching too much
Youtube
beforehand

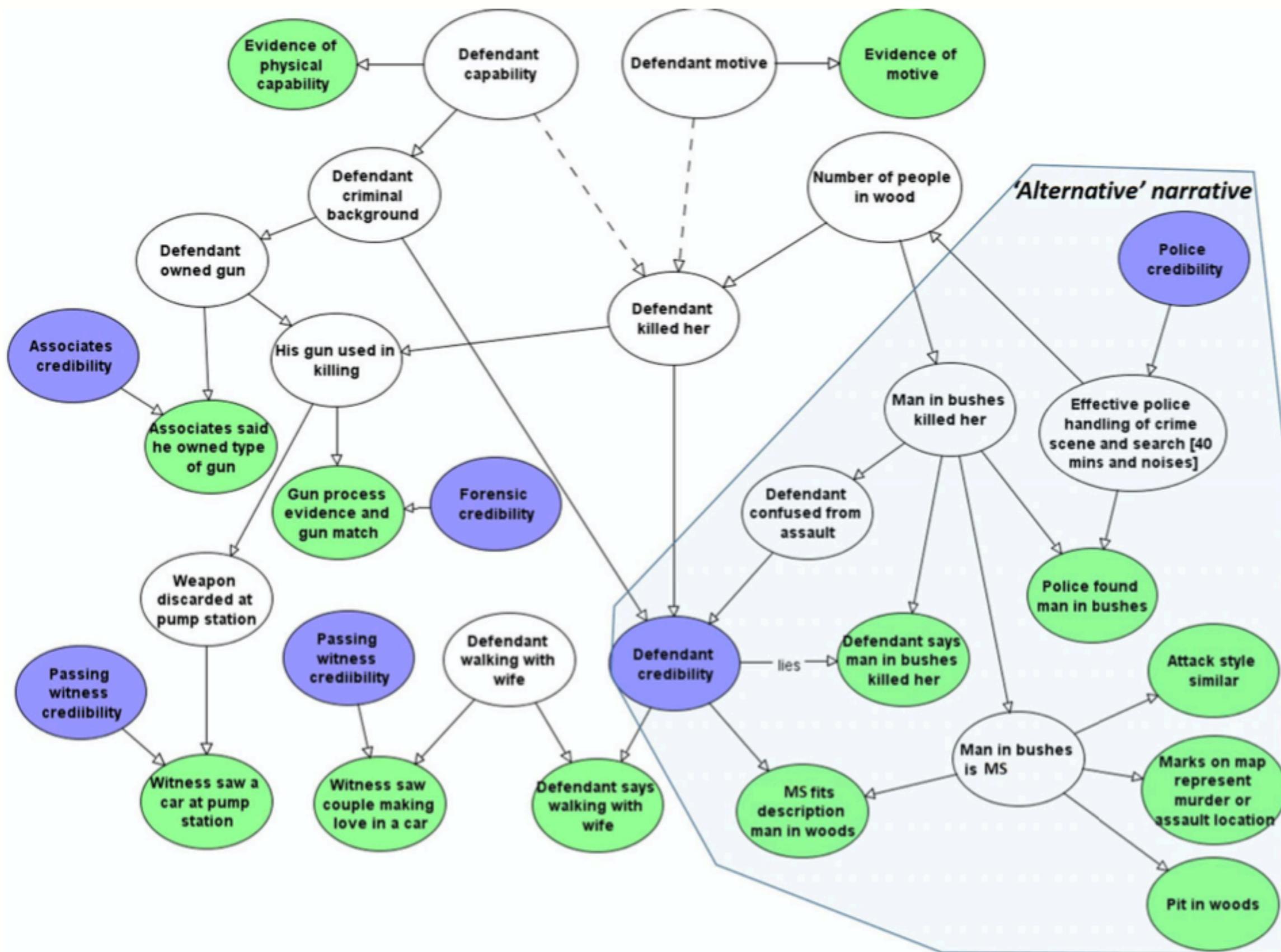
Updated on evidence:

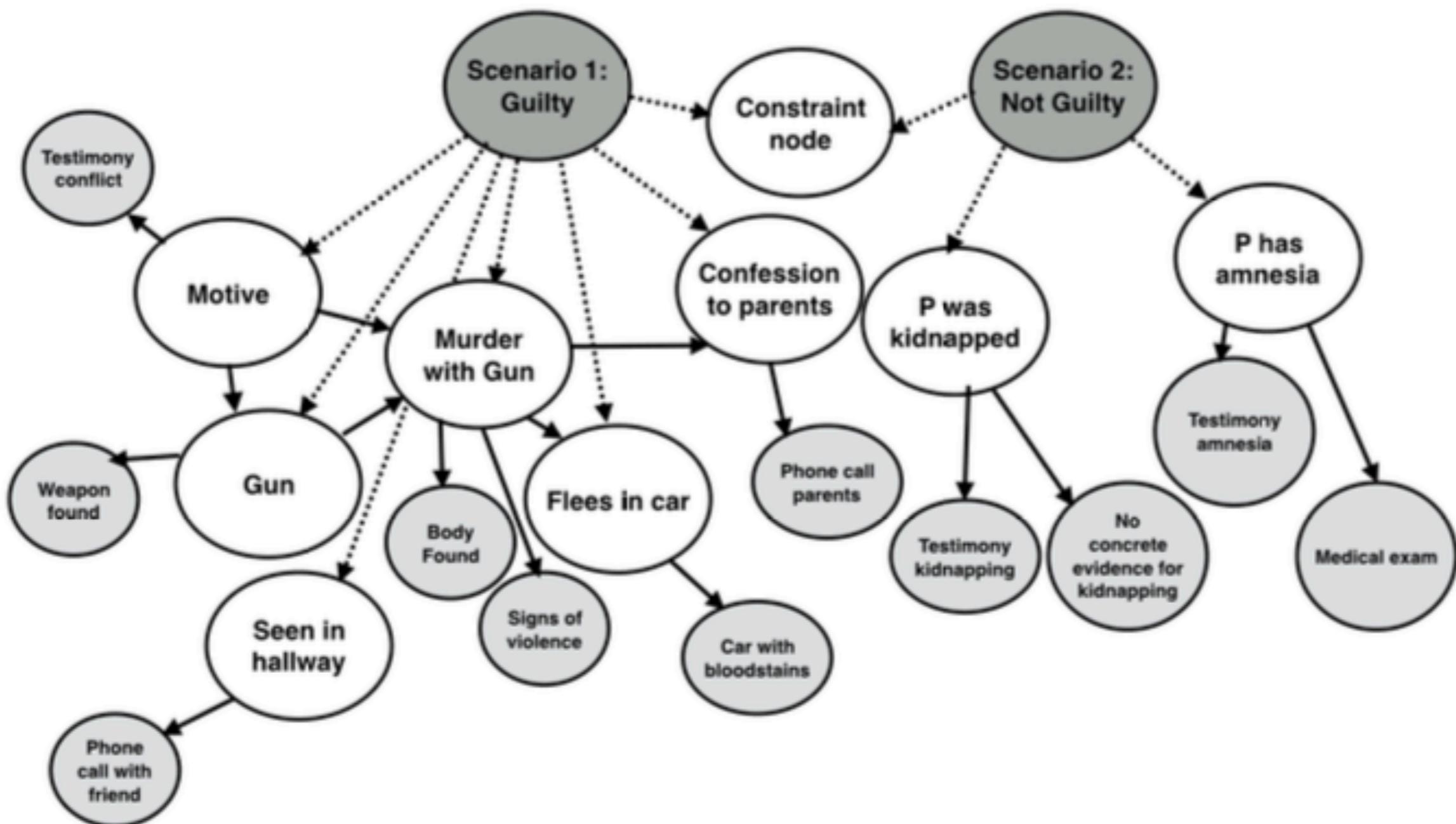
	nervous	not nervous
	0.97	0.03



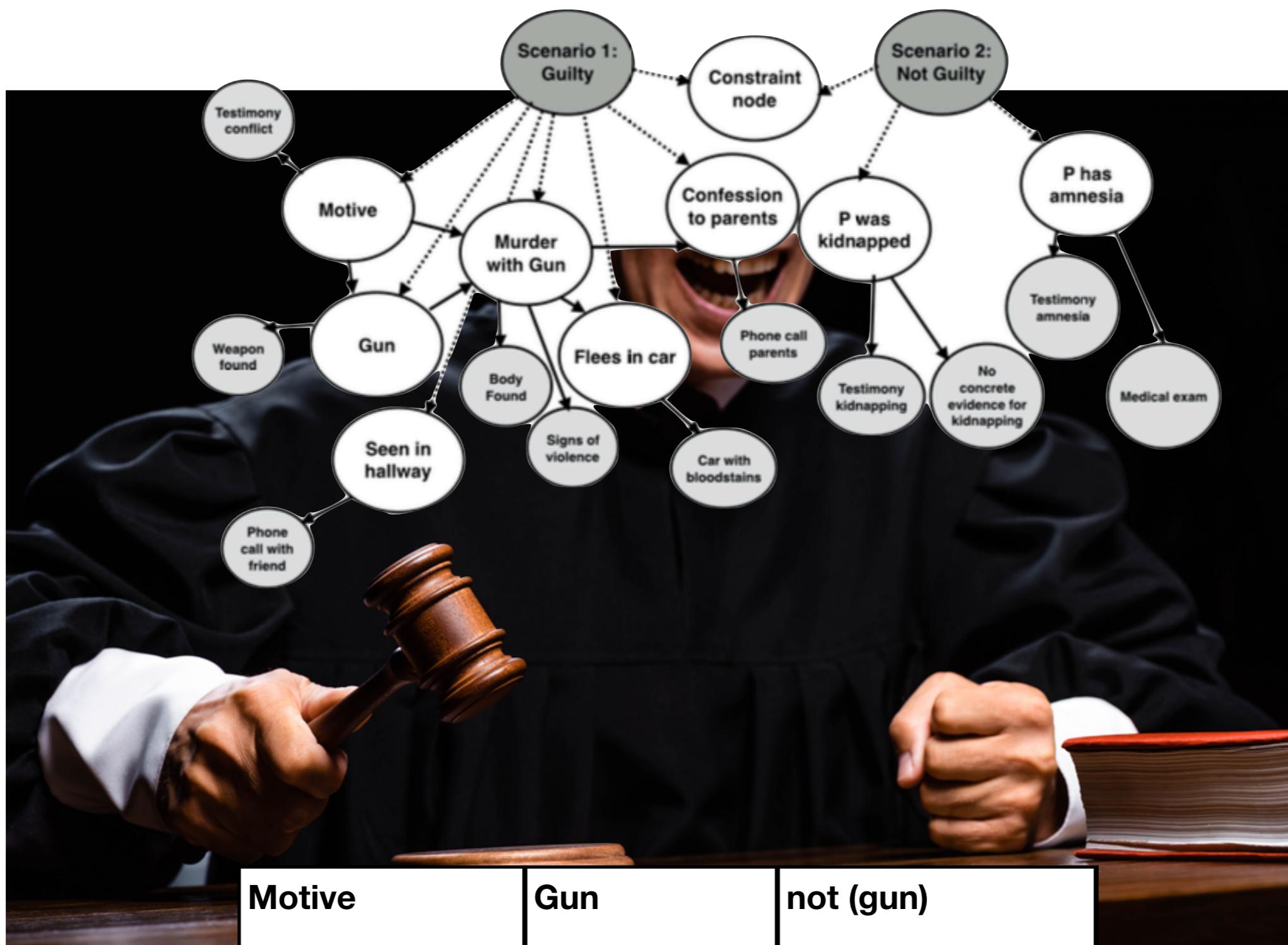












Motive	Gun	not (gun)
TRUE	?	?
FALSE	?	?

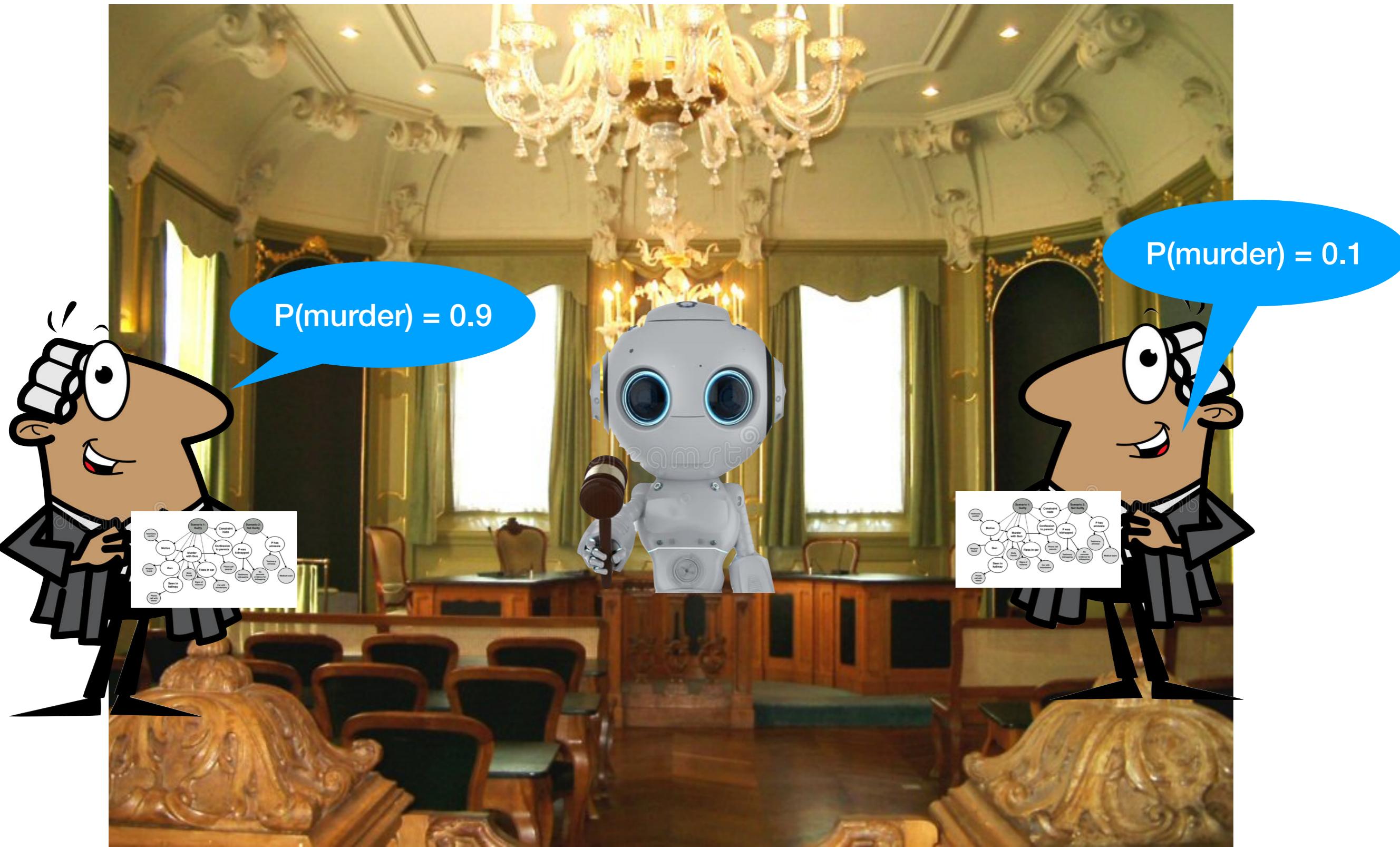


Motive	Gun	not (gun)
TRUE	?	?
FALSE	?	?

introspection, probability elicitation and collaborative discussion, to establish **subjective probabilities**



subjective probability =
just making implicit assumptions explicit



Is there a way to mitigate the subjective probability?

The existing approaches focus on building the network, but not on evaluating the networks.

Methods of evaluation that are used:

- **cumulative evidence**
 - Turning one set of nodes off and on
- **sensitivity analysis**
 - Small changes in CPTs to see effects

these methods are not satisfactory



LB

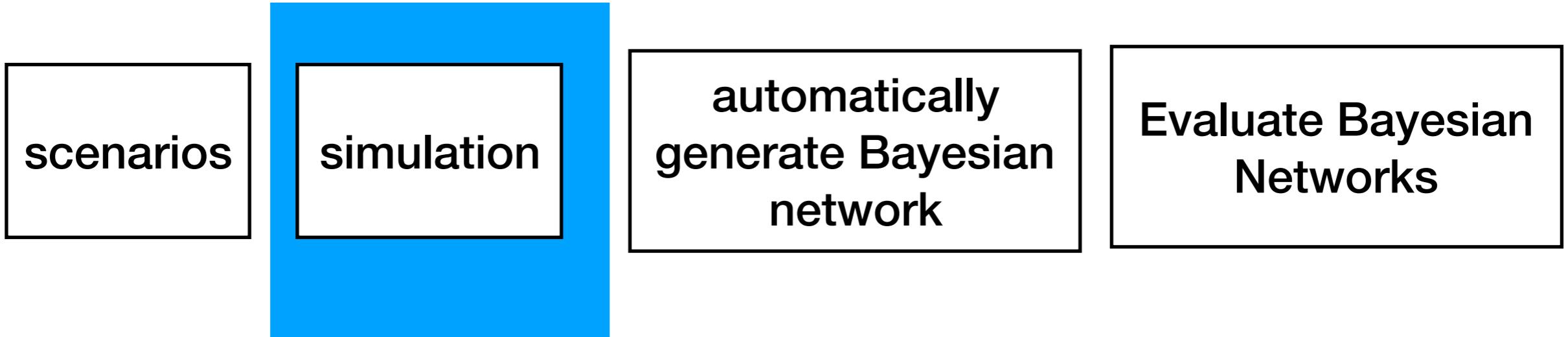
The aim of this project

scenarios

simulation

automatically
generate Bayesian
network

The aim of this project



RQ: Do Bayesian Networks work as a tool for rationally dealing with evidence?

Do Bayesian Networks work as a tool for rationally dealing with evidence?

Criteria discussed here...

- Can we create a BN that reflects the probabilities of the simulation?
- Does this BN respond ‘rationally’ to all possible combinations of evidence?
- Is it plausible that this method generalises to real life?

Building a Simulation



Scenario: Robbery on Grote Markt

scenario 1



street robbery

scenario 2

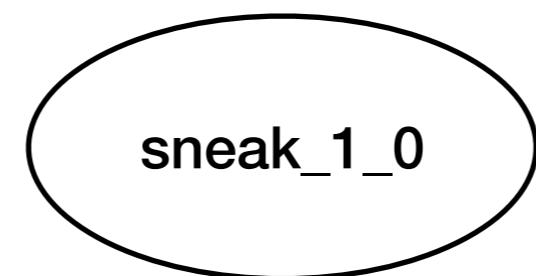


accidentally losing

We represent all relevant events in the simulation



In the network, we call the thief 1, and the old lady 0



means: Agent 1 sneaks up on Agent 0

scenario 1

motive_1_0

sneak_1_0

steal_1_0

evidence

psych
report 1

camera
1

camera seen
stealing

object gone

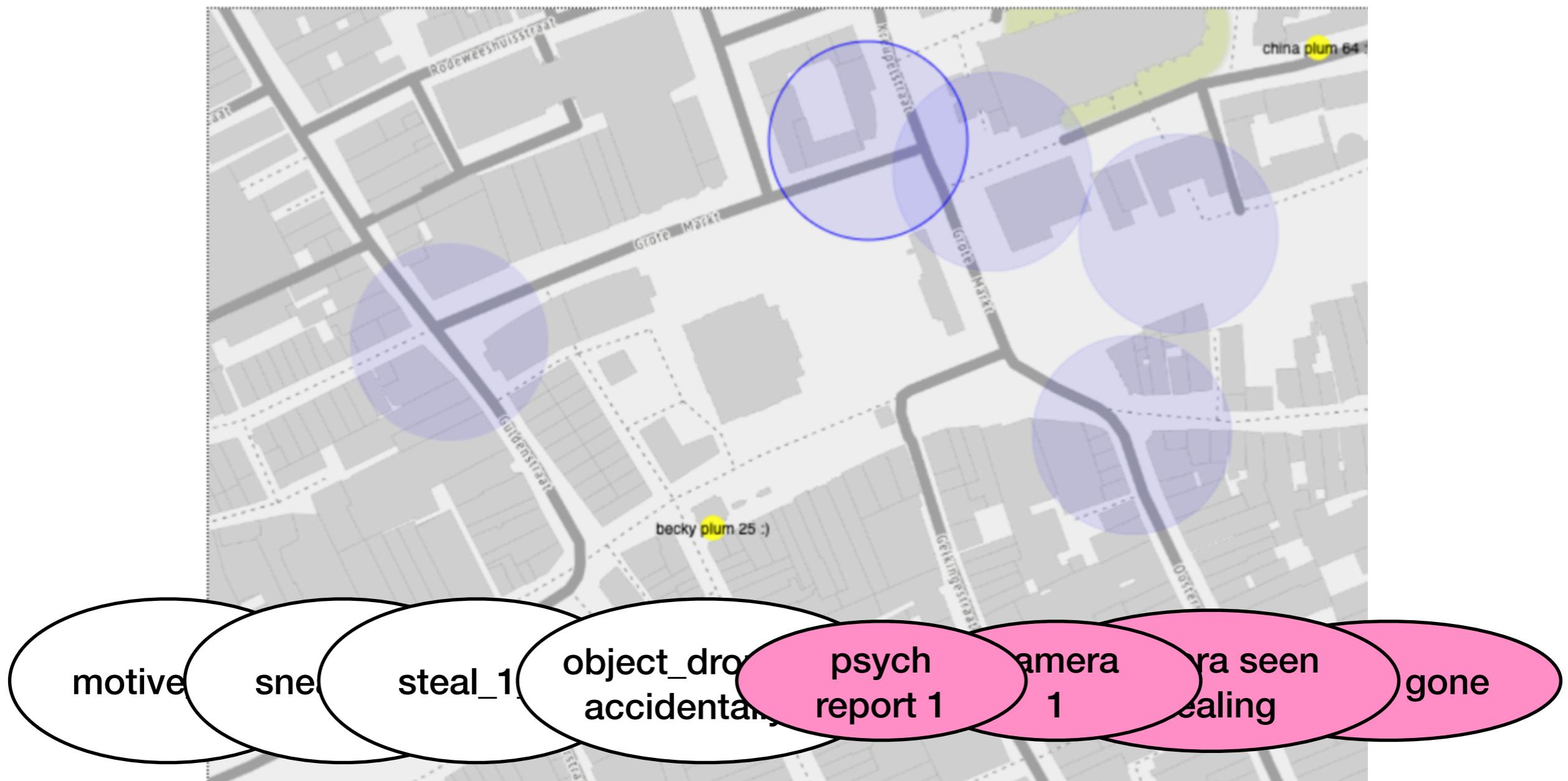
scenario 2

object_dropped_
accidentally_0

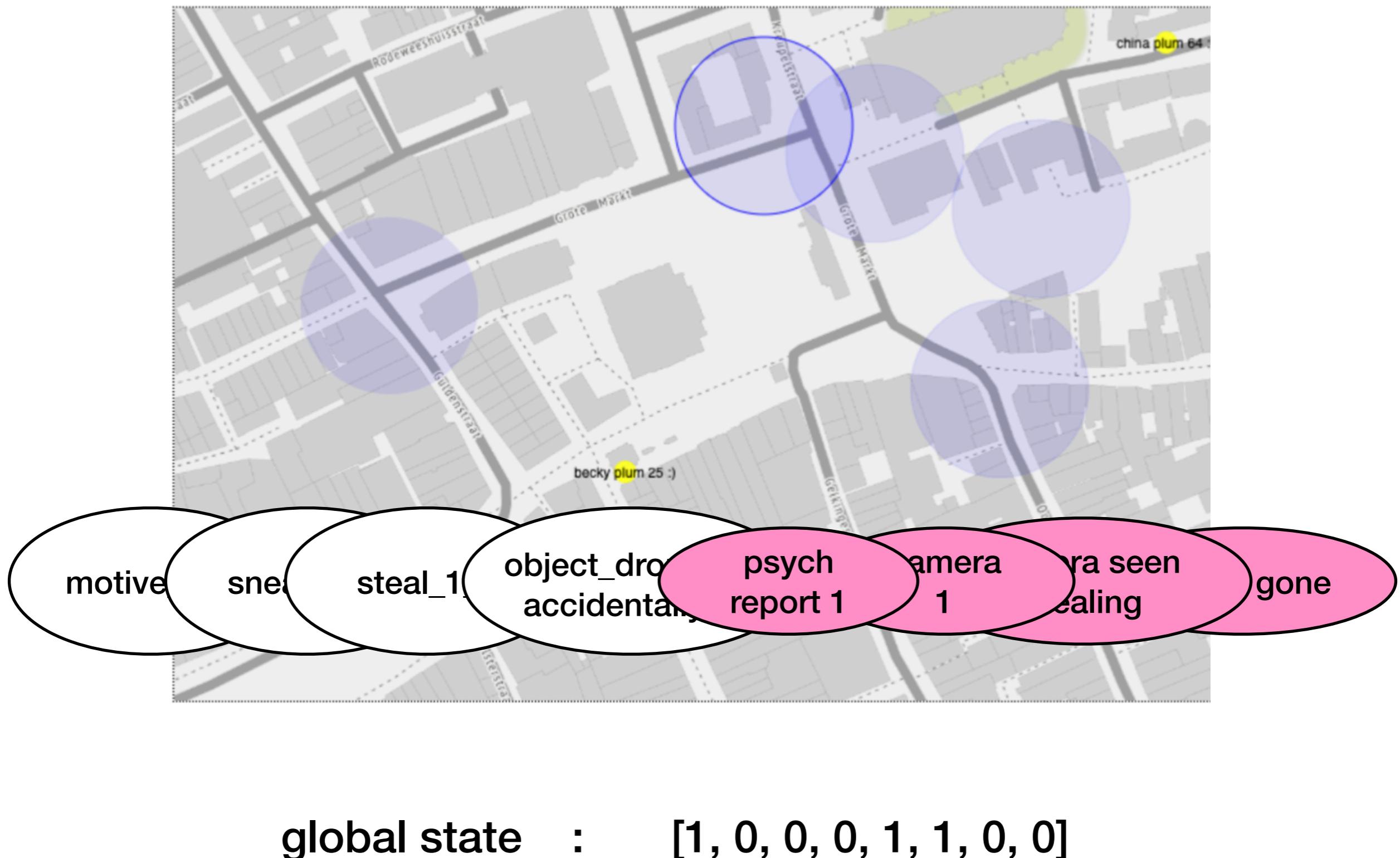
Agents

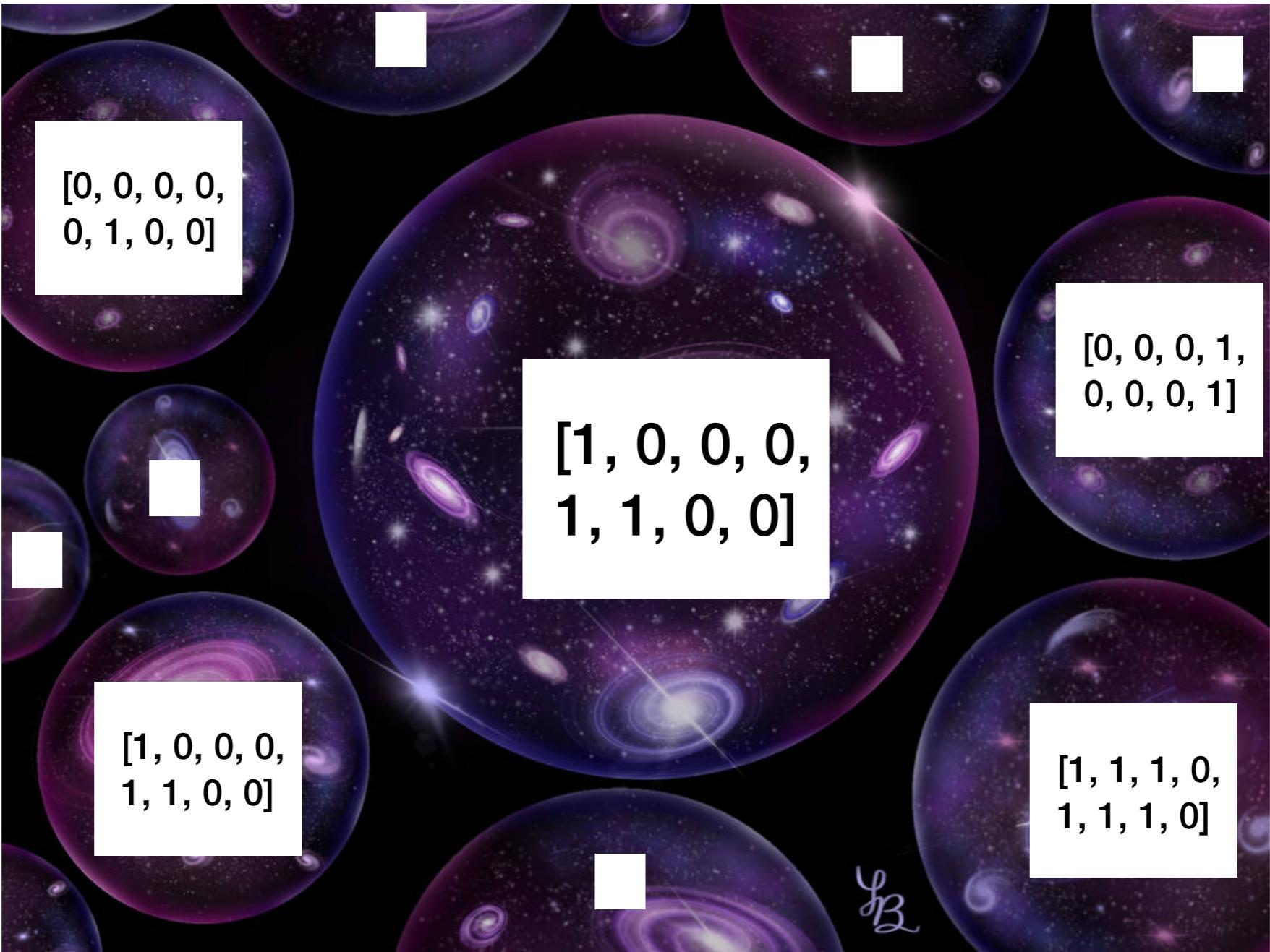


In every run, we collect data through random variables in code

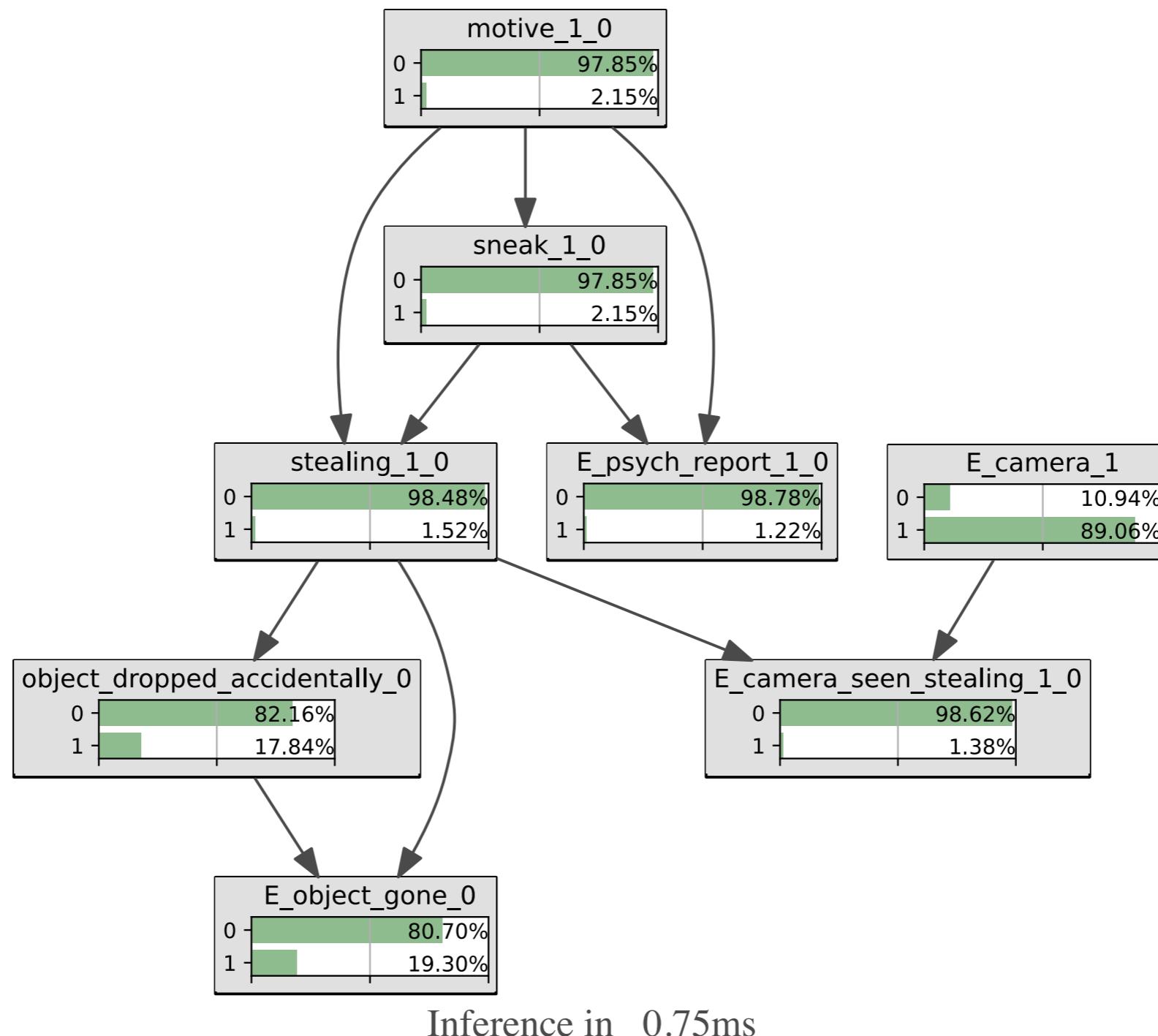


In every run, we collect data through random variables in code





Automatically create a Bayesian network



Created with the K2 algorithm (Cooper and Herskovits, 1992) with temporal node ordering

Criteria

- Can we create a BN that reflects the probabilities of the simulation?
- Does this BN respond ‘rationally’ to all possible combinations of evidence?
- Is it plausible that this method generalises to real life?

Does the BN reflect the frequencies in the simulation?

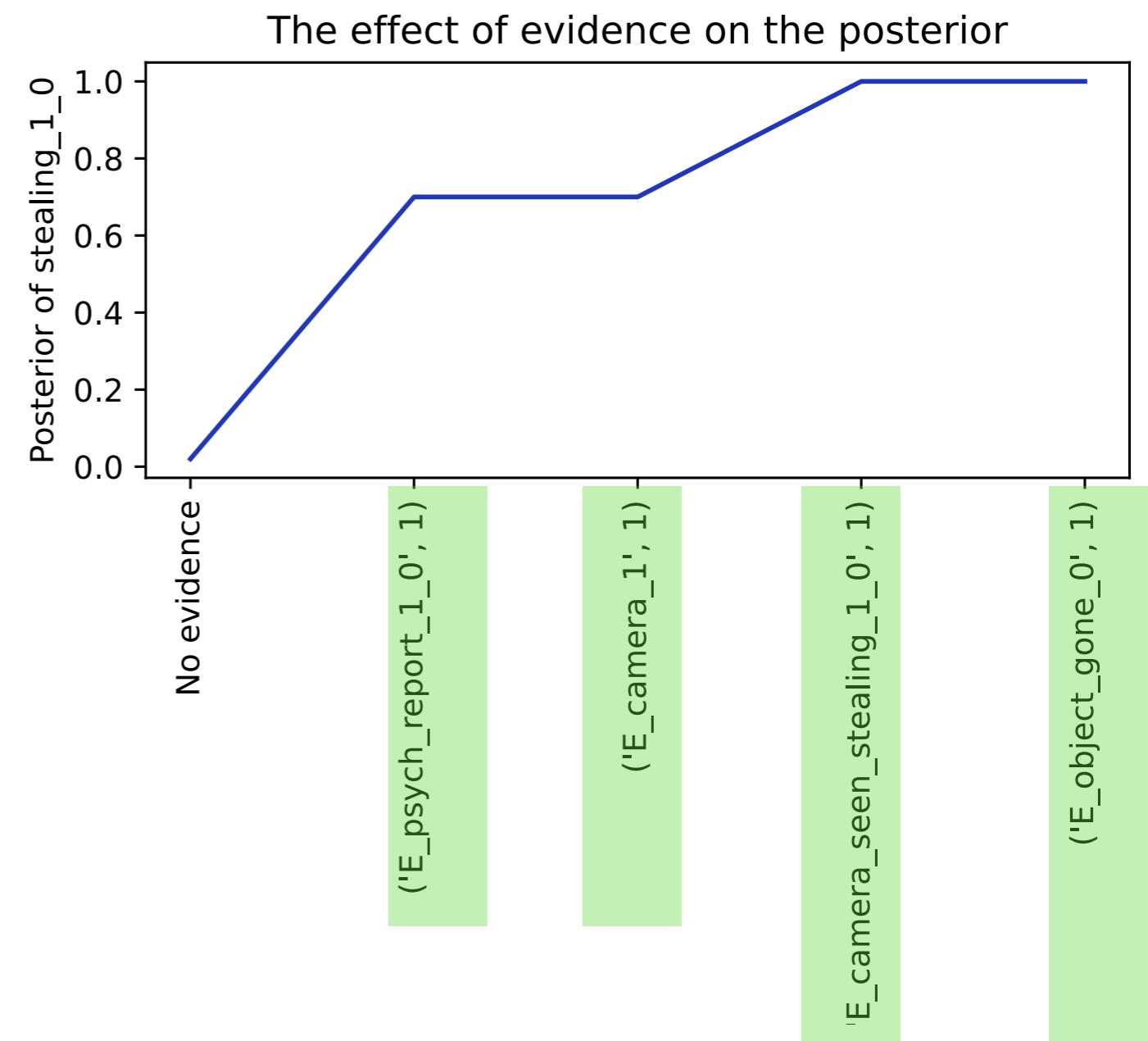
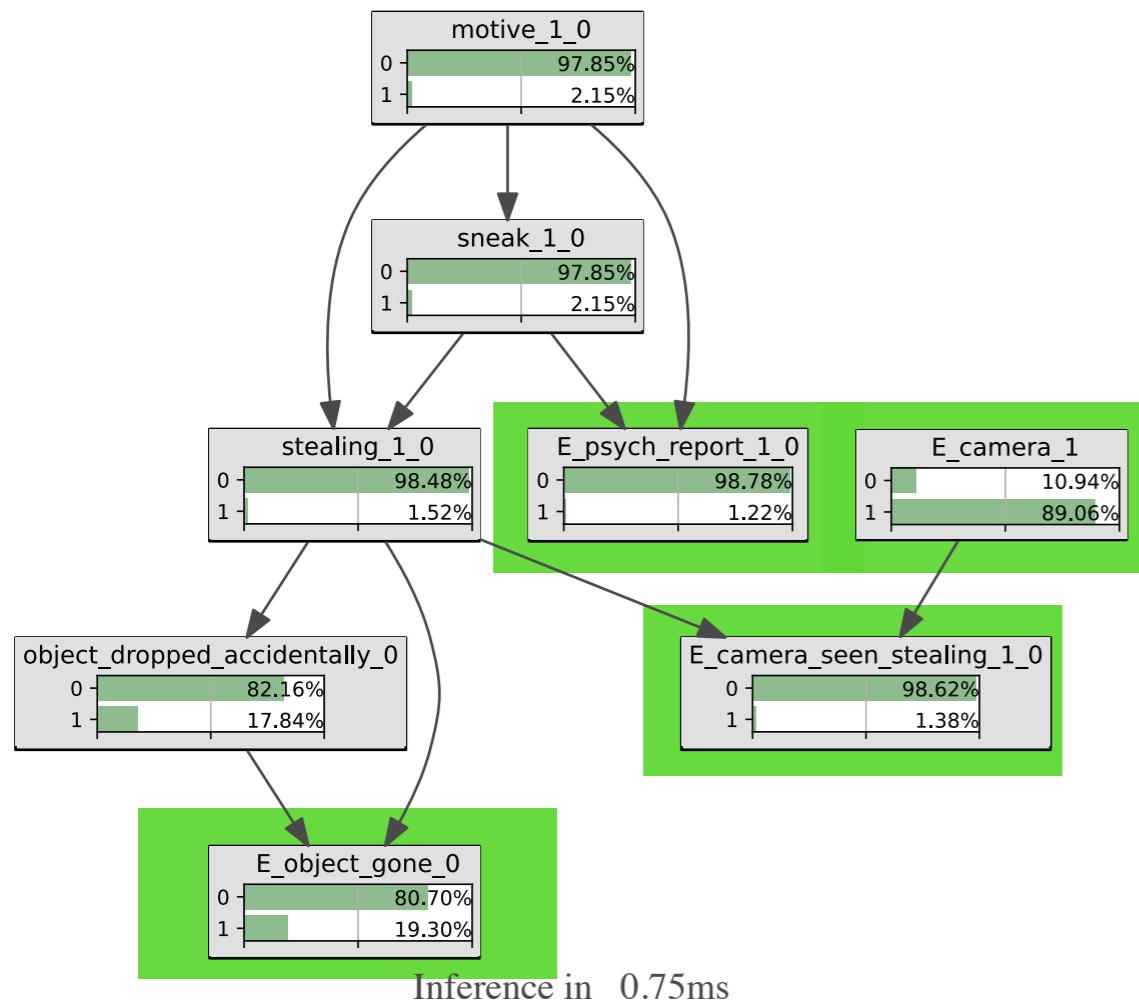
Node name (short)	Simulation	BN
motive	0.021	0.022
sneak	0.021	0.022
stealing	0.015	0.015
accident	0.178	0.178
psych report	0.012	0.012
camera	0.891	0.891
seen stealing	0.013	0.014
object gone	0.193	0.193

Yes, ± 0.001

Pragmatically, if we define a guilt threshold as > 0.99 ,
this is not a precision to worry about

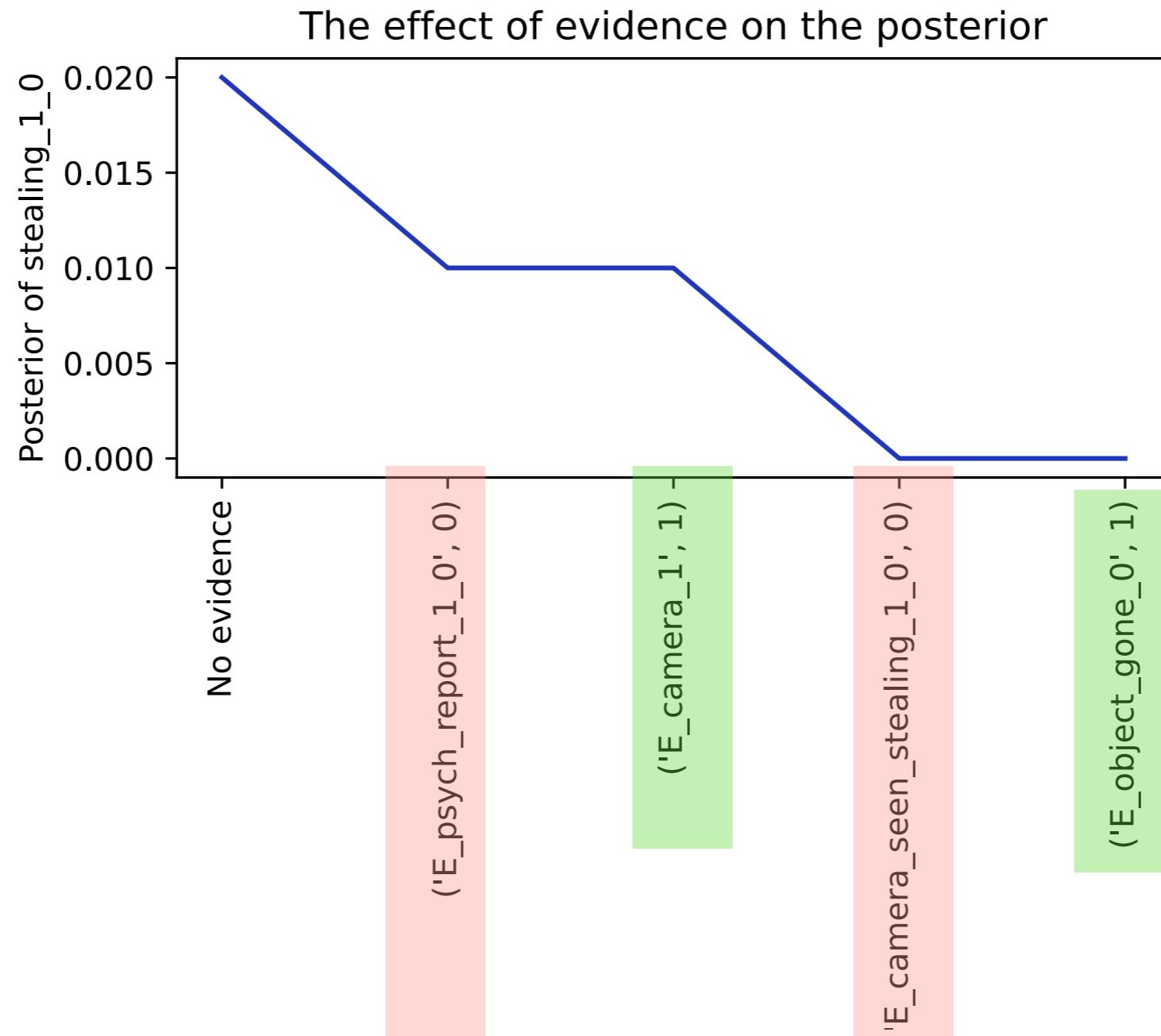
Does this BN respond ‘rationally’ to all possible combinations of evidence?

All evidence supports scenario 1:



Does this BN respond ‘rationally’ to all possible combinations of evidence?

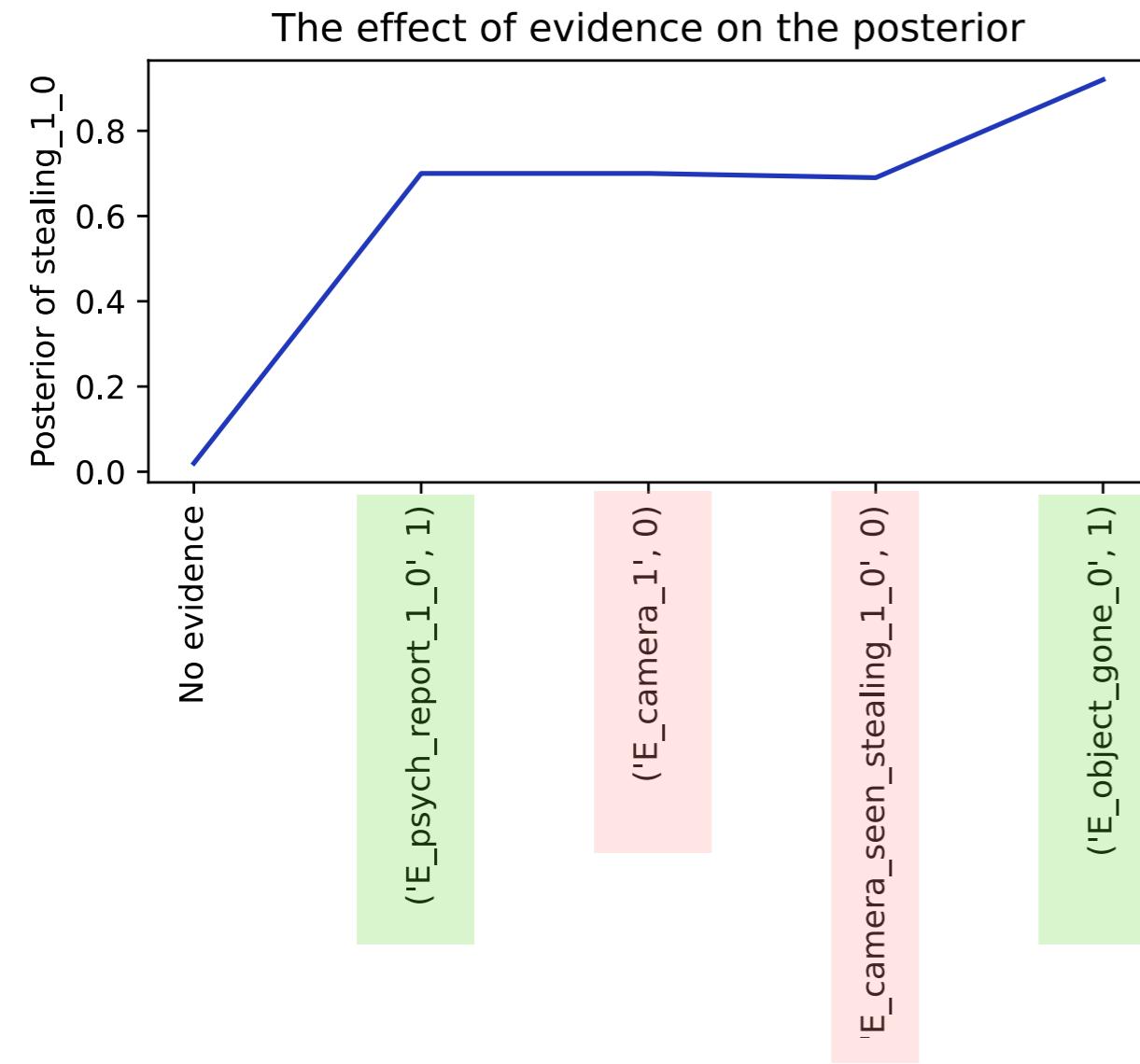
Only the object is gone! We shouldn't convict!



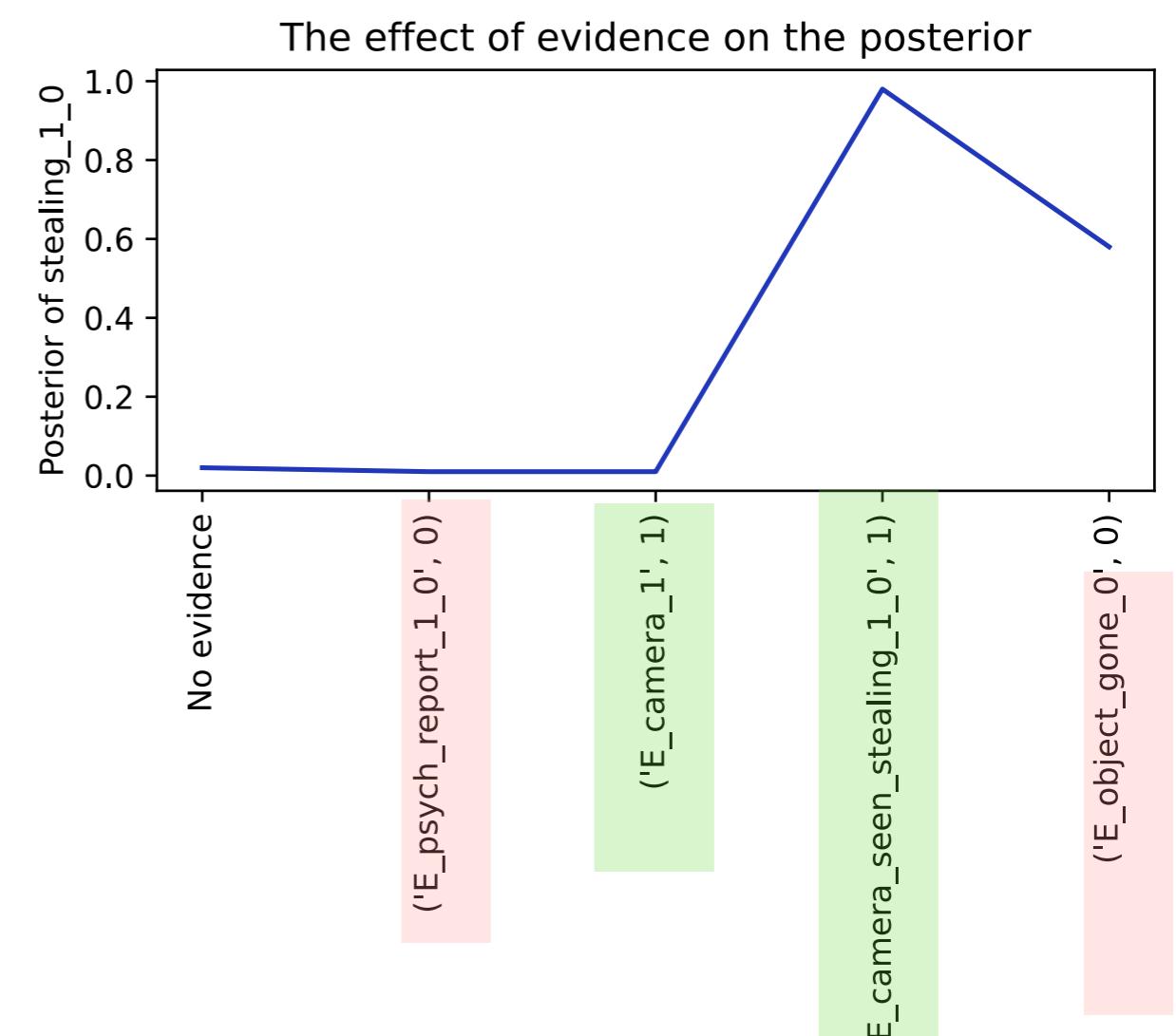
Unexpected behaviour

suspect fits profile and object is gone... but no video evidence

**Conflicting evidence:
Stealing without object gone**



**implausible in court
reflection of simulation -
insufficiently complex**

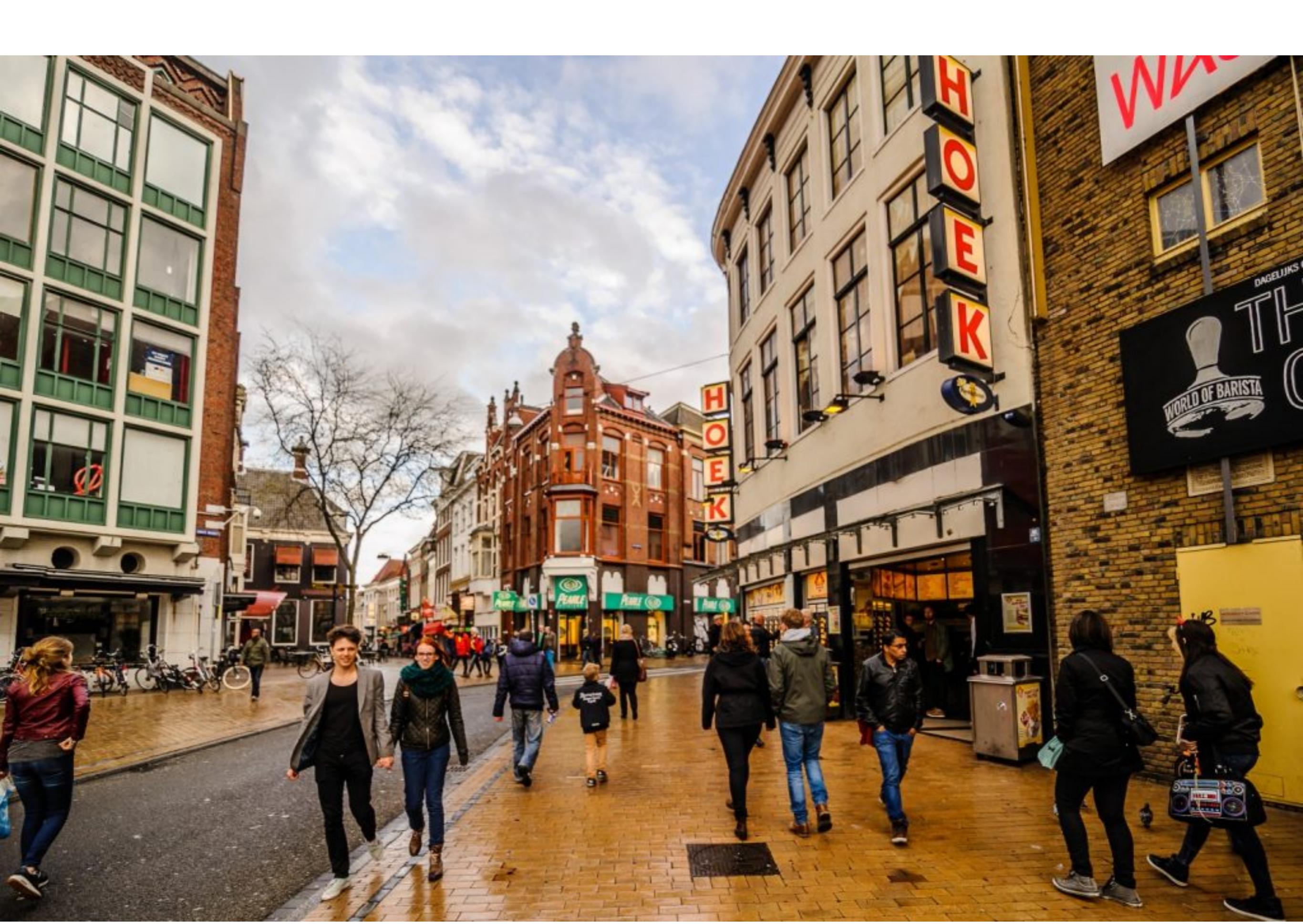


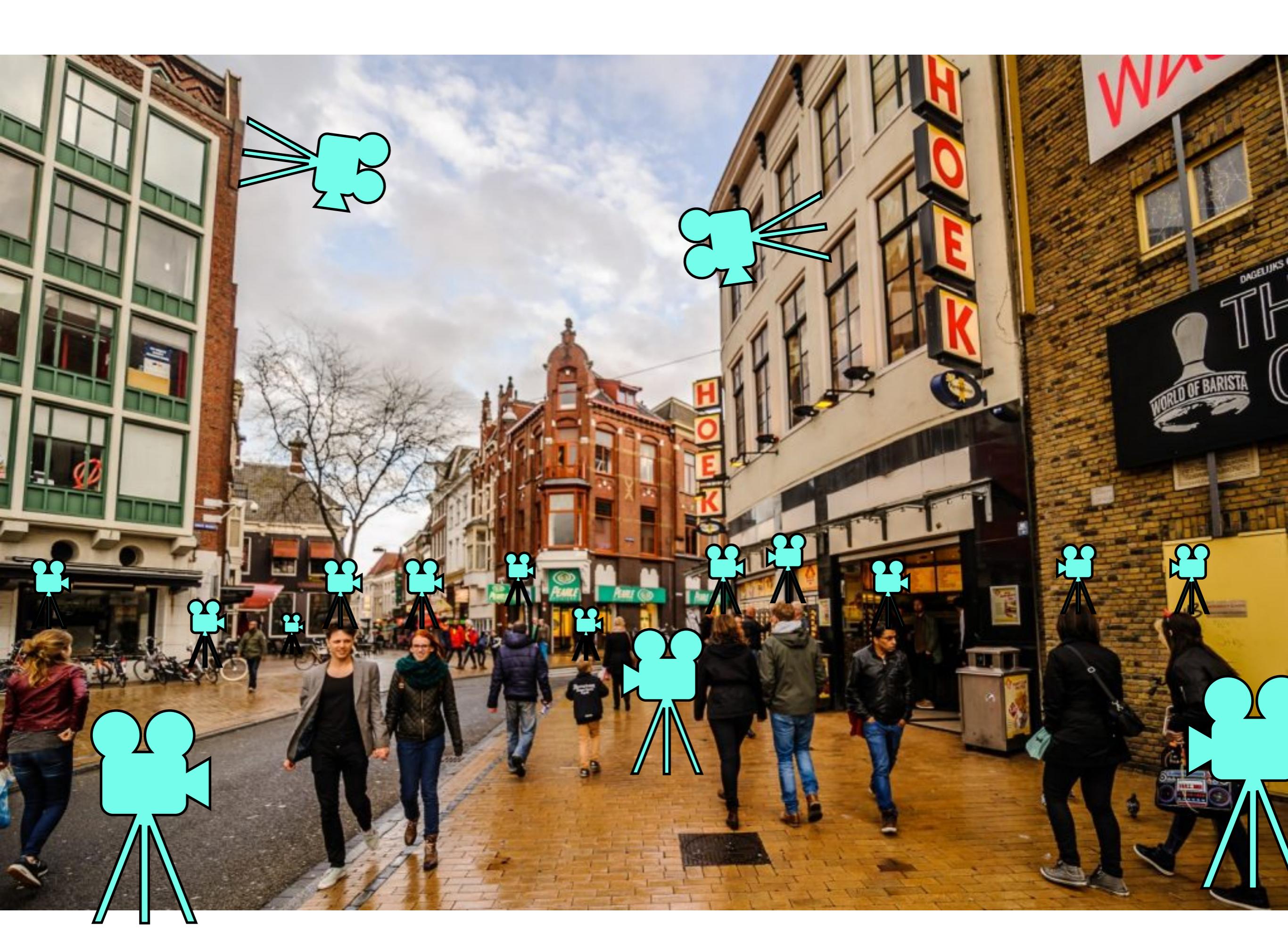
**Should give error...?
modeller's error?**

Is it plausible that this method generalises to real life?

Is it plausible that this method generalises to real life?

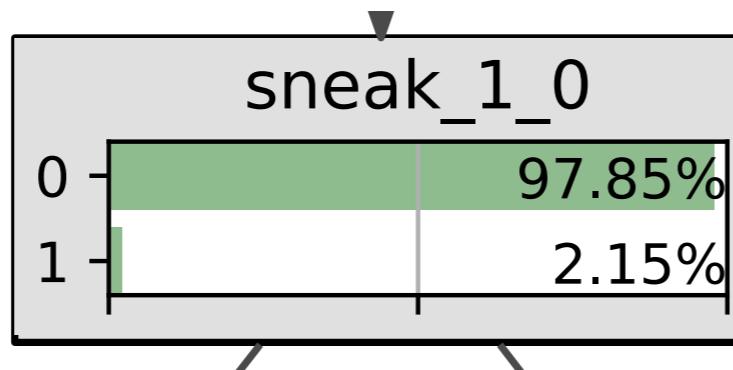
no





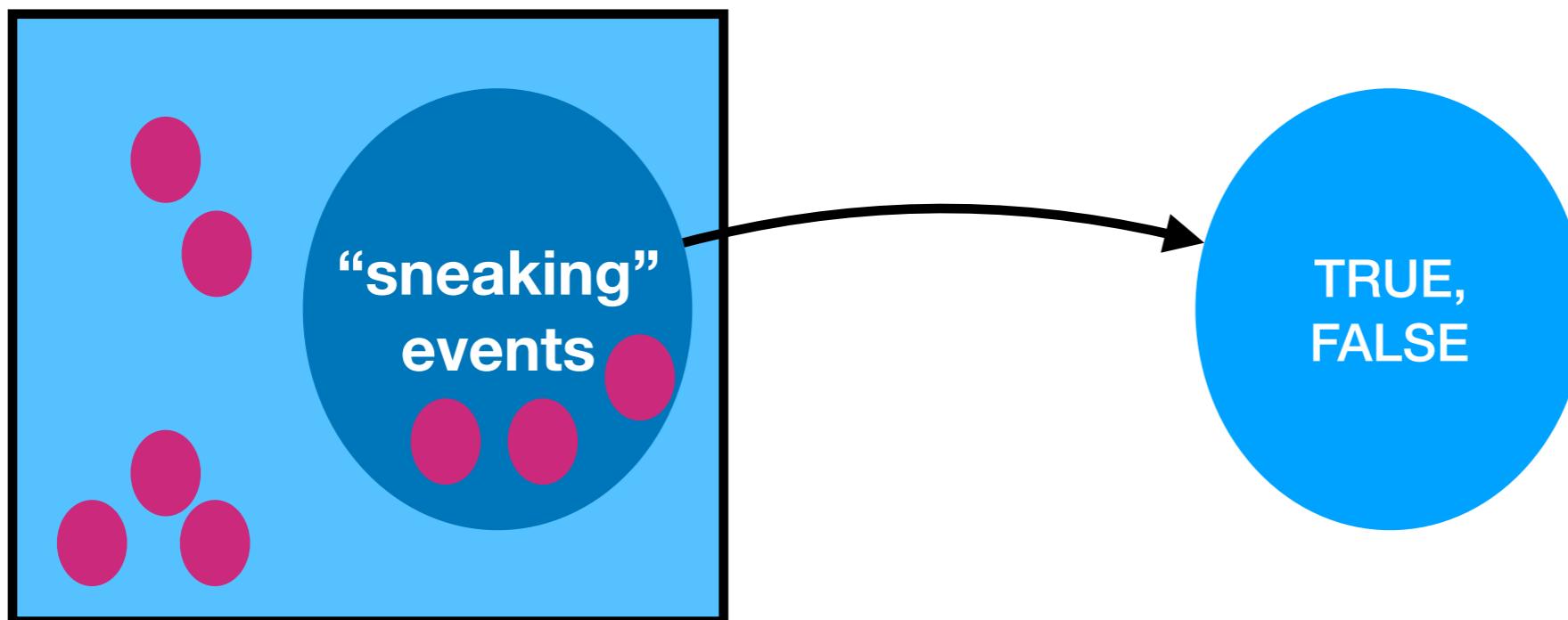
Is it plausible that this method generalises to real life?

Operationalisation



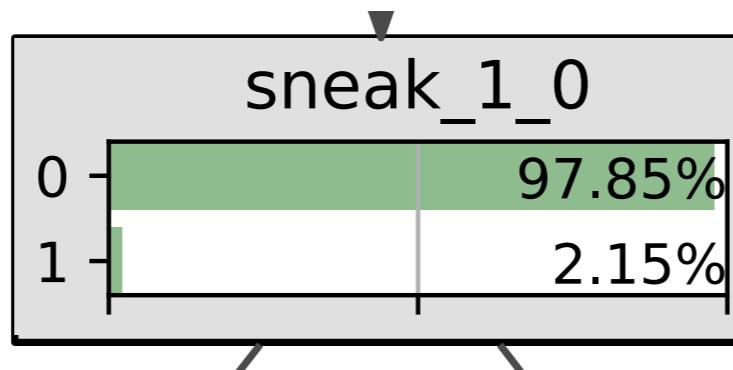
is a random variable

informally speaking



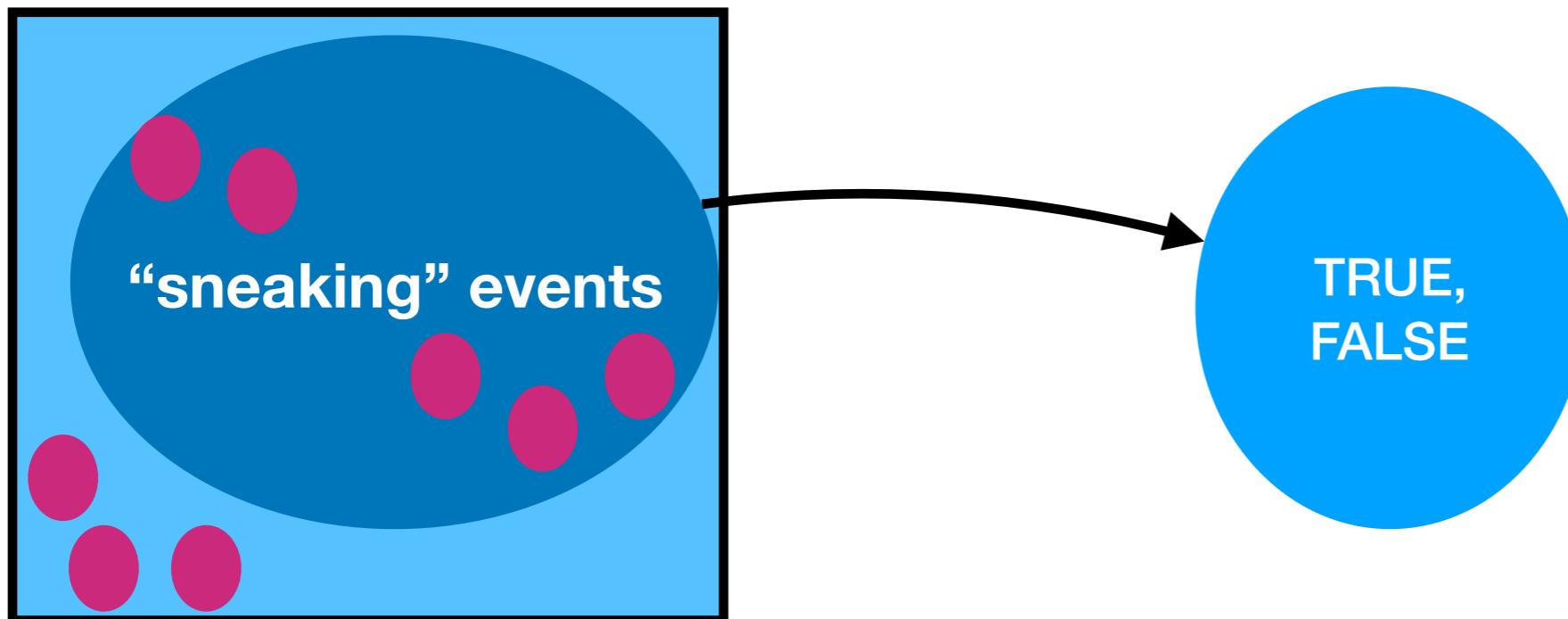
Is it plausible that this method generalises to real life?

Operationalisation



is a random variable

informally speaking



Do Bayesian Networks work as a tool for rationally dealing with evidence?

Criteria discussed here...

- Can we create a BN that reflects the probabilities of the simulation? (yes)
- Does this BN respond ‘rationally’ to all possible combinations of evidence? (mostly)
- Is it plausible that this method generalises to real life? (no)

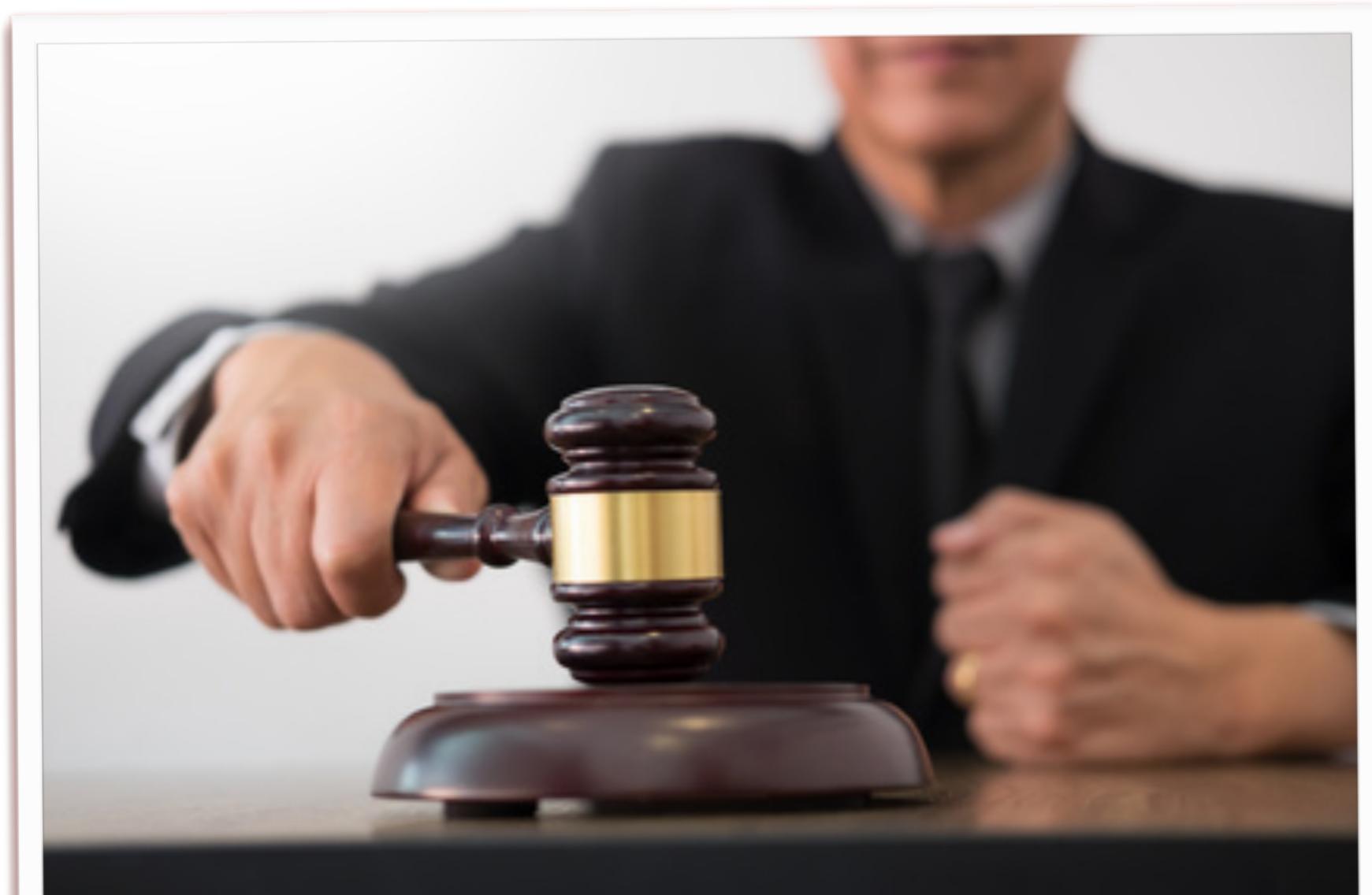
Future research

Add people

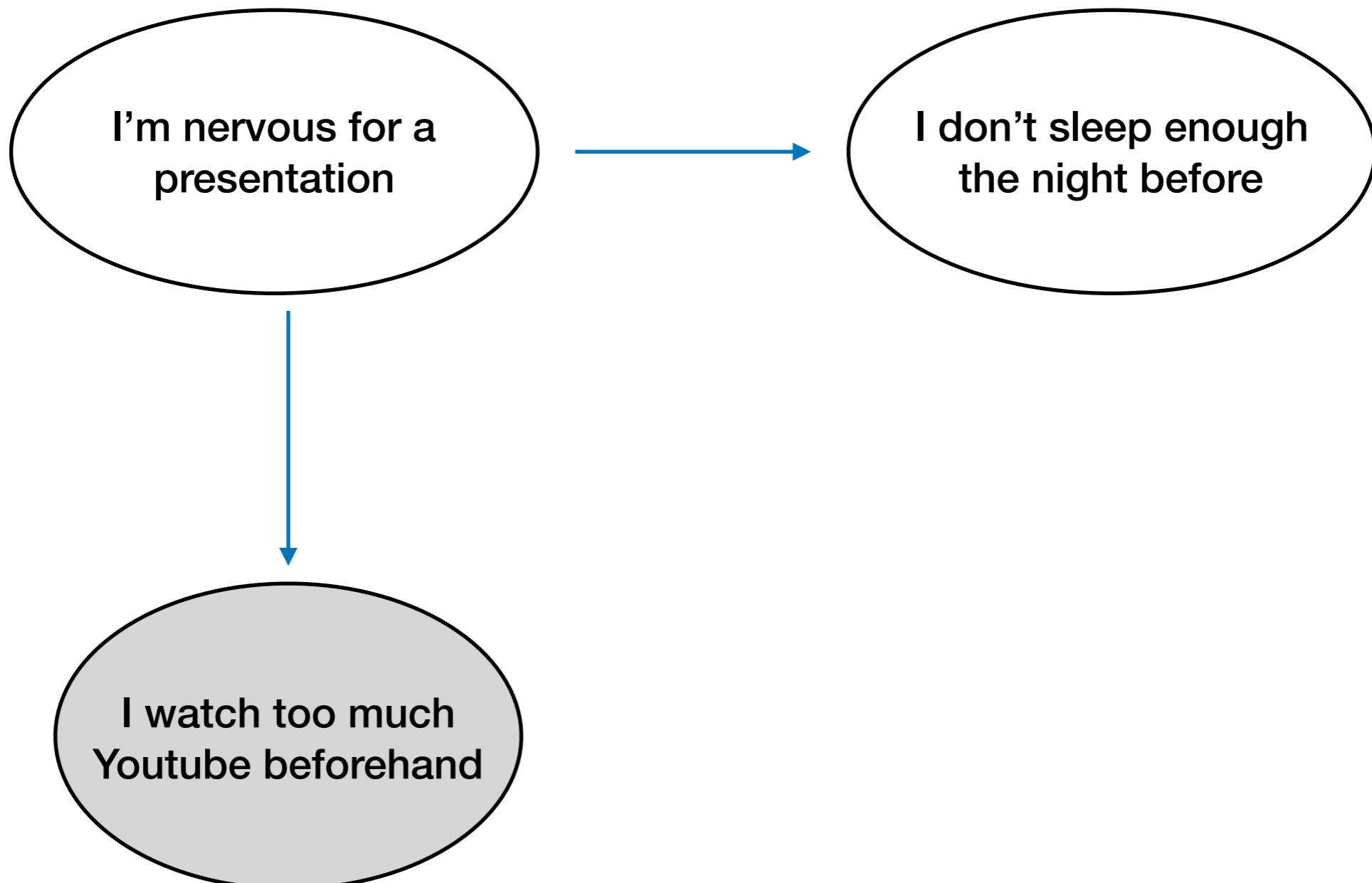
“we can never ask how accurate is a person's assessment of the probative weight of evidence given at trial. Such evidence involves unique events, and each fact finder evaluates the evidence according to personal strategies based upon a unique matrix of prior experience.”

Schum, 1982

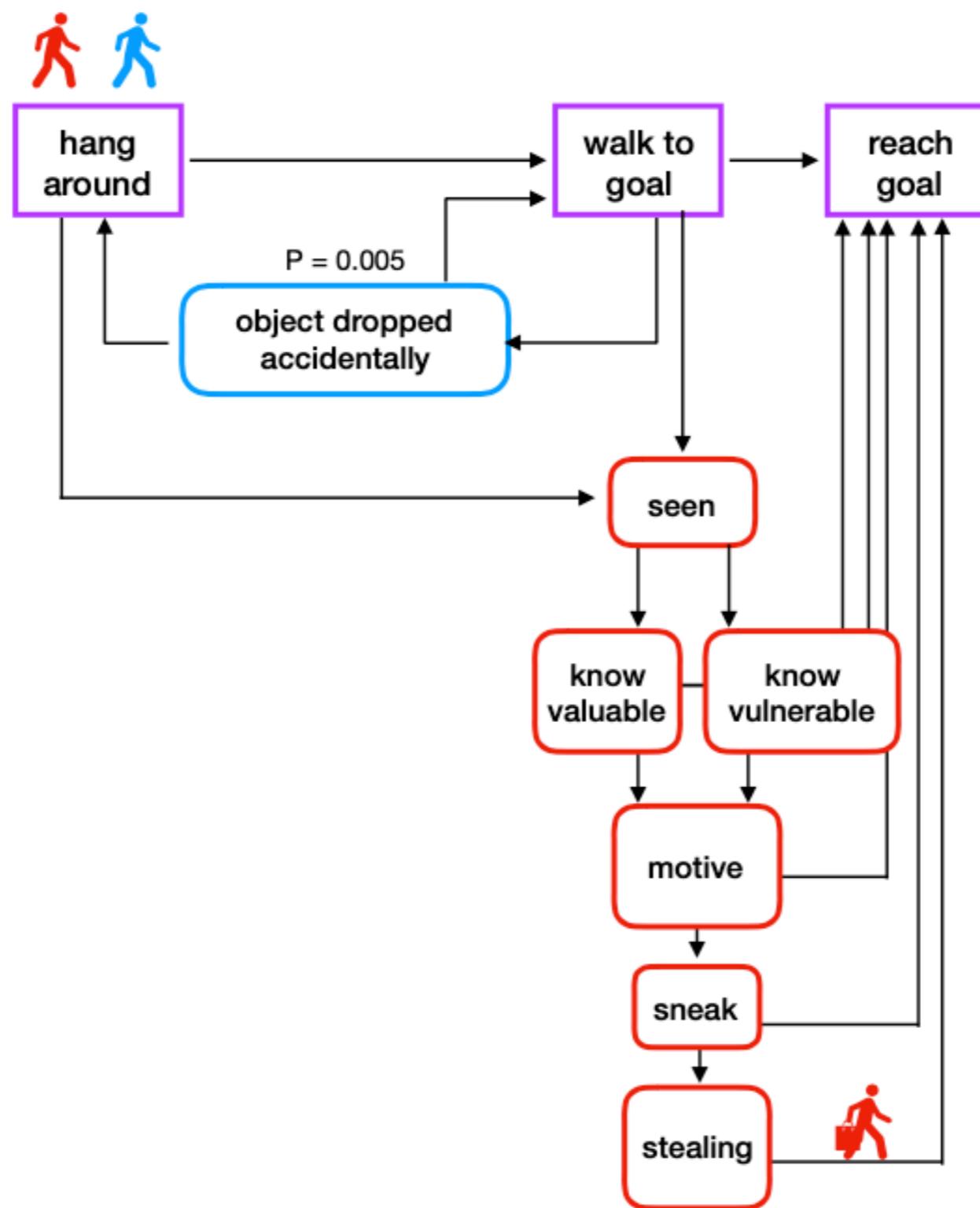
RQ: Do Bayesian Networks work as a tool for rationally dealing with evidence?

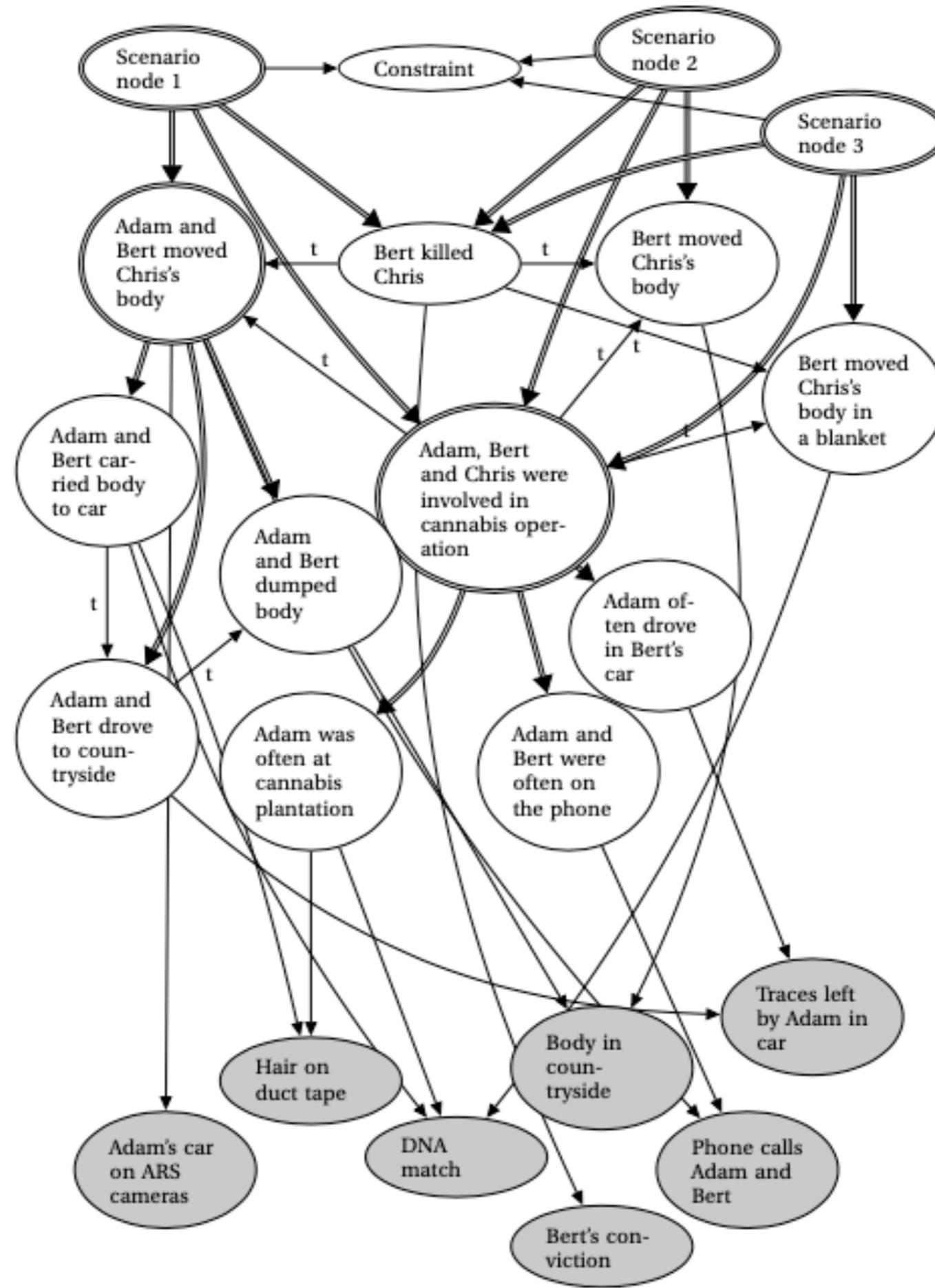


- find ways to test the effect of different operationalisations of random variables (node operationalisations) on the network
- more evaluation



initialise simulation



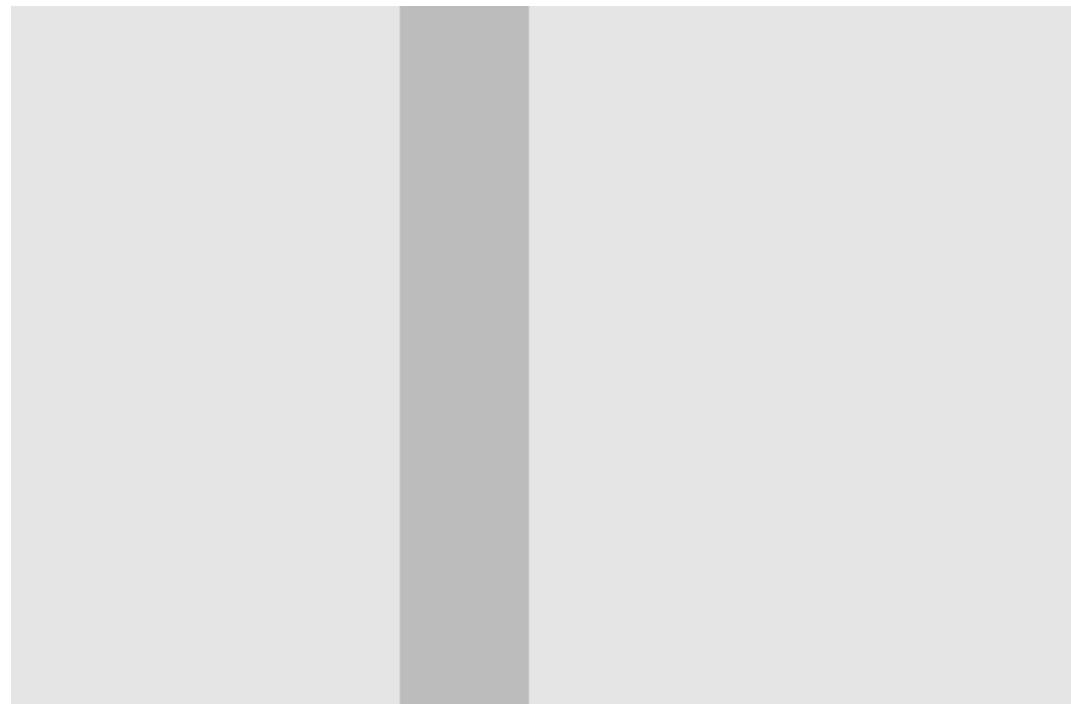


“we can never ask how accurate is a person's assessment of the probative weight of evidence given at trial. Such evidence involves unique events, and each fact finder evaluates the evidence according to personal strategies based upon a unique matrix of prior experience.”

Schum, 1982

Have we represented everything that we need to reason correctly explicitly in the BN?

thought experiment: we do not change anything about how we determine any of the nodes in the code, we do not change agent behaviour at all. Should the values in the nodes change if we change the environment?



a wall



selwerd

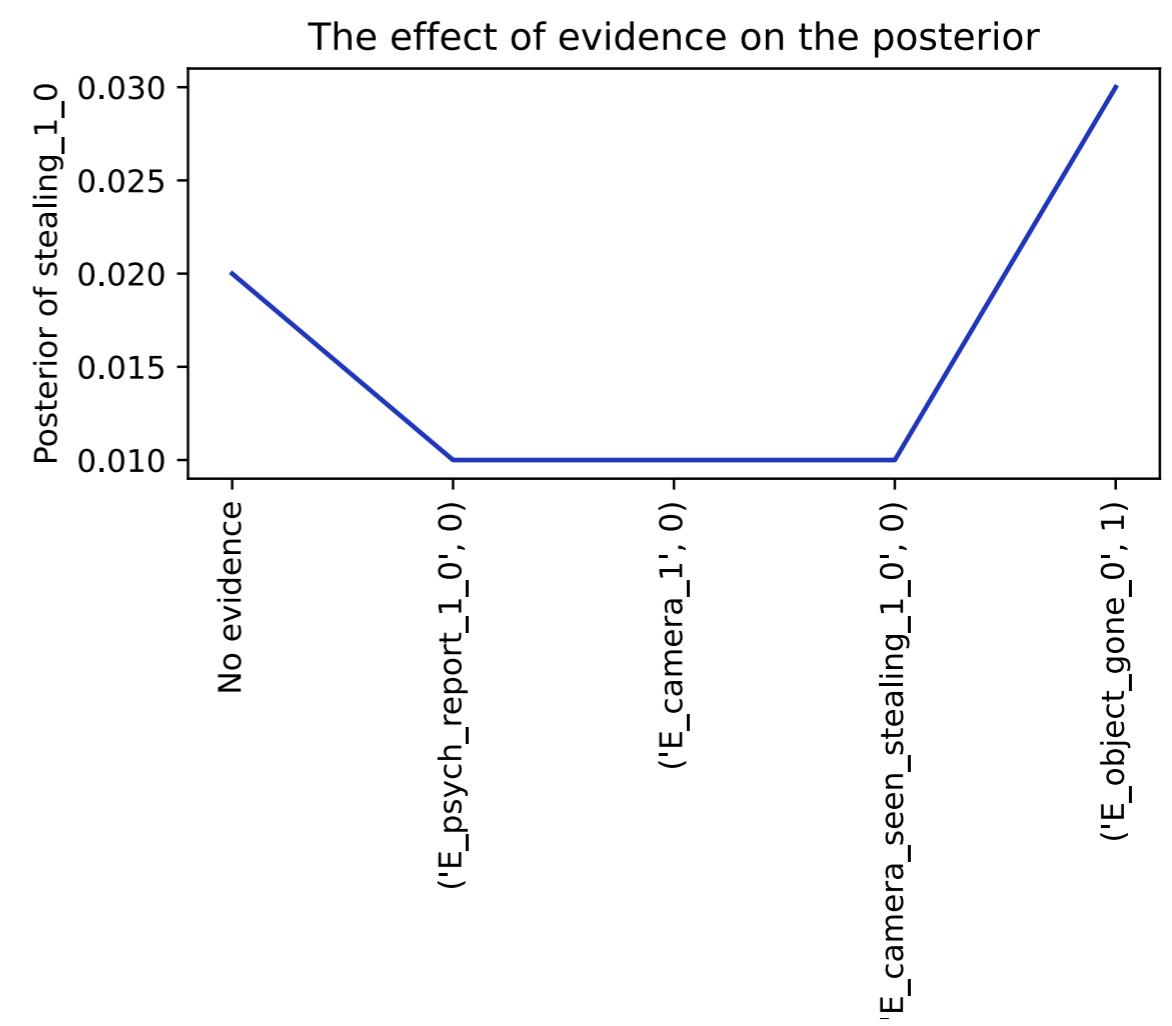
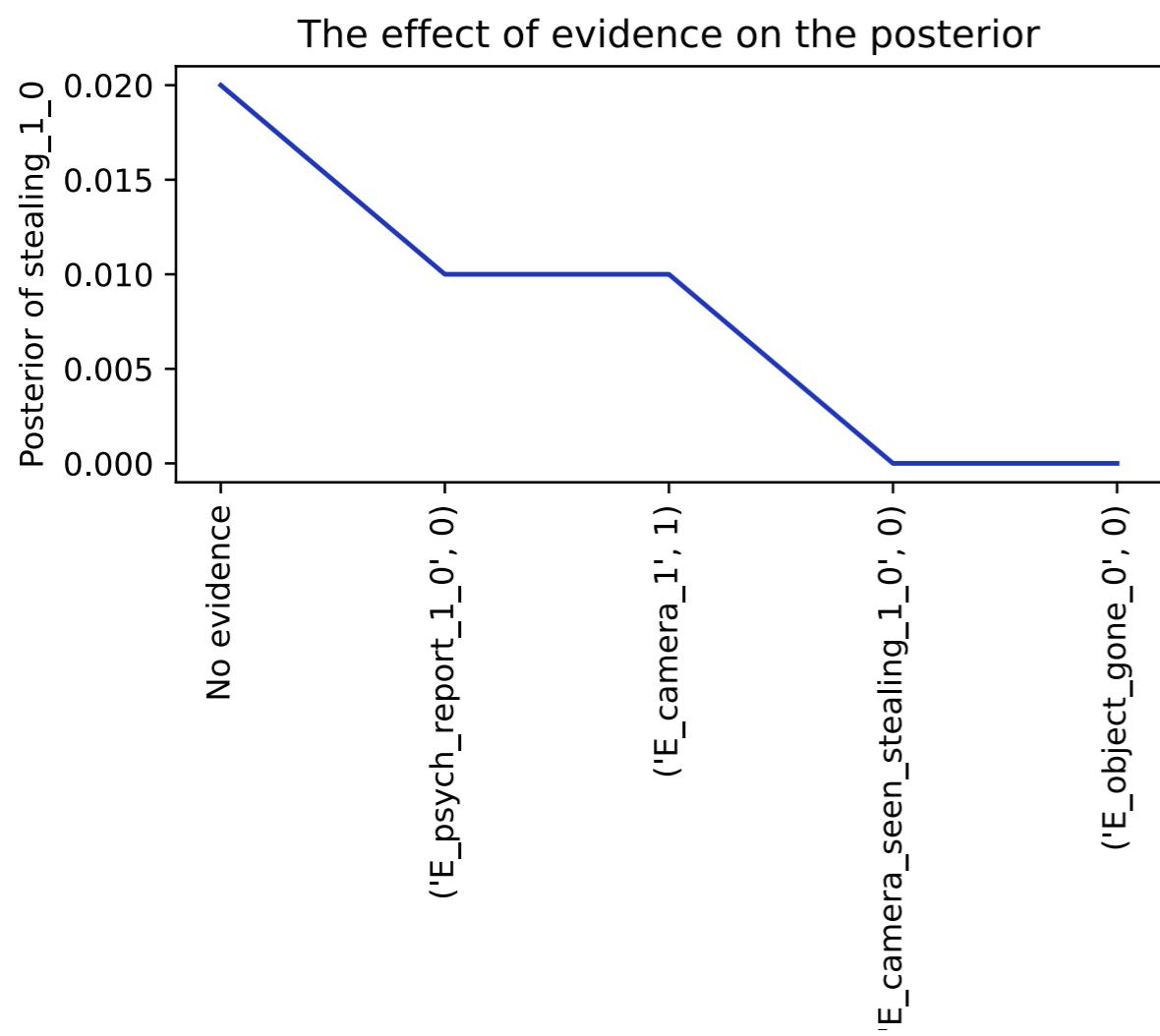
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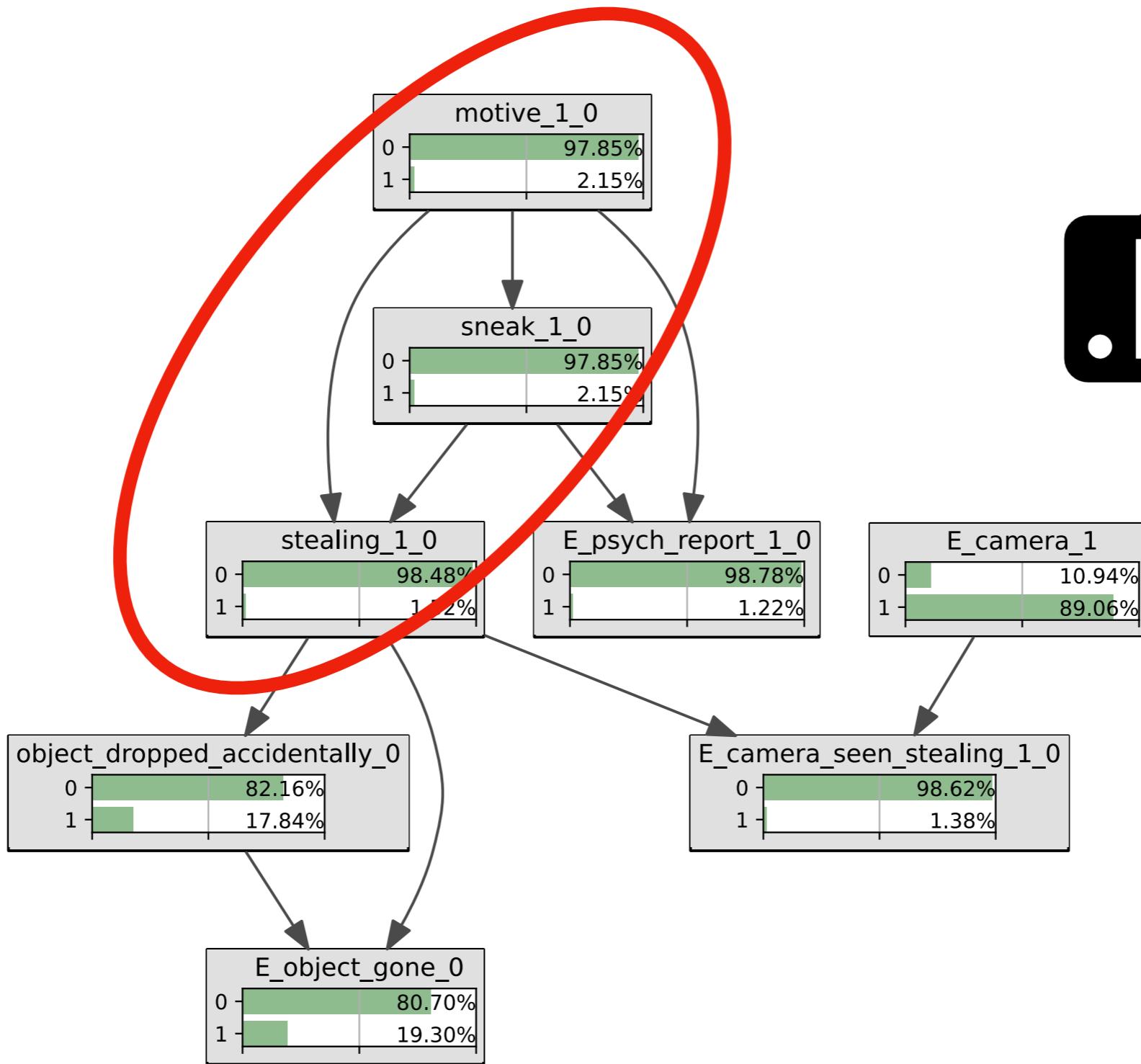
Node name (short)	wall	selwerd	grote markt
motive	0.04	0.03	0.03
camera	0.88	0.85	0.9

Does this BN respond ‘rationally’ to all possible combinations of evidence?

Other rationals



Automatically create a Bayesian network using the K2 algorithm



Inference in 0.75ms

Automatically create a Bayesian network using the K2 algorithm

