Variational Inference over Combinatorial Spaces

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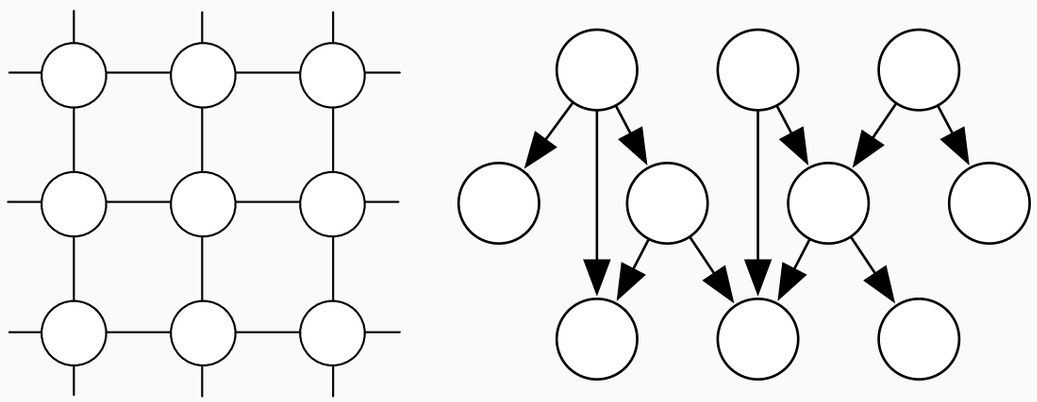
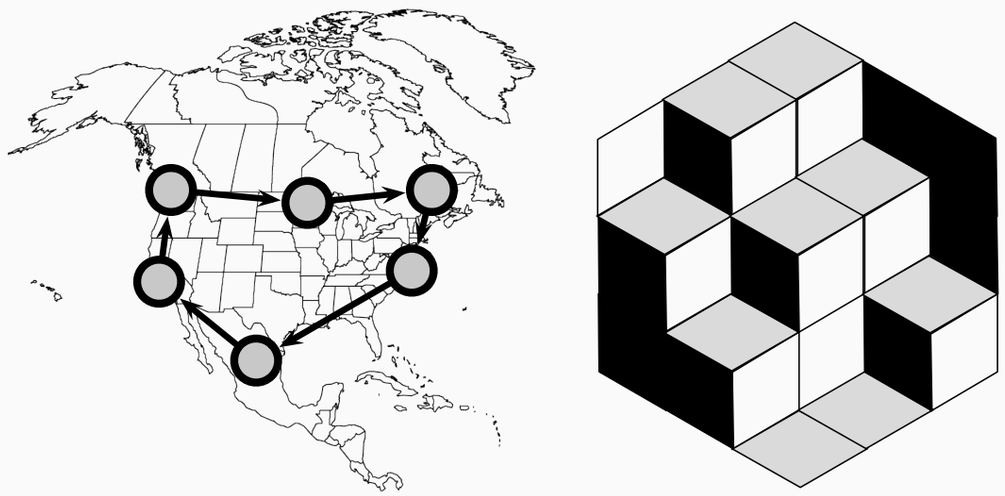
Hard inference problems

$$Z_\theta = \sum_x \underbrace{\exp\langle T(x), \theta\rangle}_{f_\theta(x)} \quad \mathbf{1}[x \in S]$$

Large treewidth



Combinatorial space S



Approximation	Inferential Situation	
	Large Treewidth	**Combinatorial Space**
MCMC	Gibbs	Metropolis-Hastings
Variational	Message passing, Structured mean field	*Measure factorization*

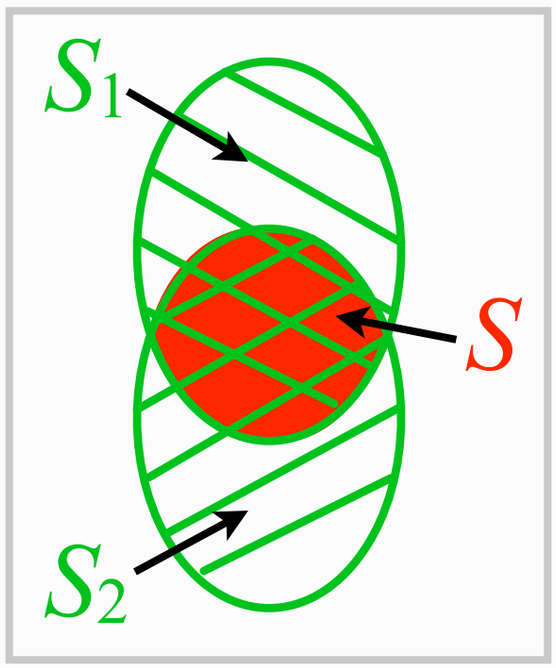
Goal:

$$Z = \sum_{x \in S} f(x) \qquad \text{(intractable)}$$

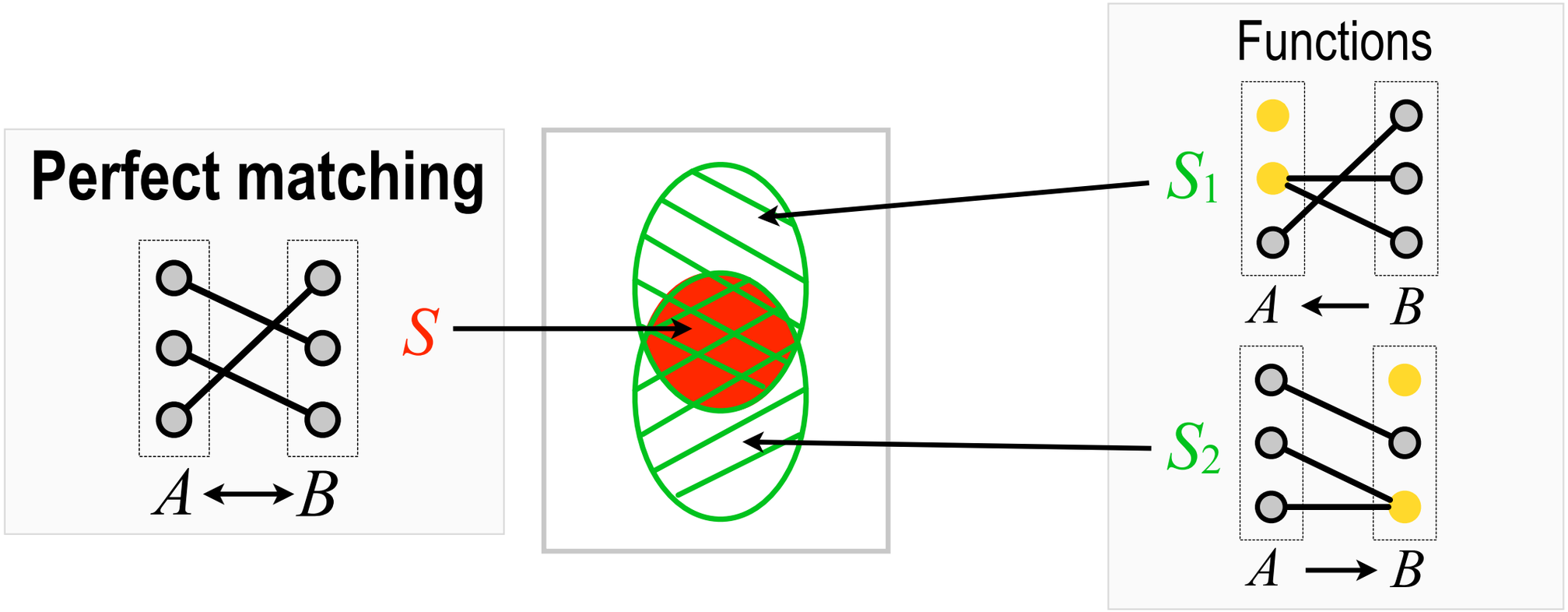
Assumption:

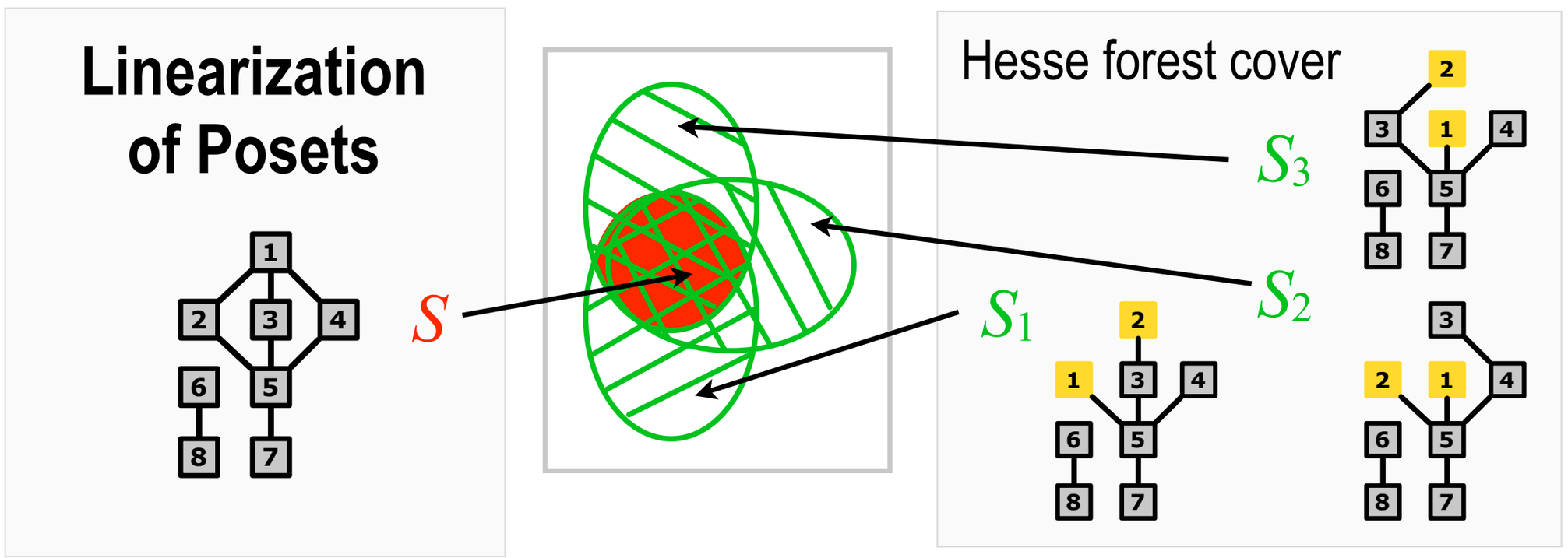
$$S = \bigcap S_i \qquad \text{such that:}$$

$$Z_i = \sum_{x \in S_i} f(x) \qquad \text{is tractable}$$



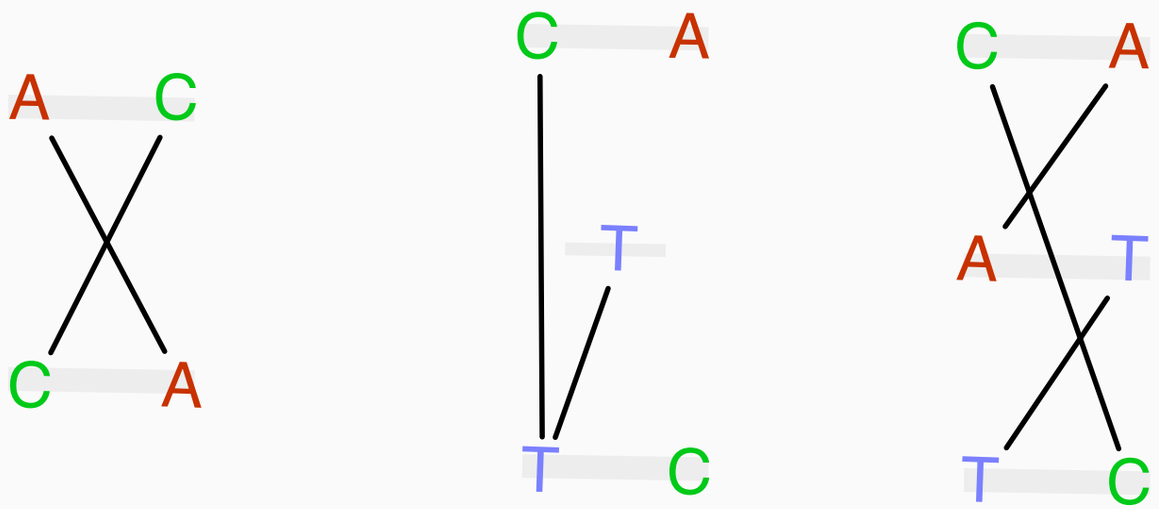
Examples of measure factorization





Application: Multiple Sequence Alignment

Types of constraints



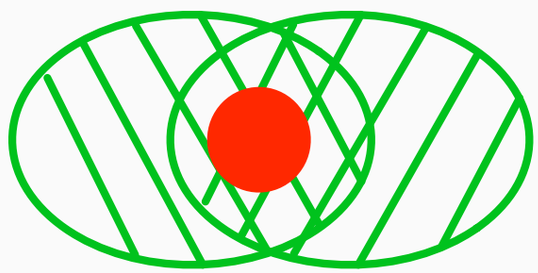
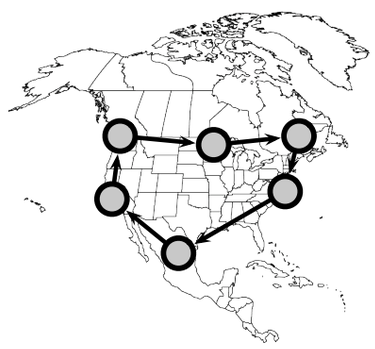
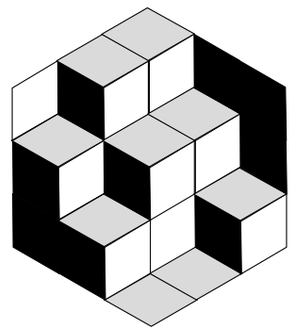
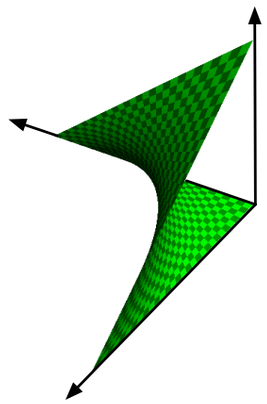
Monotonicity

Transitivity

Poset structure

Generalized setup

$$S \subset \bigcap S_i$$



At our poster: algorithms, analysis, more examples