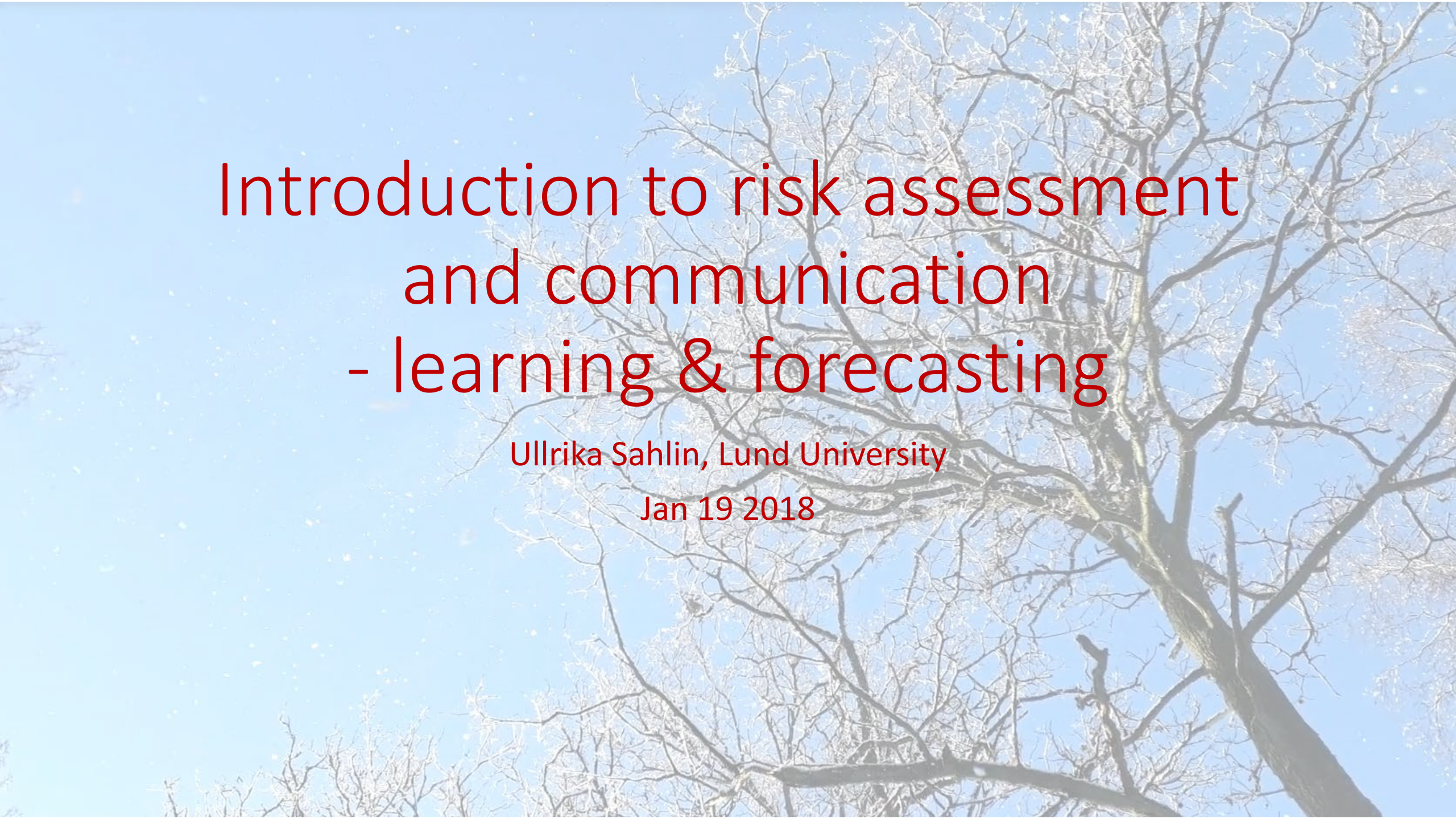

Introduction to risk assessment and communication - learning & forecasting

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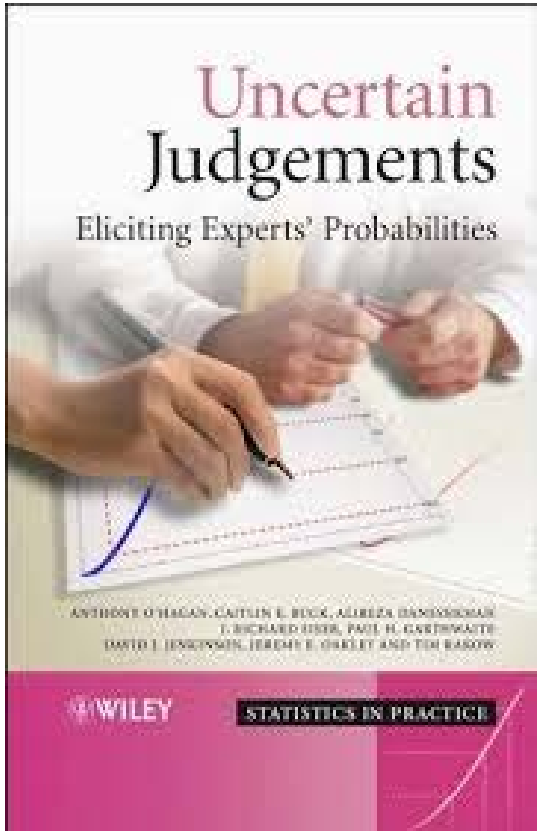
Learning & Forecasting

- Use experts to assess risk
- Use theory in risk assessment
- Data assimilation

Expert's Knowledge Elicitation

- Aim to describe the Expert's Knowledge about one or more uncertain quantities in probabilistic form
- i.e. a joint probability distribution for the random variable in question

- EKE can be used to build priors distributions or prior predictive distributions



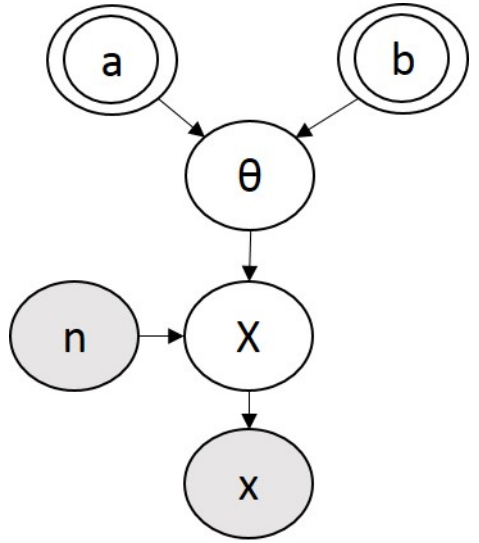
An Expert Knowledge Elicitation

- Formulate the elicitation questions
- Ask experts about
  - Probabilities
  - Quantiles
  - Probability intervals
  - Moments or other descriptions of a probability distribution
- Fit and aggregate into a probability distribution for the uncertain quantity

Direct methods for EKE

- Simple and a bit crude
  - *Intervals* – Lower and Upper limits, then a Uniform distribution
  - *Triangular distributions* – Mode, Lower and Upper limits
- Cumulative Density Function (CDF)
  - *Quartiles* – 4 intervals, median and 25th and 75th percentiles
  - *Tertiles* – 3 intervals with equal probability
  - *Probabilities/Hybrid* – Choose probabilites and intervals
- Probability Density Function (PDF)
  - Mode/Mean, percentiles, shape,…
  - Place chips, draw it by hand…

Indirect methods for EKE



- Equivalent Prior Sample (EPS)
  - *What is the expected frequency of the event?*
  - *What is the size a sample that you imagine to have behind this estimate?*

$$\frac{x}{n} = ? \qquad n = ?$$

- Hypothetical Future Sample (HFS)
  - *In a future sample of size 100 – in how many times has the event occured?*

$$n = 100 \qquad x = ?$$

Selection of Structured EKE Software

- EXCALIBUR (EXpert CALIBration): www.lighttwist.net/wp/excalibur
- ElicitN: www.downloadcollection.com/elicitn.htm
- SHELF (The SHeffield ELicitation Framework): www.tonyohagan.co.uk/shelf/
- MATCH Uncertainty Elicitation Tool: optics.eee.nottingham.ac.uk/match/uncertainty.php#
- UncertWeb - The Elicitator: http://elicitator.uncertweb.org/
- Variogram elicitation: www.variogramelicitation.org
- Unicorn: www.lighttwist.net/wp/unicorn-download

cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

Source: http://www.expertsinuncertainty.net/Software/tabid/4149/Default.aspx

EK.R

Source on Save | Run | Source

```
1  library(SHELF)
2
3  ## elicit one expert or consensus distribution
4  EK_info <- roulette(lower = 0, upper = 100, gridheight = 10, nbins = 10)
5
6  EK_info
7  $v
8  [1]  10  20  30  40  50  60  70  80  90 100
9
10 $p
11 [1] 0.1428571 0.5714286 0.8571429 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
12 [10] 1.0000000
13
14 ## fit distribution to expert info
15 EK <- fitdist(vals = EK_info$v, probs = EK_info$p, lower = 0, upper = 100)
16
17 plotfit(EK, ql = 0.05, qu = 0.95, d = "beta")
18
19
```

C:/Users/Ullrika/Box Sync/Bayesian/bayes@lund2017 - Shiny

http://127.0.0.1:6563 | Open in Browser | Publish

Roulette elicitation

- [x] Show fit
- [x] Spread end probs over empty bins

Distribution

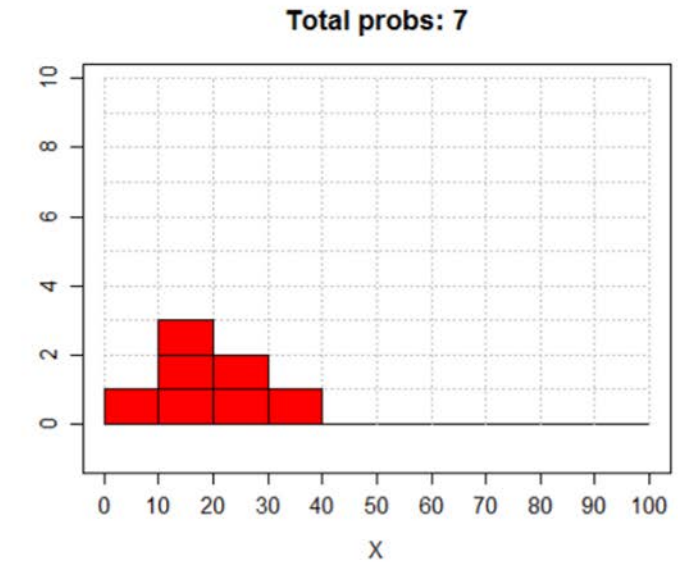
- ( ) Normal
- ( ) Student t
- ( ) Gamma
- ( ) Log normal
- ( ) Log Student t
- (•) Beta
- ( ) Best fitting

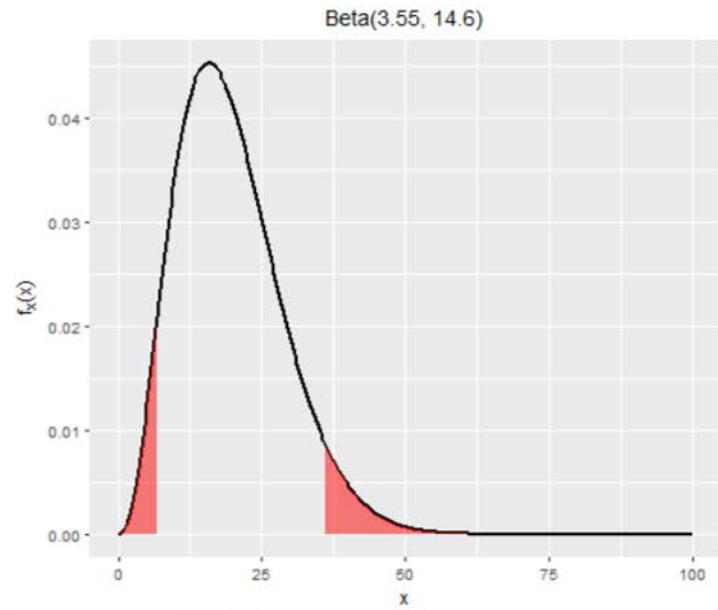
Student-t degrees of freedom: 3

lower feedback quantile: 0.05

upper feedback quantile: 0.95

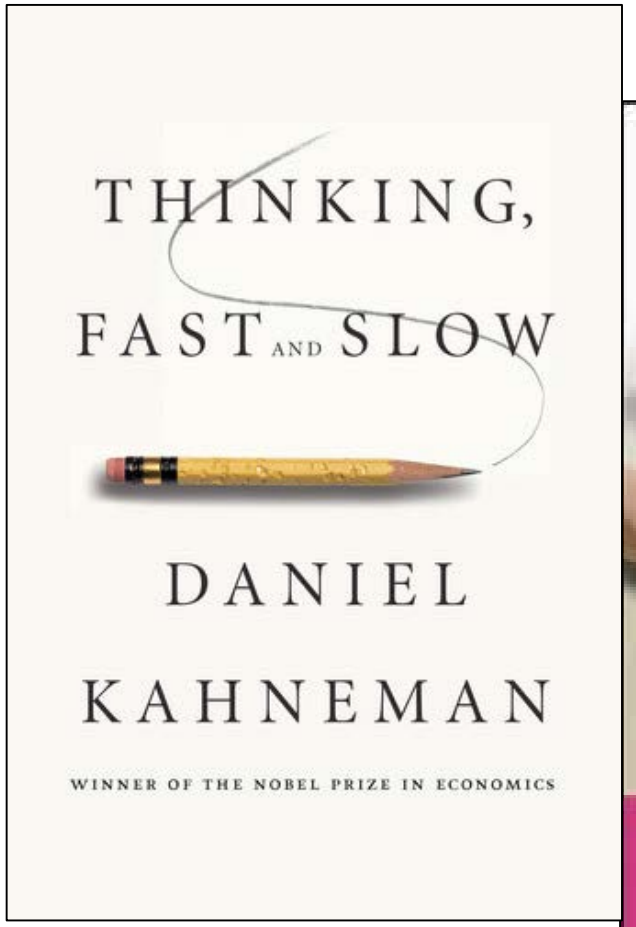
Finish

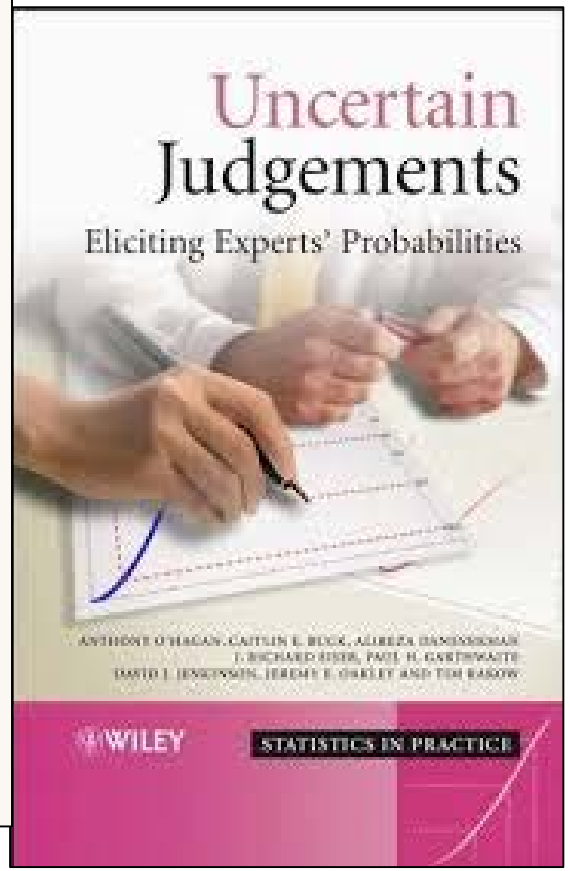




Pshycological factors and elicitation

- Anchoring and adjustment
- Availability
- Range–frequency compromise
- Representativeness and baseline neglect
- Conjuction fallacy
- The law of small numbers
- Overconfidence





Elicitation with multiple experts

- Psychological factors when working with several experts

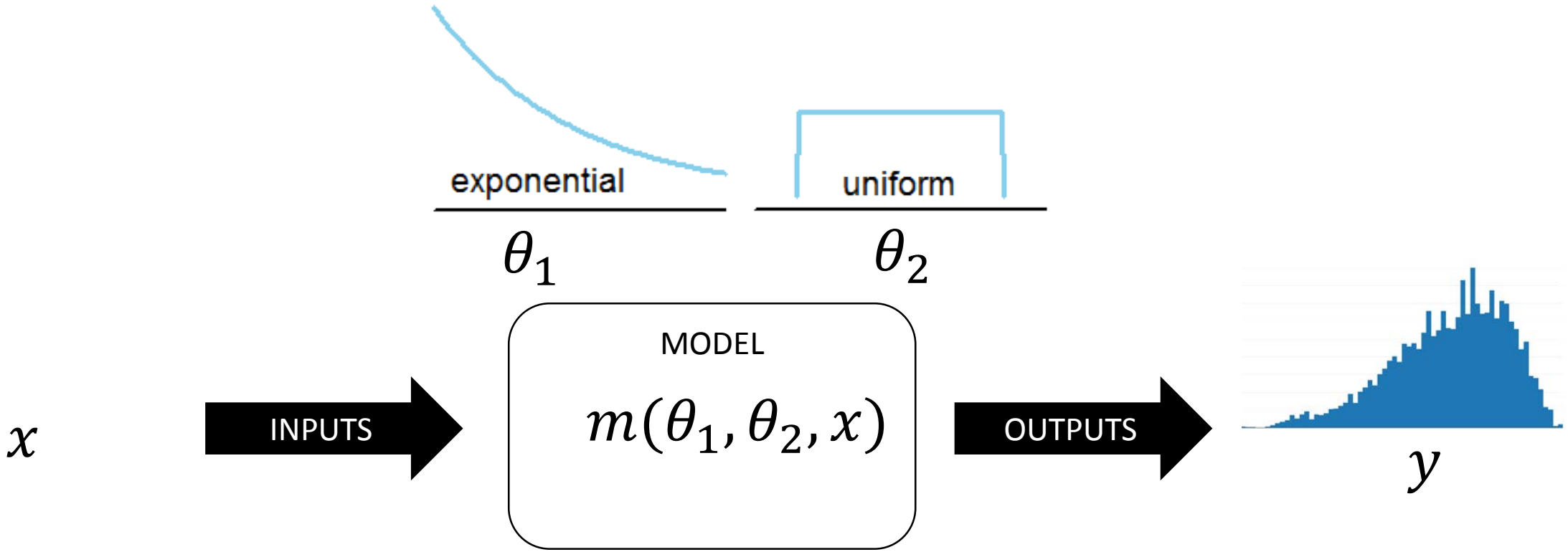
- Behavioural aggregation
  - Group elicitation
  - One or several iterations, individually and in group
- Mathematical aggregation
  - Treat each expert’s distribution as data and update the decision maker’s belief
  - Pooled opinions – linear or logarithmic pooling
  - Calibrate experts and weight according to their performance

What is a model?

- Data model
- Statistical model
- Mechanistic model
- Theoretical model
- Mathematical model
- Causal model
- Risk model
- Machine learning
- Deep learning
- Physical model
- Micro or mesocosms
- Simulation model
- Conceptual model
- Probability model

Questions

1. Have you ever done a Monte Carlo simulation? How did you interpret the probability distributions?



Analysis in different situations

$$m(\theta, x) \rightarrow y$$

	Parametric inference	Predictive inference
Data rich	Classical and Bayesian data analysis, anything goes as long as data quality is good, beware of p-hacking	Classical data analysis if target variables have been observed Bayesian analysis with data and system models
Data sparse	Bayesian analysis for estimation or hypothesis testing combining expert knowledge and data	Bayesian analysis for forecasting or decision analysis combining expert knowledge and data
No data	Expert elicitation	Forward simulation

Monte Carlo simulation

Forward

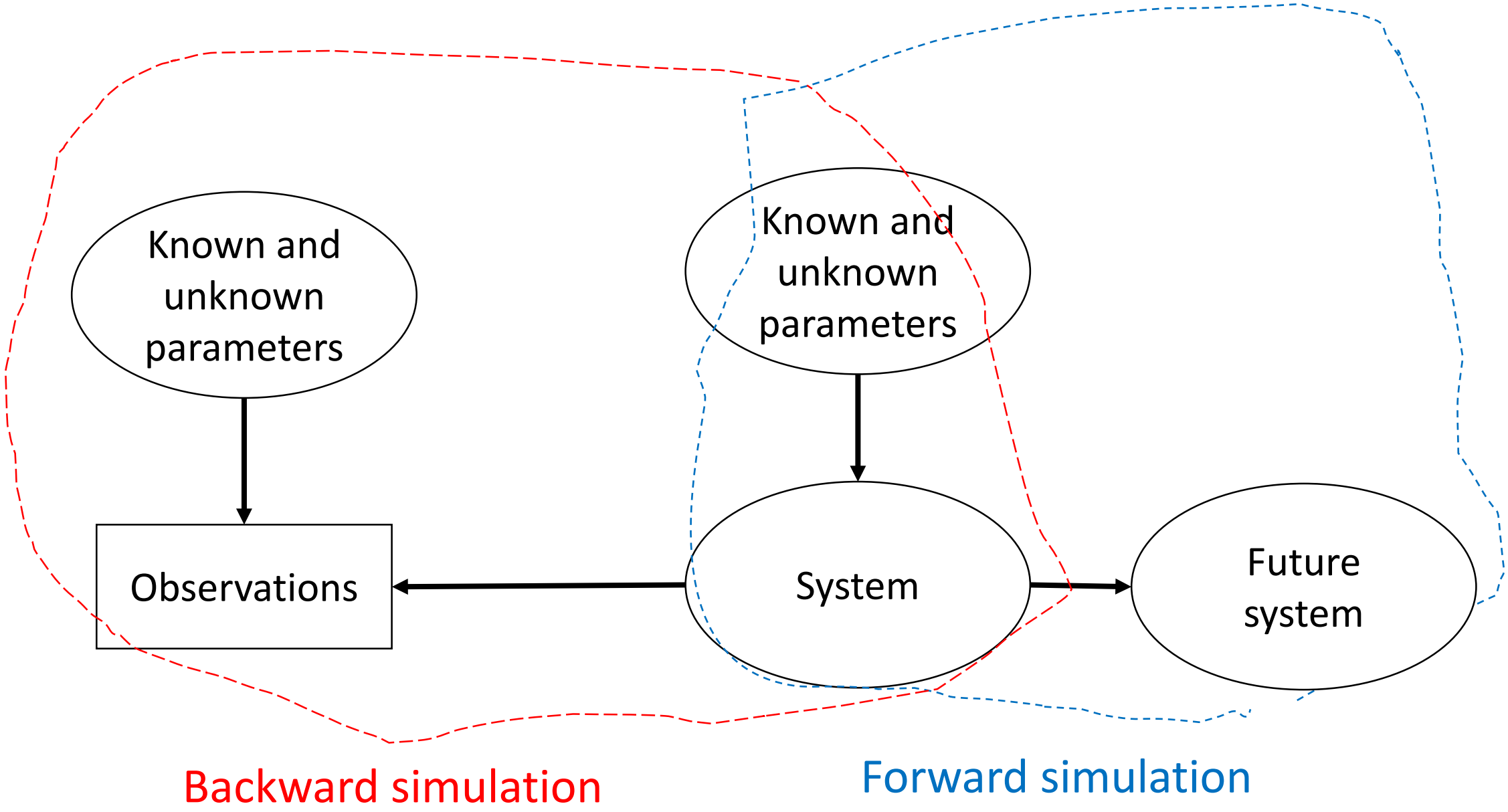
- 1 DM
- 2 DM

Backward

- Inverse modelling
- MCMC sampling
- Approximate Bayesian Computation

Mixtures

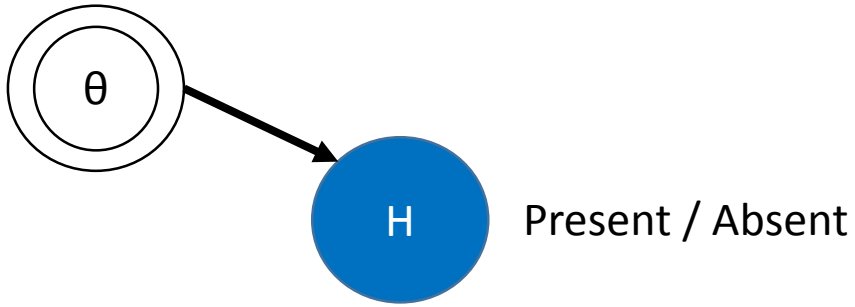
- Sequential MCMC sampling
- Hybrid approaches mixing probabilistic and non-probabilistic descriptions of uncertainty


Known and unknown parameters
Known and unknown parameters
Observations
System
Future system
Backward simulation
Forward simulation

Is there something out there?

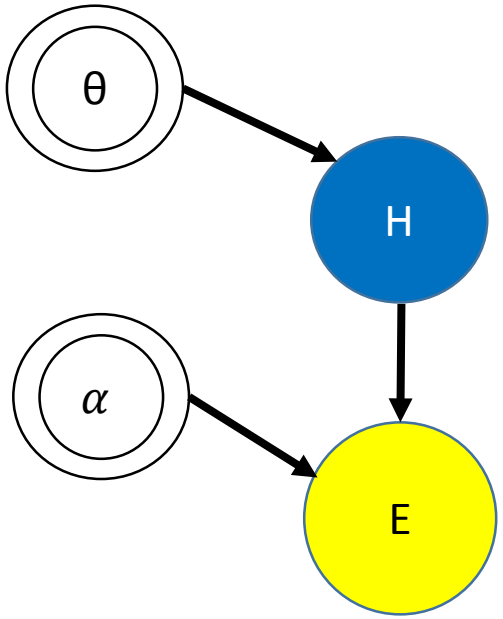
- You, me, experts have different judgments if there is something out there
- We make two observations, but these are not perfect
- We did not see anything
- Is there something out there?

Is there something out there?



H	
Present	θ
Absent	$1 - \theta$

Is there something out there?



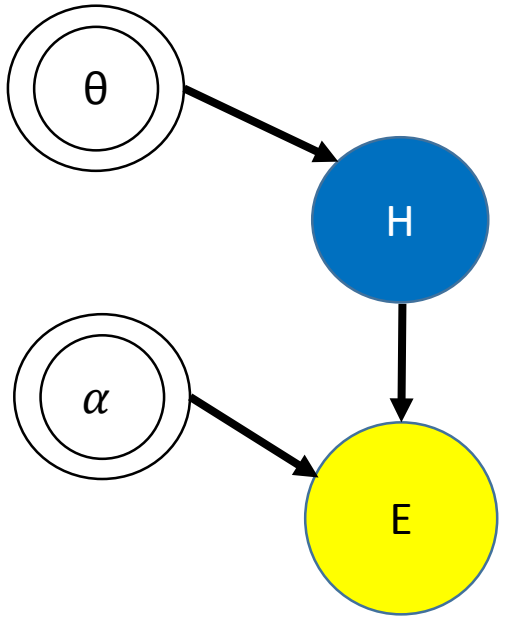
Present / Absent

Observed / Not observed

H	
Present	θ
Absent	$1 - \theta$

	H	
E	Present	Absent
Observed	α	0
Not observed	$1 - \alpha$	1

Is there something out there?



Present / Absent

Observed / Not observed

H	
Present	θ
Absent	$1 - \theta$

	H	
E	Present	Absent
Observed	α	0
Not observed	$1 - \alpha$	1

$$P(H|not\ E) = \frac{(1 - \alpha)\theta}{1 - \alpha\theta}$$