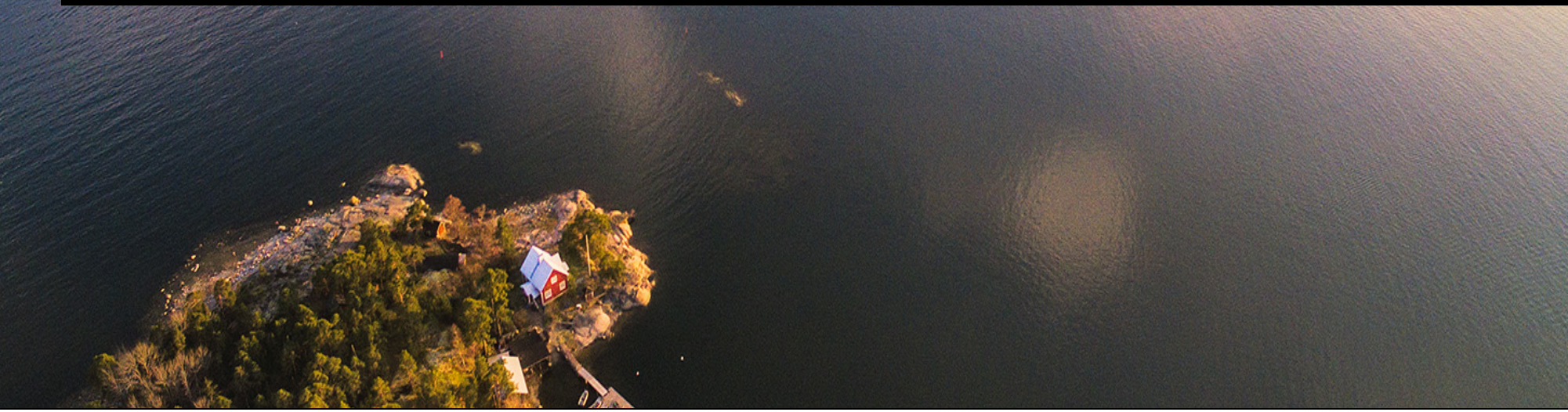
Structural elicitation for Bayesian Networks

Joint work with Anca Hanea (CEBRA, UniMelb) and Sophia Wright (Univ of Warwick)

Tina Nane (TU Delft)



TU Delft

Citation Performance of Researchers

Influencing factors

- Publication record, years of activity
- Journal citation scores
- Field
- (International) collaboration, etc.

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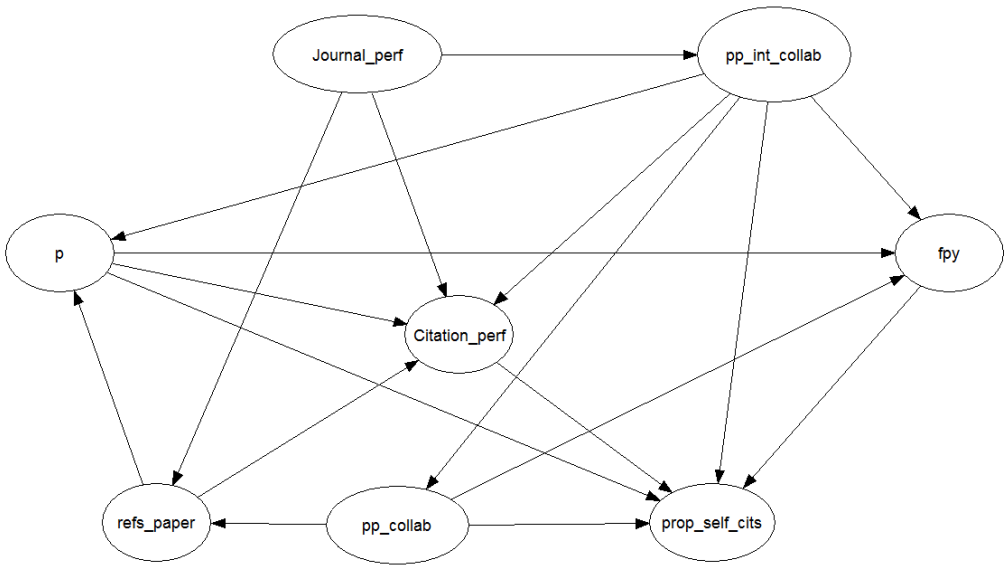
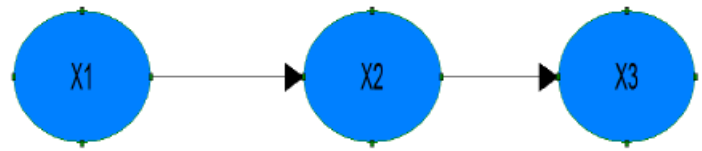
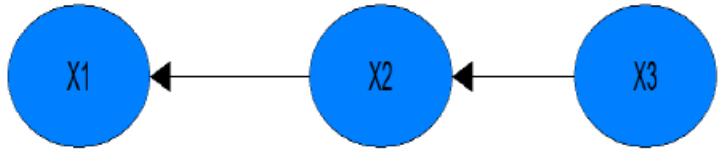


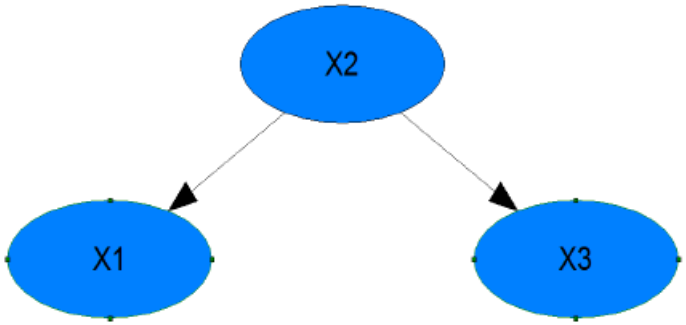
Bayesian Networks



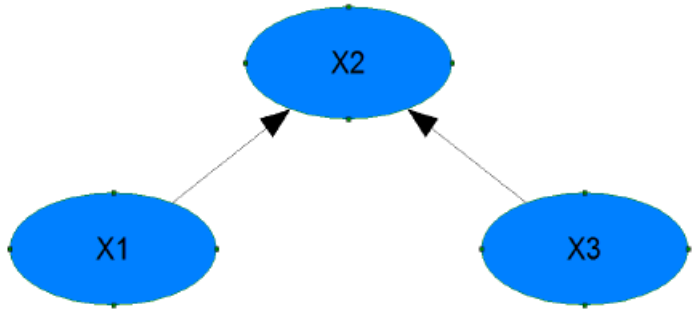
a)



b)

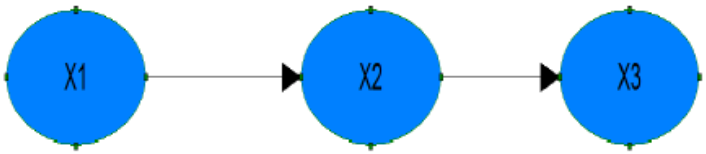


c)

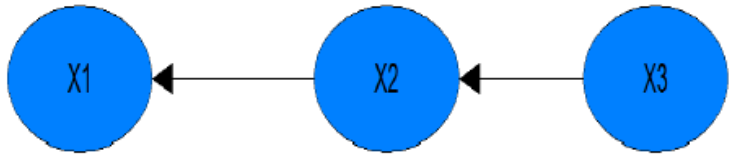


d)

Bayesian Networks



a) $X_1 \perp X_3 | X_2$



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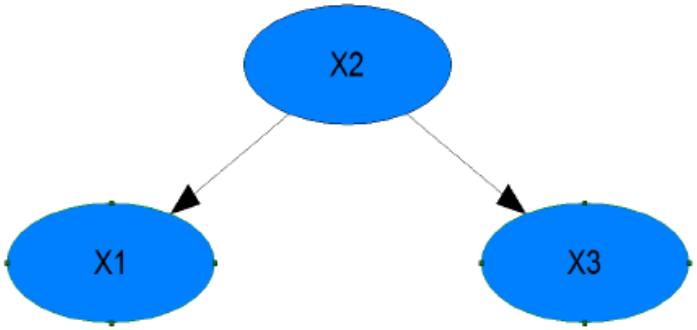

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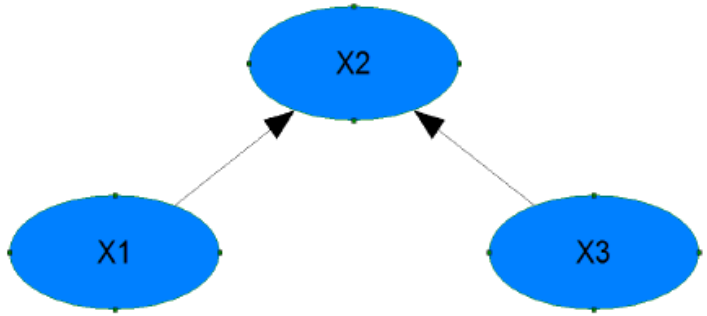

d) $X_1 \not\perp X_3 | X_2,\ X_1 \perp X_3$

Bayesian Networks

Number of possible structures

n	2	3	4	5	10
nr of DAGs	3	25	543	29281	4.2×10^{18}

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Learning the structure of a Bayesian Network

- Experts
  - Write all the variables of interest
  - Write all variables that could influence the variables of interest
  - Write parents of these variables, etc.
- Data driven
  - Constraint based algorithms
  - Score based algorithms
- Experts + Data

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- How can we measure performance when eliciting the structure of a Bayesian Network?

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  2. Assign arcs in particular order
  3. Compute the conditional distribution of the variable of interest
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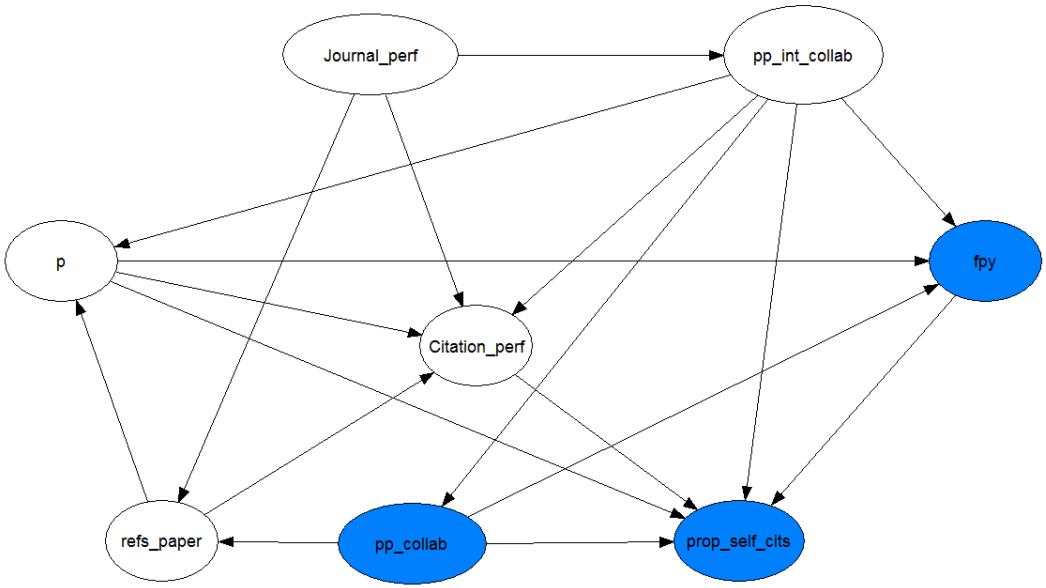
  1. Ask experts about the conditional distribution of the variable of interest
- Data
  2. Assign arcs in particular order
  3. Compute the conditional distribution of the variable of interest
  4. Repeat 2 & 3
- Compare the conditional distributions in 1 and 3
- Choose the conditional distribution from data closest to the conditional distribution from experts (with respect to a particular distance)

Citation performance of researchers



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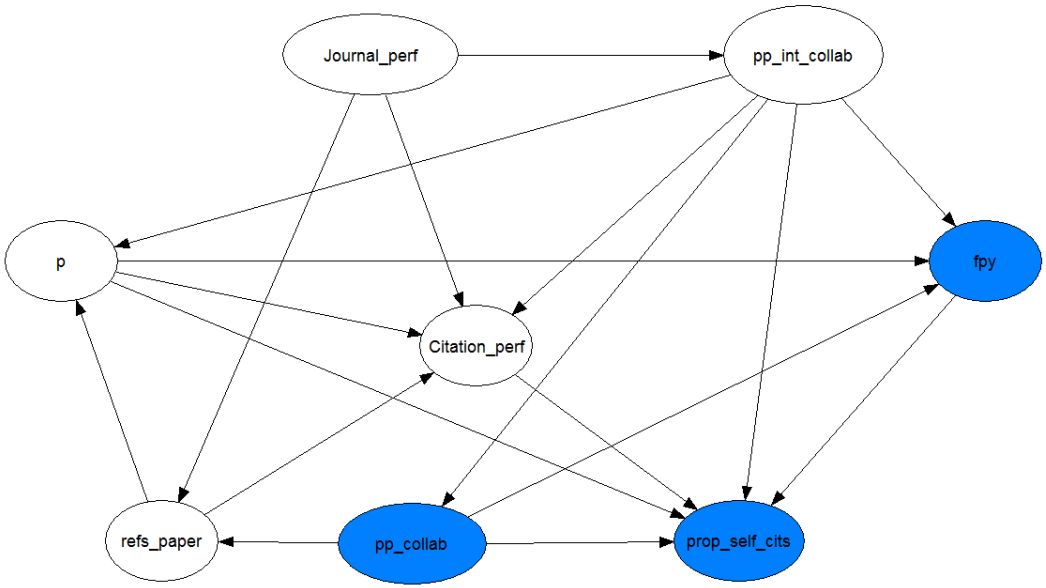
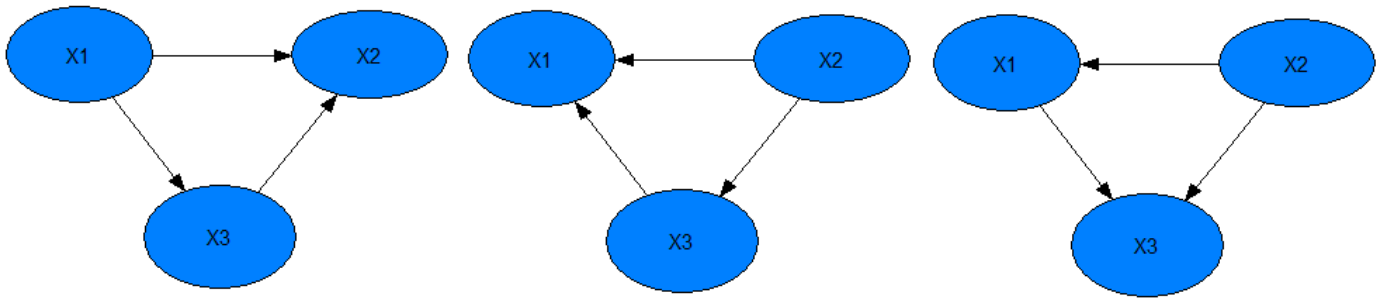
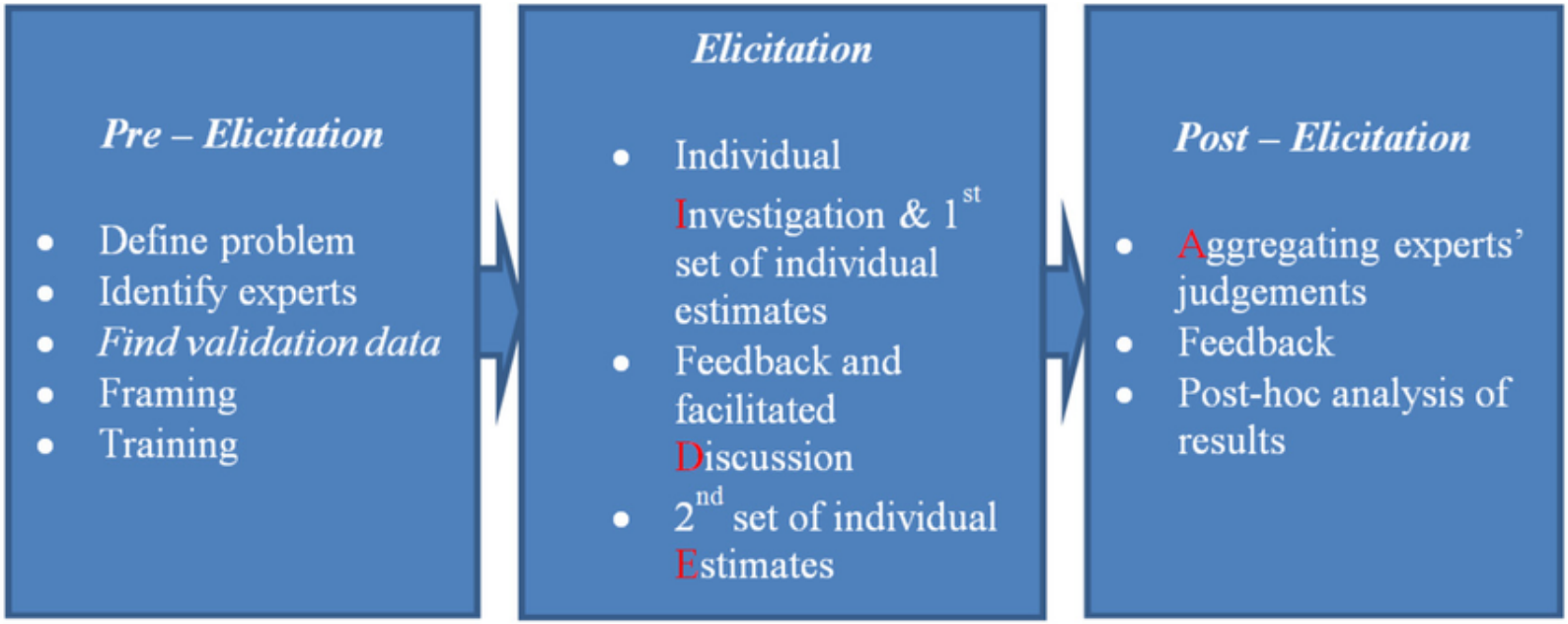




IDEA protocol



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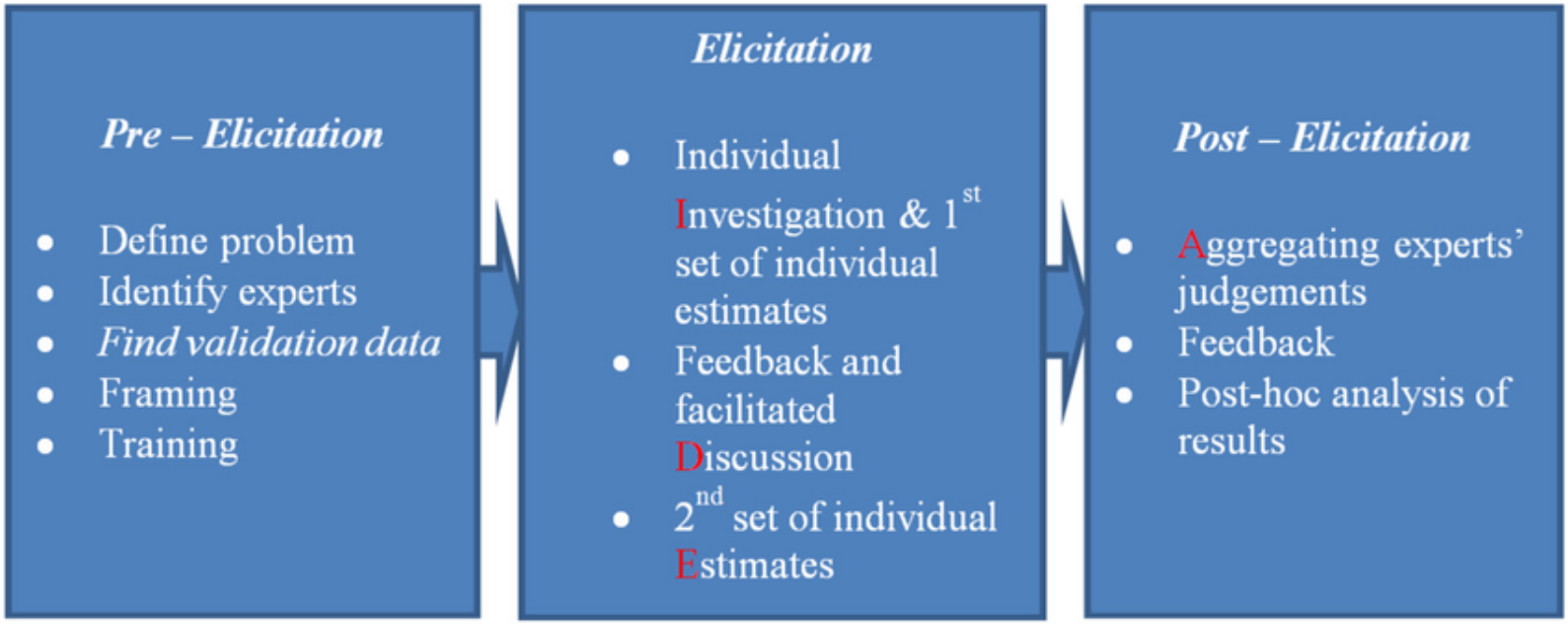

Two rounds of the Classical Model, intermediated by feedback and facilitated discussion

Elicitation results

Round one

Id	Calibr.	Mean relative realization	Normaliz.weight without DM
A	0.01397	1.183	0.0553
B	0.2895	0.5229	0.5067
C	0.06083	0.6187	0.126
D	0.06372	0.7125	0.152
E	0.2895	0.1651	0.16
DM_{perf}	0.4735	0.1377	

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Round two

Id	Calibr.	Mean relative realization	Normalized weight without DM
A	0.04706	0.7362	0.06141
B	0.4735	0.3703	0.3108
C	0.6827	0.3883	0.4699
D	0.06372	0.5211	0.05885
E	0.2895	0.1931	0.09908
DM_{perf}	0.6827	0.1418	

Elicitation results

Influencing factors

EXPERT A	EXPERT B	EXPERT C	EXPERT D	EXPERT E
1. Journal score	1. Journal score	1. pp_int_collab	1. Journal score	1. refs_paper
2. pp_int_collab	2. pp_int_collab	2. Journal score	2. pp_int_collab	2. Journal score
3. Output	3. pp_collab	3. pp_collab	3. pp_collab	3. pp_int_collab

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Conditioning

- Given that the Journal score is at its 95% quantile and the International collaboration score is at its 95% quantile and the Output is at its 95% quantile, what are your estimates for the average citation performance of a researcher?

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2. pp_int_collab	2. pp_int_collab	2. Journal score	2. pp_int_collab	2. Journal score
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Results

Percentile		5%	50%	95%
Round	1.	15.88	28.19	51.91
	2.	8.531	30.61	48.81
Data		7.5	31.1	57.143

Discussion and conclusions

- Regardless the arcs assignment, the conditional distribution of the variable of interest might not change
- Given a particular structure of the BN, the experts can assess conditional distributions of the variable of interest quite accurately
- IDEA can help experts to become more calibrated, with a possible small decrease in information score
- IDEA can increase the performance of the DM

Thank you!