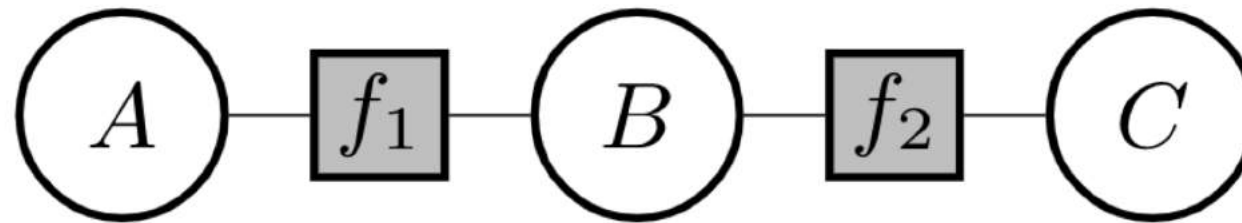


Approximate Knowledge Compilation by Online Collapsed Importance Sampling

Tal Friedman and Guy Van den Broeck

Motivation

Factor Graphs:



Motivation

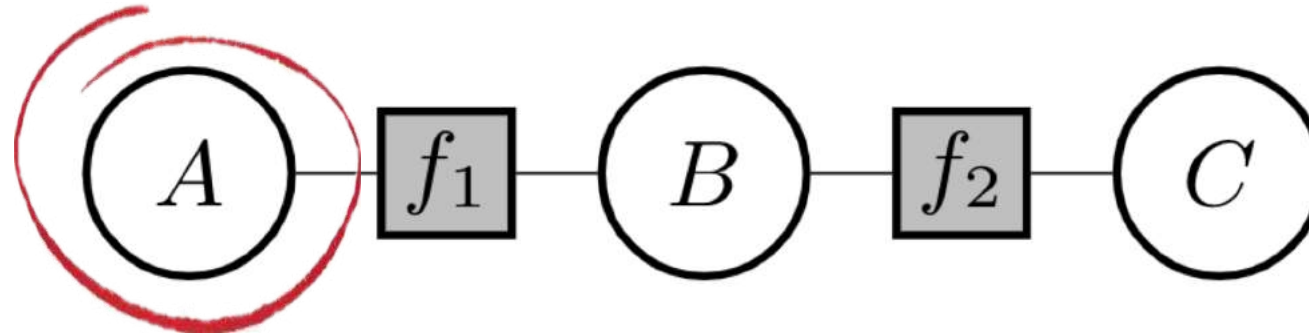
Factor Graphs:



Great! But asking queries is hard

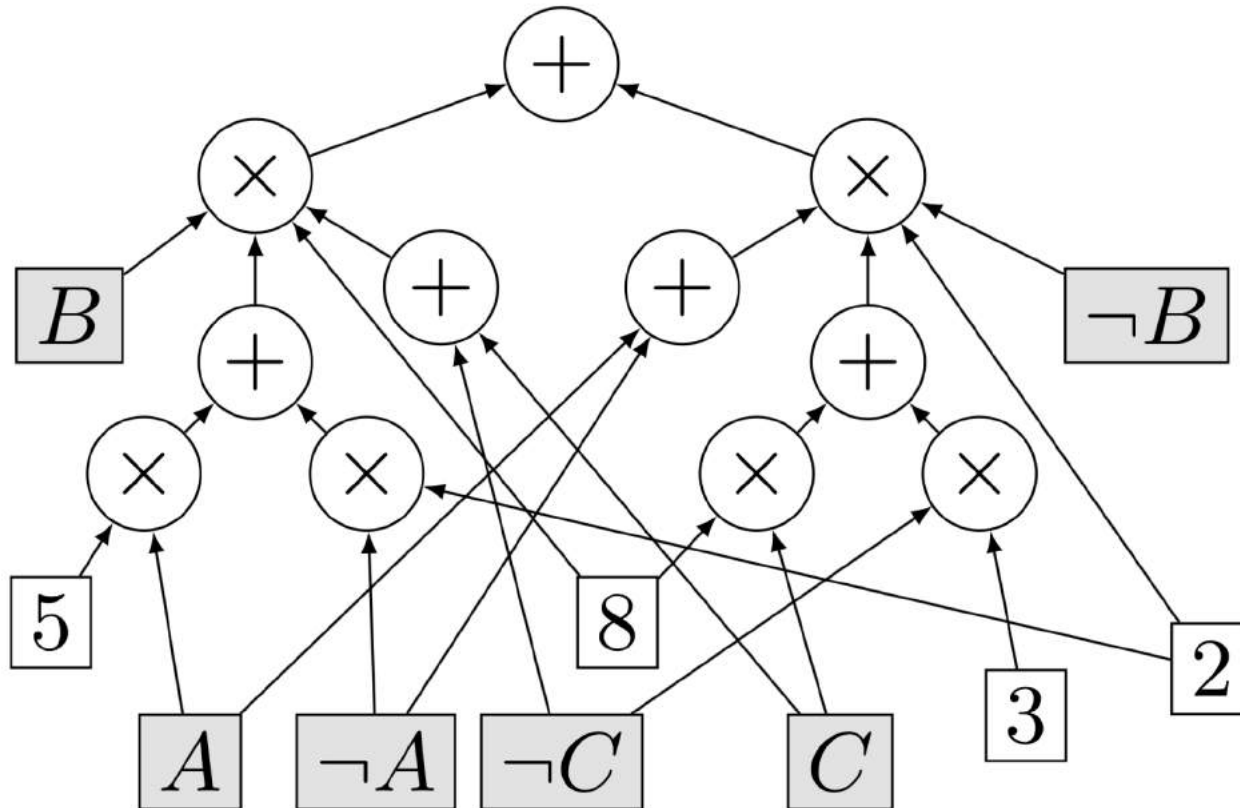
Motivation

Factor Graphs:



Motivation: Arithmetic Circuit

- Exact inference: Use Knowledge Compilation (e.g. BDD, SPN)

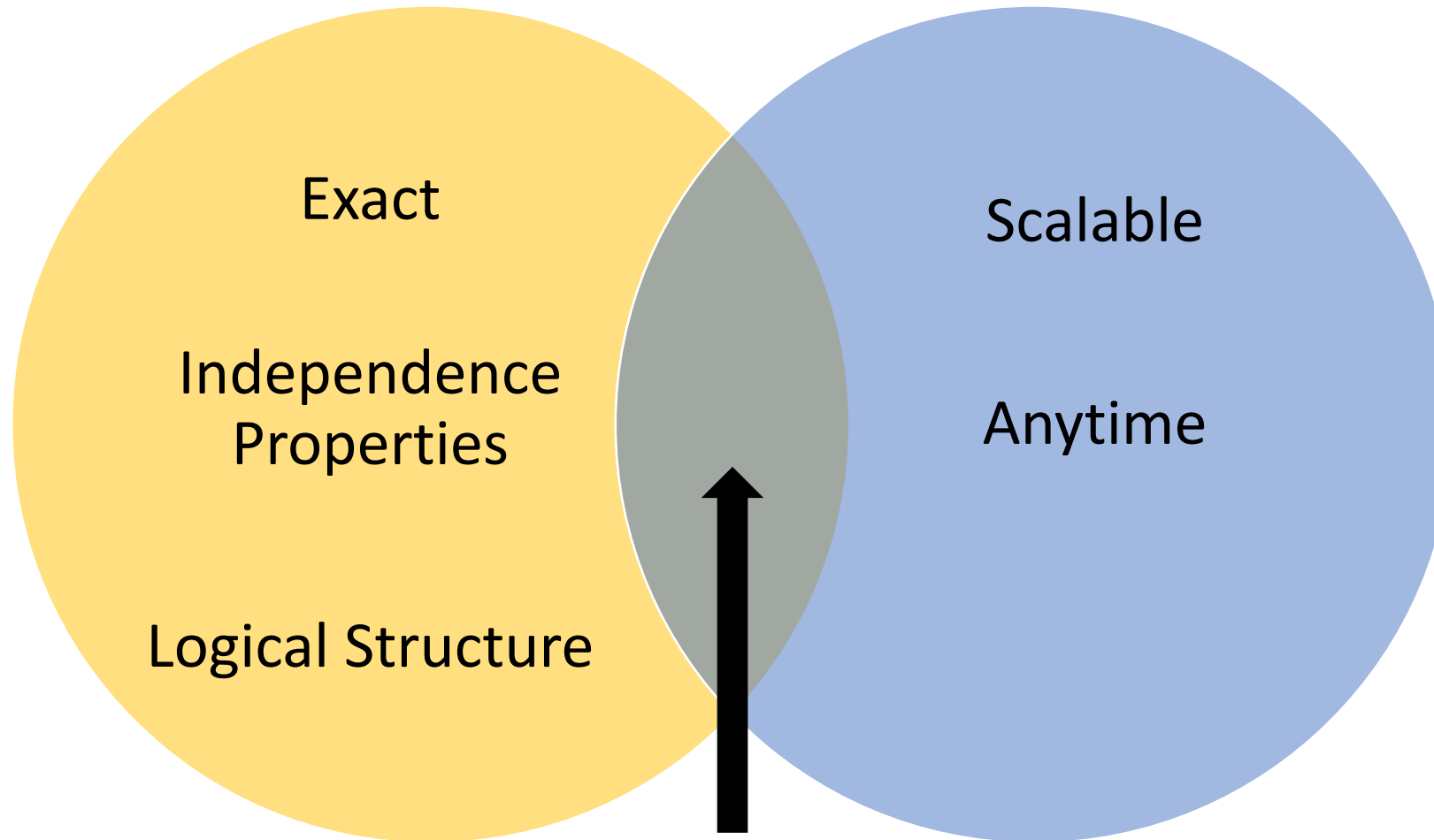


- **Tractable** form: easy queries + operations
- Take advantage of further independence properties, logical structure

*But they don't **scale**!*

Knowledge Compilation

Sampling



This work

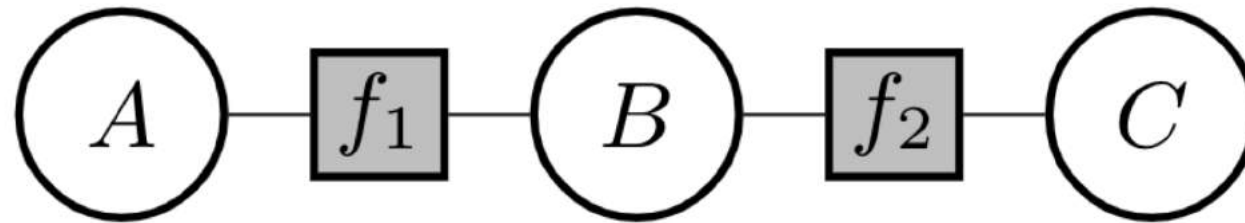
Collapsed Sampling (Rao-Blackwell)



Sampling on some variables, exact inference conditioned on sample

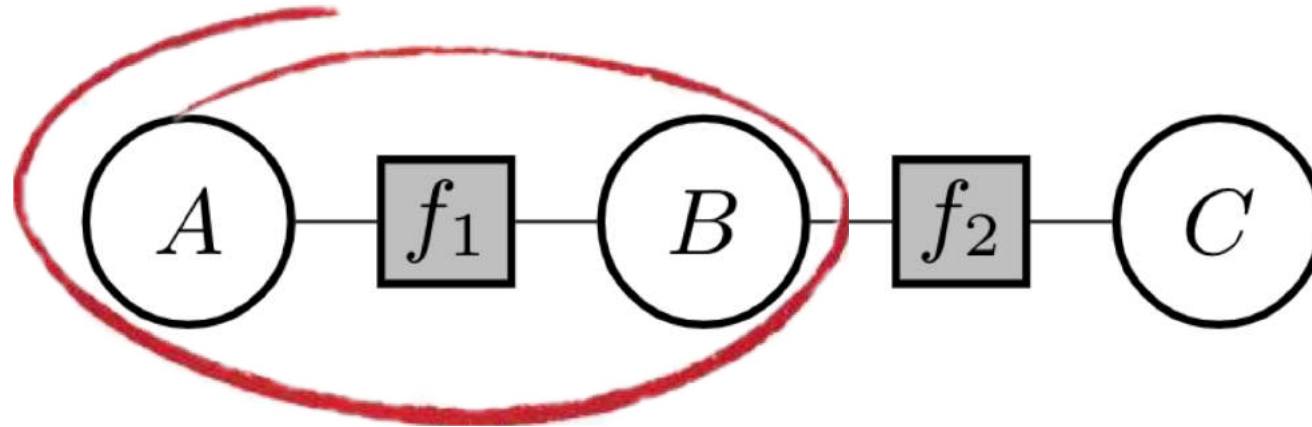
Collapsed Sampling (Rao-Blackwell)

Sampling on some variables, exact inference conditioned on sample



Collapsed Sampling (Rao-Blackwell)

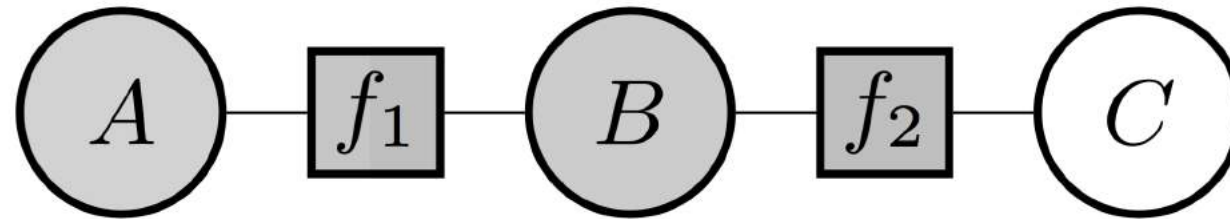
Sampling on some variables, exact inference conditioned on sample



Sample A, B

Collapsed Sampling (Rao-Blackwell)

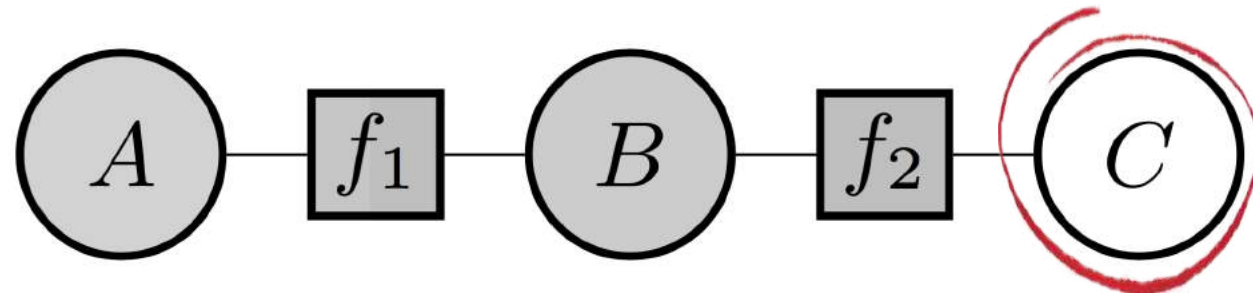
Sampling on some variables, exact inference conditioned on sample



Observe sampled values

Collapsed Sampling (Rao-Blackwell)

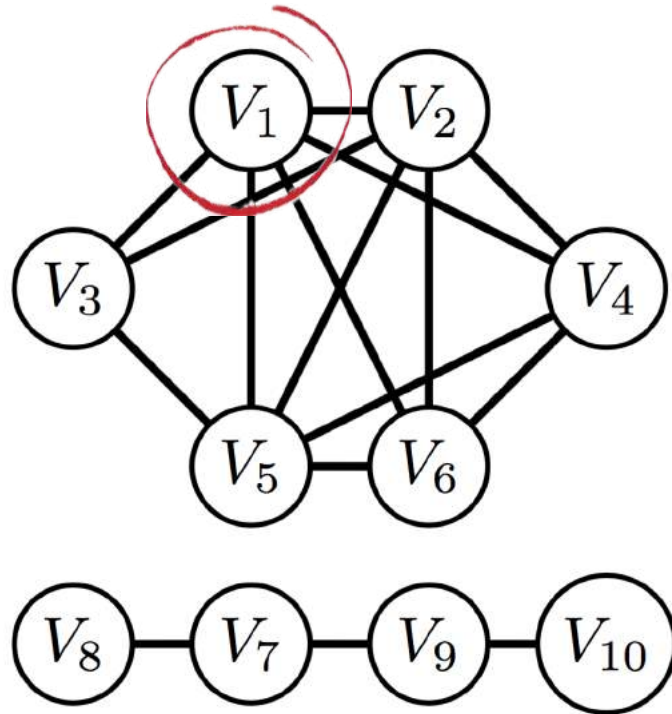
Sampling on some variables, exact inference conditioned on sample



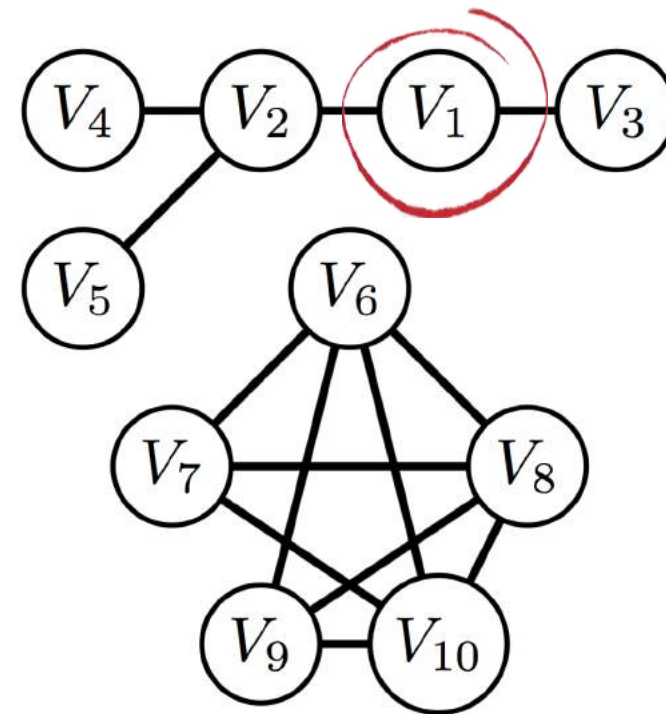
Compute exactly $P(C|A,B)$

What to Sample?

- Is it even possible to pick a correct set a priori?
- Consider a network of potential smokers, with friendships sampled



Sample 1



Sample 2

Online Collapsed Sampling



Choose *on-the-fly* which variable to sample next, based on result of sampling previous variables

Theorem: Still unbiased

How?

1. What/when do we sample?



How?

1. What/when do we sample?
2. How do we sample?



How do we Sample?



- Importance Sampling
- Need a proposal for **any** variable conditioned on **any other** variables

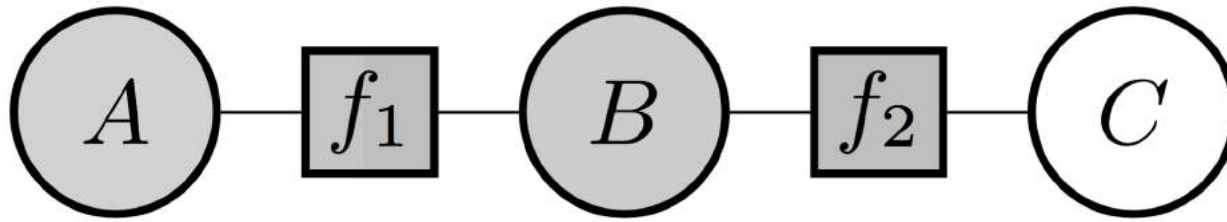
How?

1. What/when do we sample?
2. How do we sample?
3. How do we do exact inference?



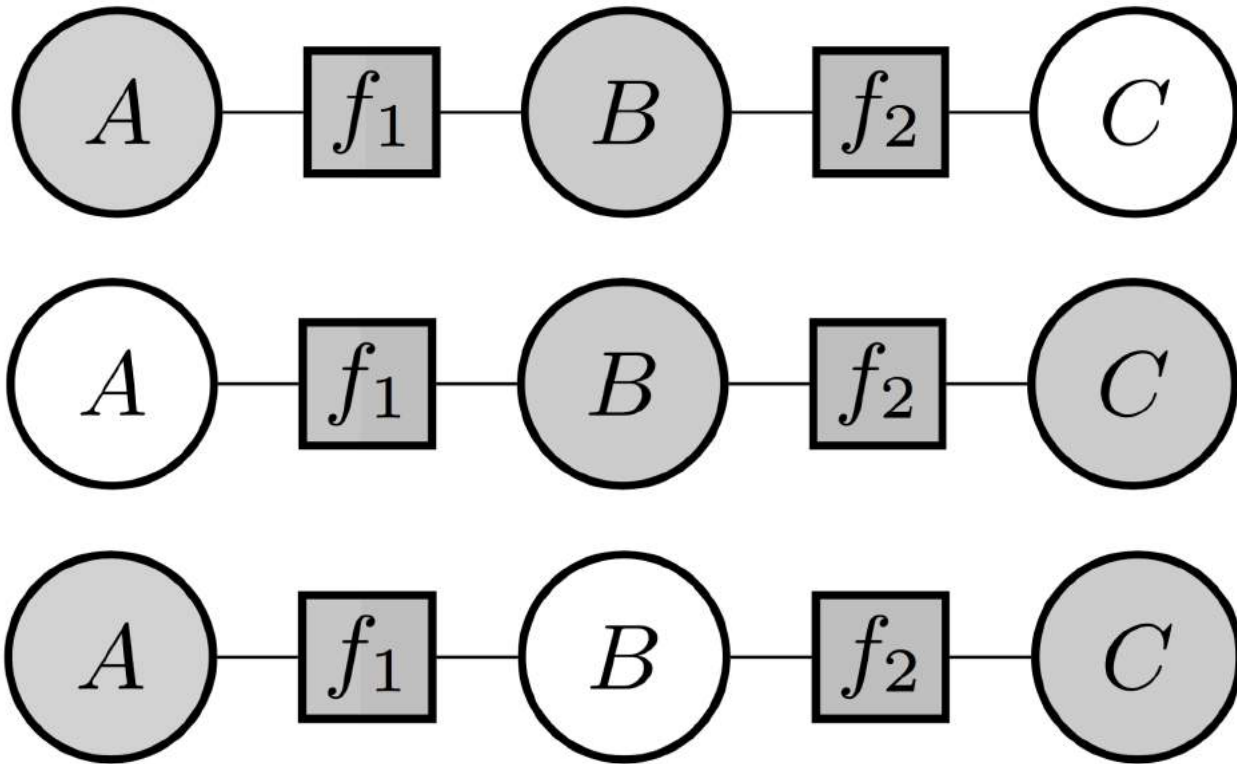
Exact Inference

How do we do exact inference conditioned on different variables?

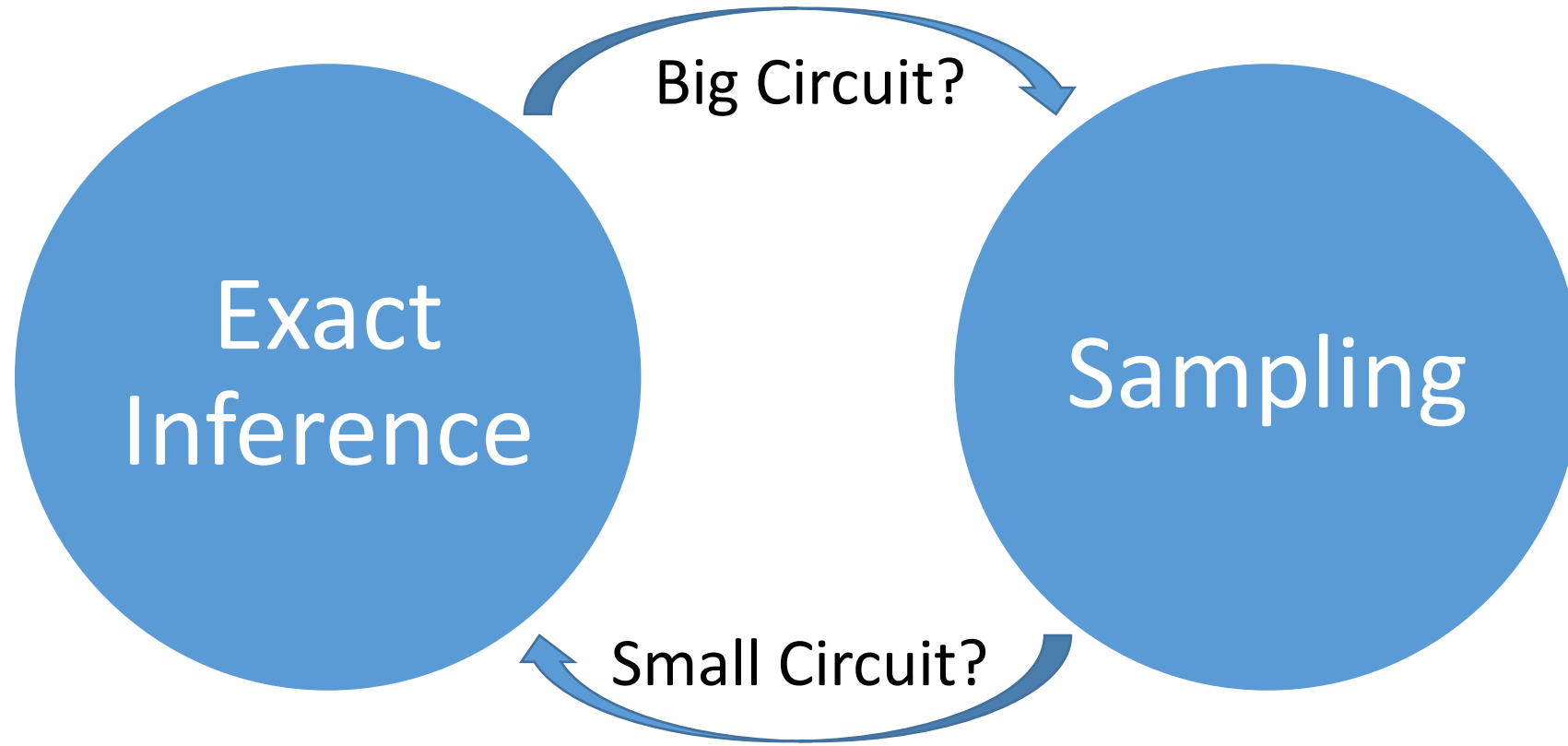


Exact Inference

- How do we do exact inference conditioned on different variables?

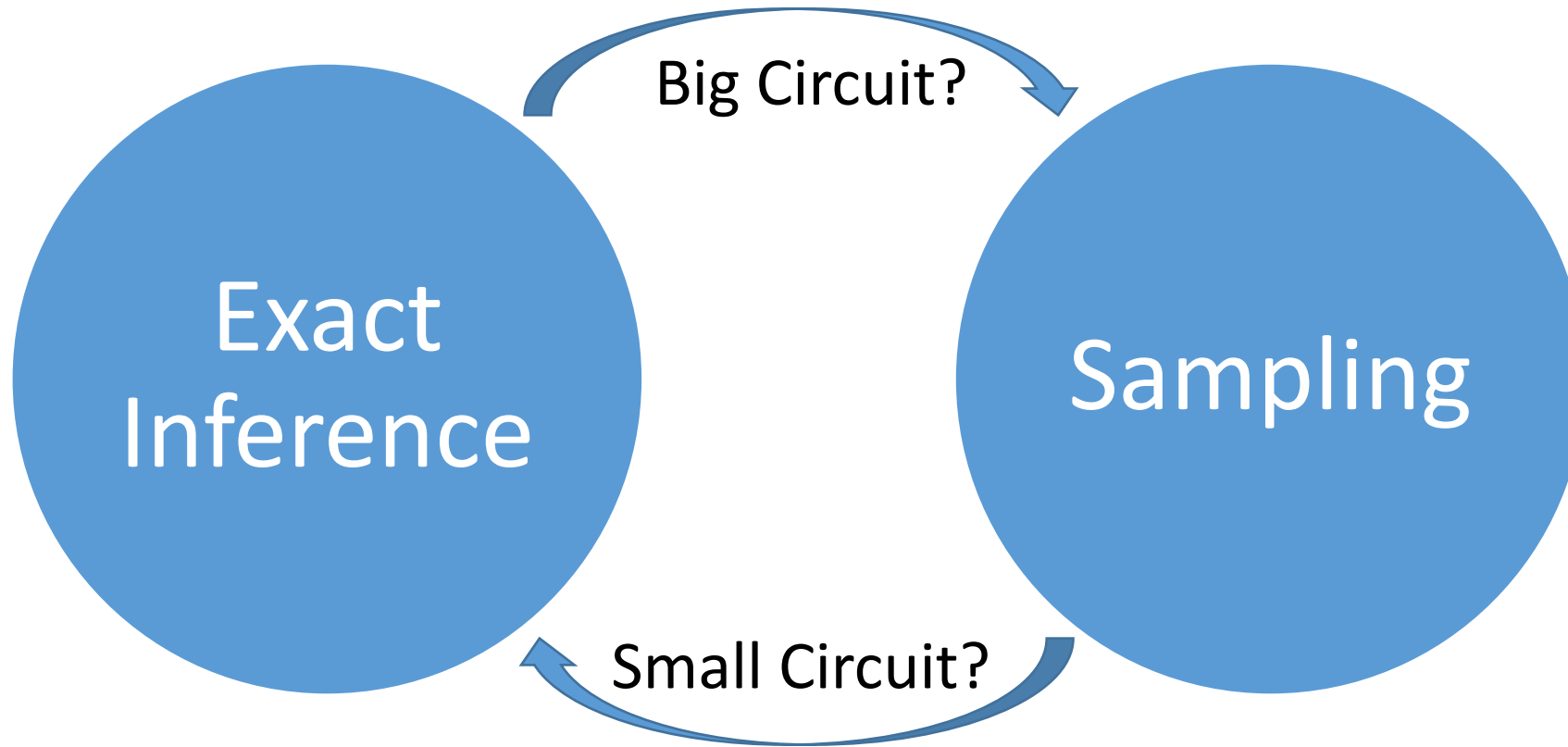


Collapsed Compilation



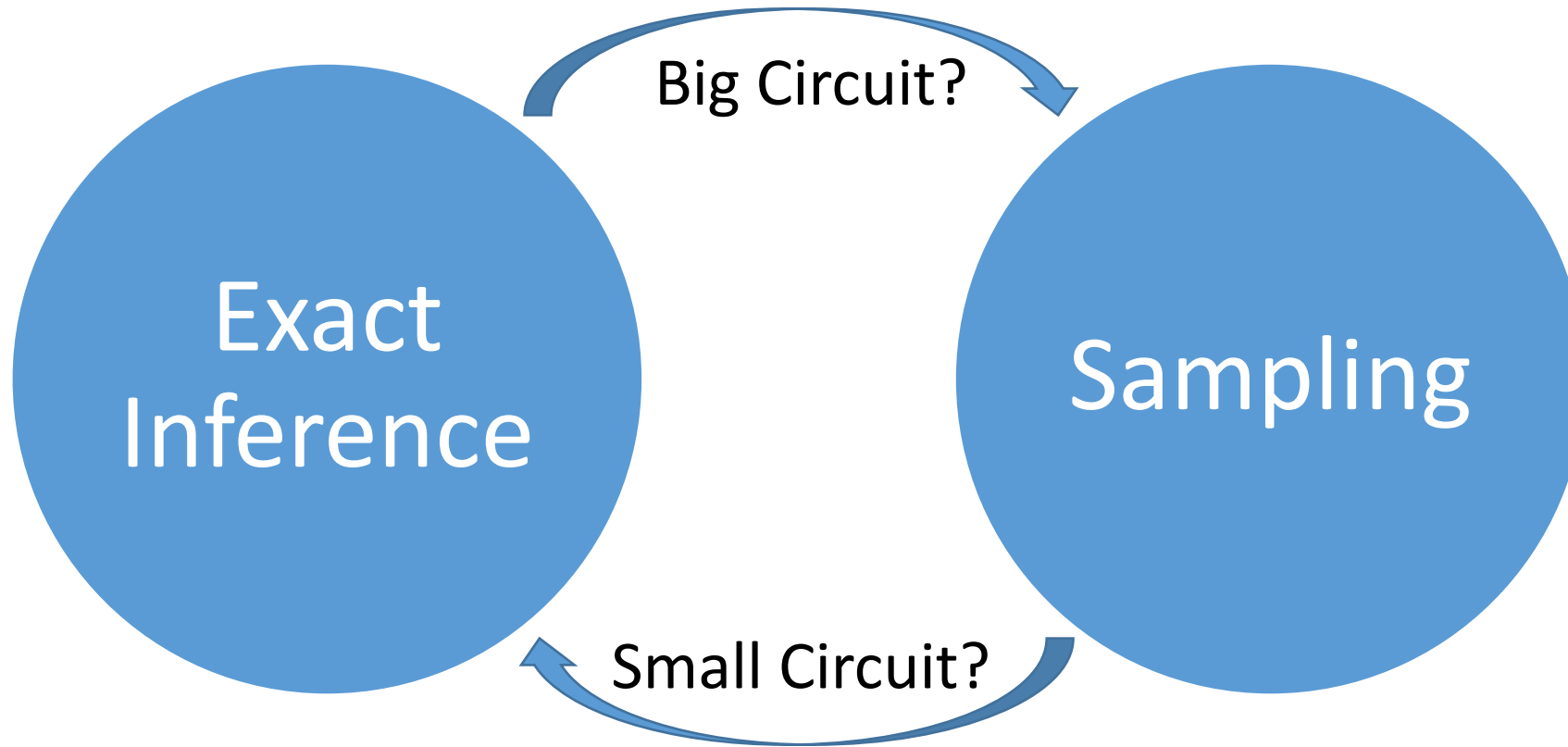
Result: A circuit for factor graph with some sampled variables

Collapsed Compilation



1. What/when do we sample?
2. How do we sample?
3. How do we do exact inference?

Collapsed Compilation



1. **What/when do we sample?**
2. How do we sample?
3. How do we do exact inference?

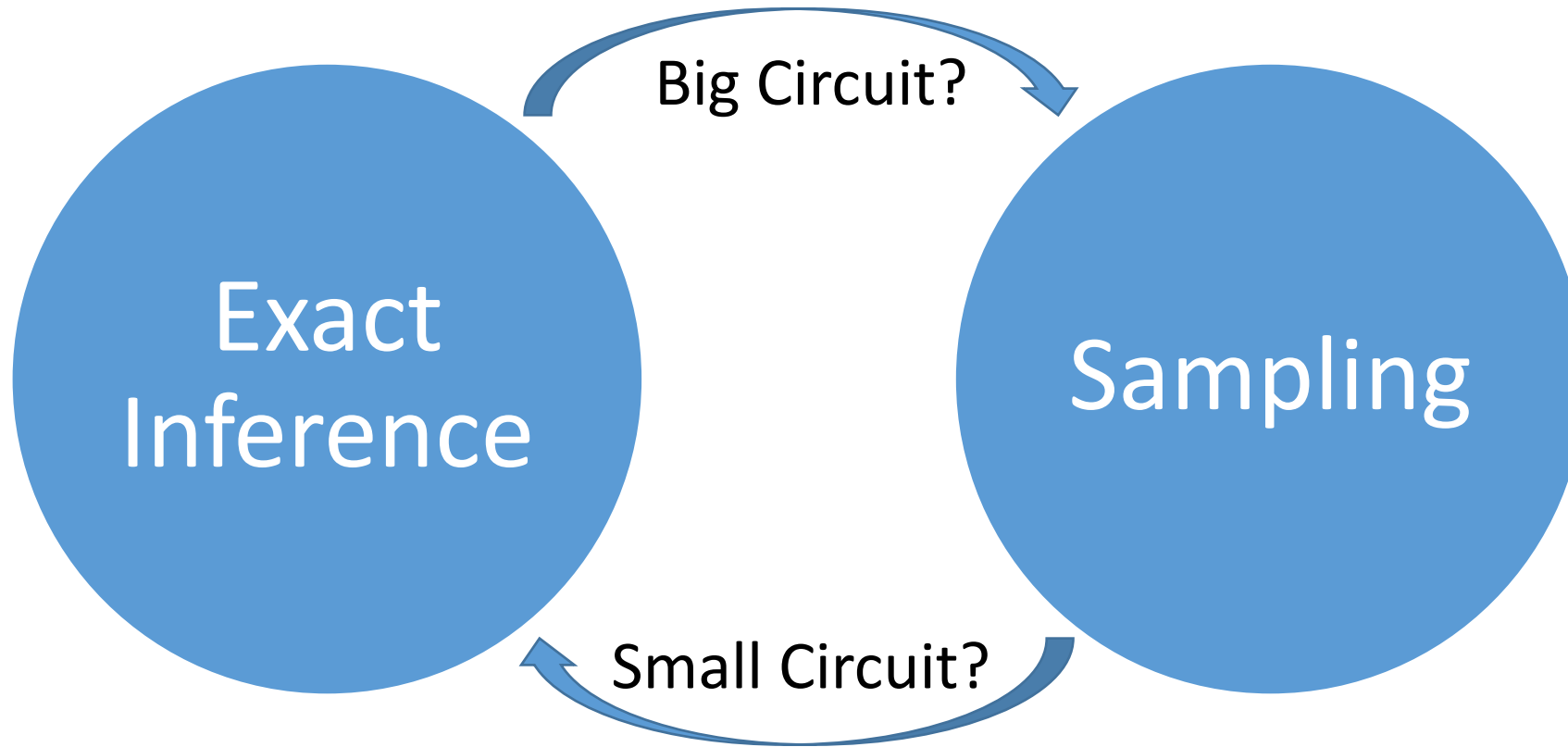
What/when do we sample?



When: Circuit too big

What: Heuristic on current circuit

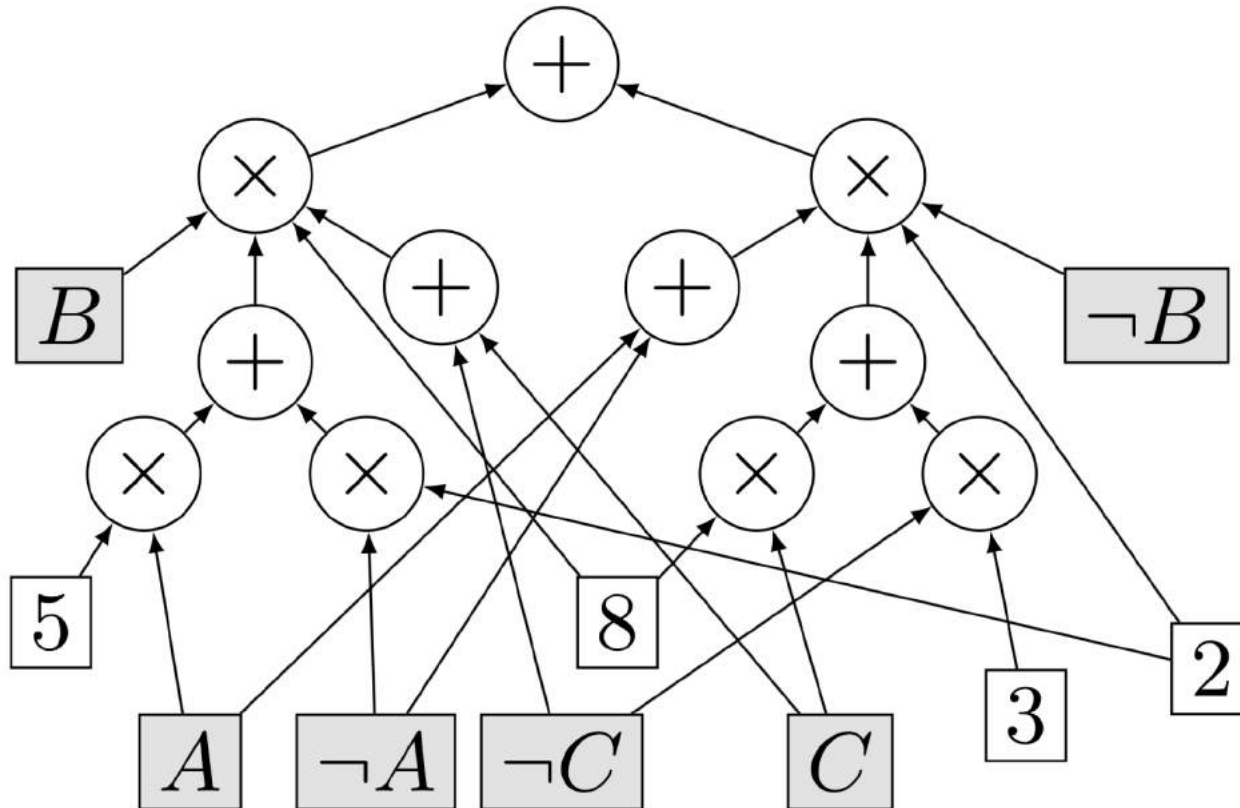
Collapsed Compilation



1. What/when do we sample?
2. **How do we sample?**
3. How do we do exact inference?

Motivation: Arithmetic Circuit

- Exact inference: Use Knowledge Compilation (e.g. BDD, SPN)



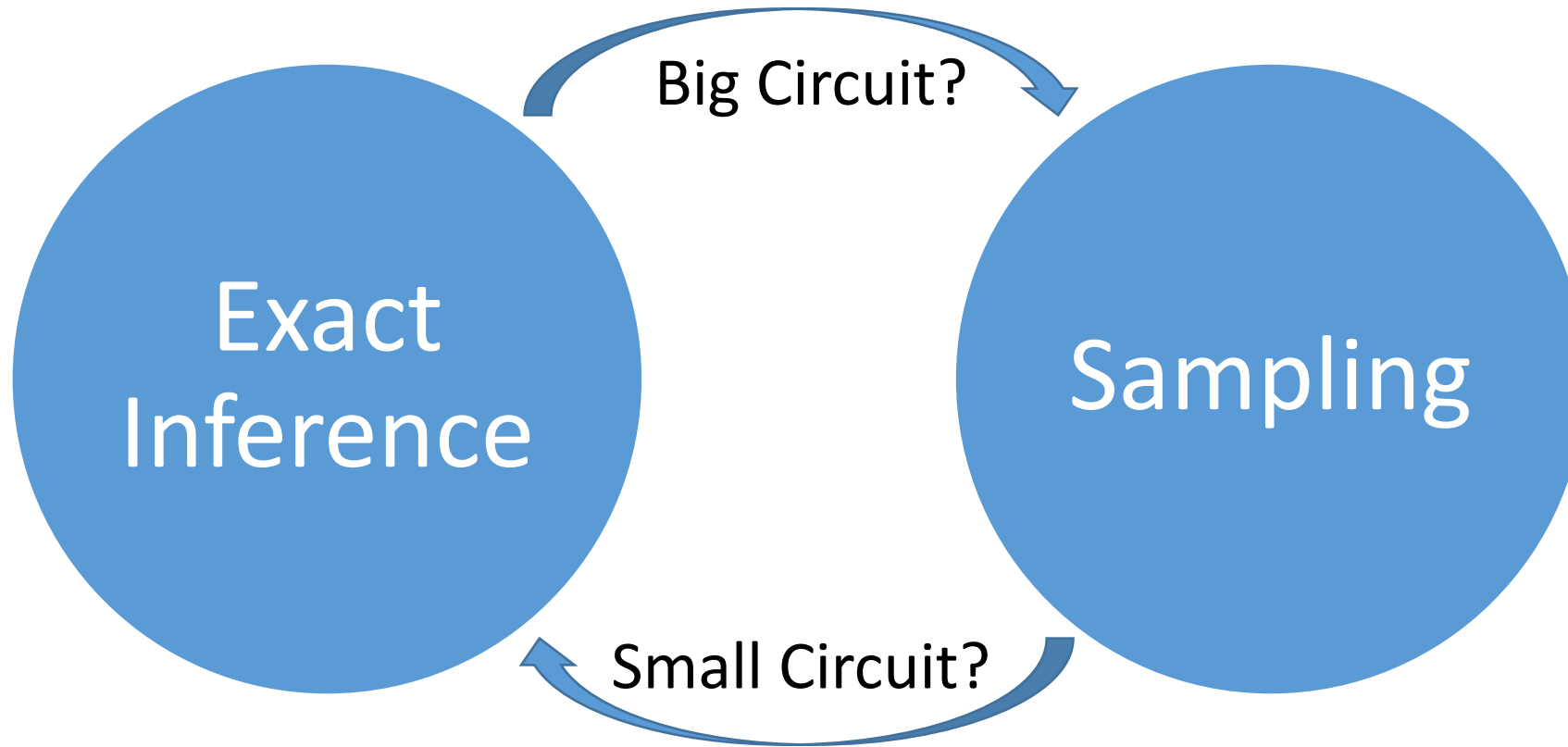
- Tractable** form: easy queries + operations
- Take advantage of further independence properties, logical structure

How do we sample?



Compute the marginal of the variable in the current circuit!

Collapsed Compilation



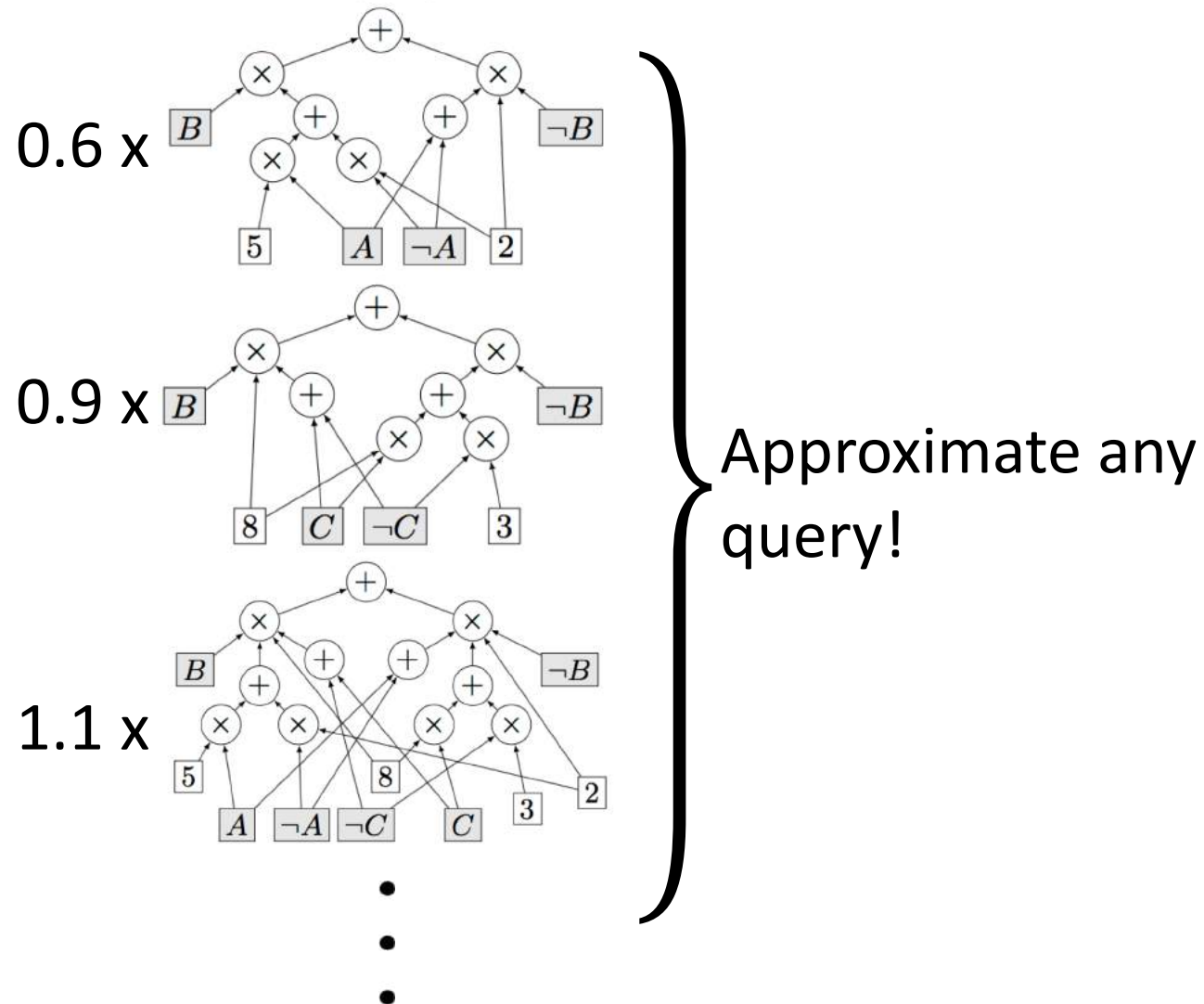
1. What/when do we sample?
2. How do we sample?
3. **How do we do exact inference?**

Conditional Exact Inference



Result is a circuit: **any** joint can be computed efficiently & exactly

Online Collapsed Importance Sampling



Experiments

- Approximate marginal in factor graph
- Algorithmically limit exact inference

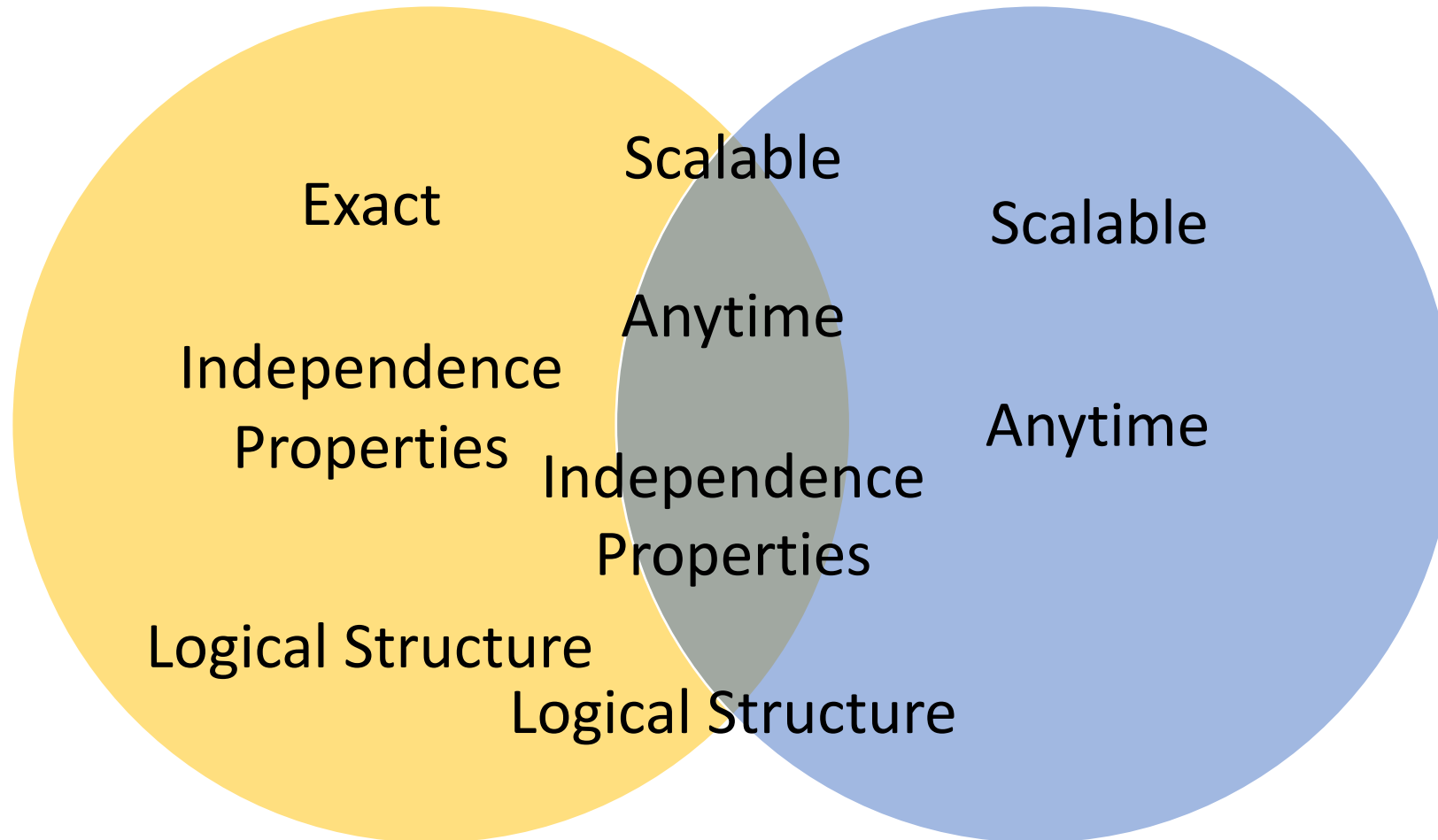


Experiments

Table 2: Hellinger distances across methods with internal treewidth and size bounds

Method	50-20	75-26	DBN	Grids	Segment	linkage	frust
EDBP-100k	$2.19\text{e-}3$	$3.17\text{e-}5$	$6.39\text{e-}1$	$1.24\text{e-}3$	$1.63\text{e-}6$	$6.54\text{e-}8$	$4.73\text{e-}3$
EDBP-1m	$7.40\text{e-}7$	$2.21\text{e-}4$	$6.39\text{e-}1$	$1.98\text{e-}7$	$1.93\text{e-}7$	$5.98\text{e-}8$	$4.73\text{e-}3$
SS-10	$2.51\text{e-}2$	$2.22\text{e-}3$	$6.37\text{e-}1$	$3.10\text{e-}1$	$3.11\text{e-}7$	$4.93\text{e-}2$	$1.05\text{e-}2$
SS-12	$6.96\text{e-}3$	$1.02\text{e-}3$	$6.27\text{e-}1$	$2.48\text{e-}1$	$3.11\text{e-}7$	$1.10\text{e-}3$	$5.27\text{e-}4$
SS-15	$9.09\text{e-}6$	$1.09\text{e-}4$	(Exact)	$8.74\text{e-}4$	$3.11\text{e-}7$	$4.06\text{e-}6$	$6.23\text{e-}3$
FD	$9.77\text{e-}6$	$1.87\text{e-}3$	$1.24\text{e-}1$	$1.98\text{e-}4$	$6.00\text{e-}8$	$5.99\text{e-}6$	$5.96\text{e-}6$
MinEnt	$1.50\text{e-}5$	$3.29\text{e-}2$	$1.83\text{e-}2$	$3.61\text{e-}3$	$3.40\text{e-}7$	$6.16\text{e-}5$	$3.10\text{e-}2$
RBVar	$2.66\text{e-}2$	$4.39\text{e-}1$	$6.27\text{e-}3$	$1.20\text{e-}1$	$3.01\text{e-}7$	$2.02\text{e-}2$	$2.30\text{e-}3$

Knowledge Compilation



Thanks!

Poster: Room 210 #5

Code: github.com/UCLA-StarAI/Collapsed-Compilation