Soft Constraints for Optimisation

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Oxford Configuration Workshop
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Motto

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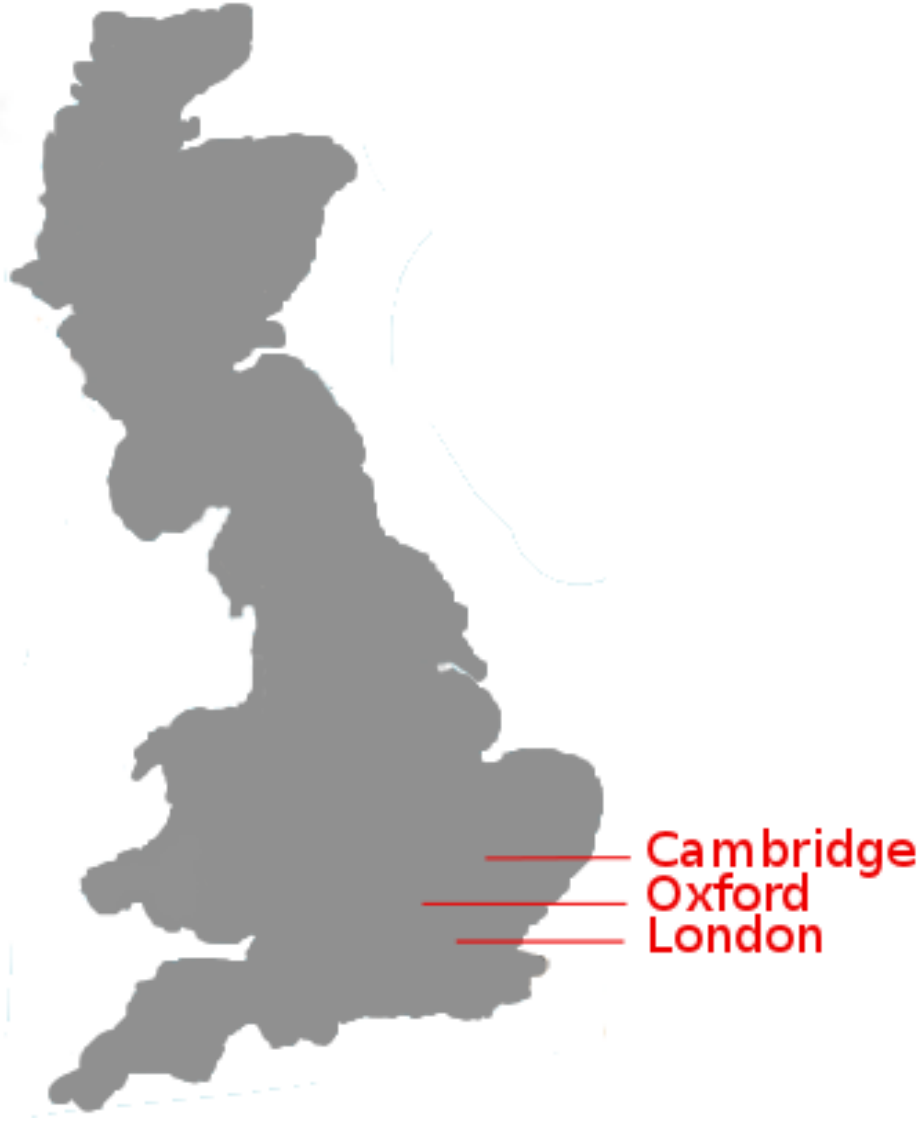
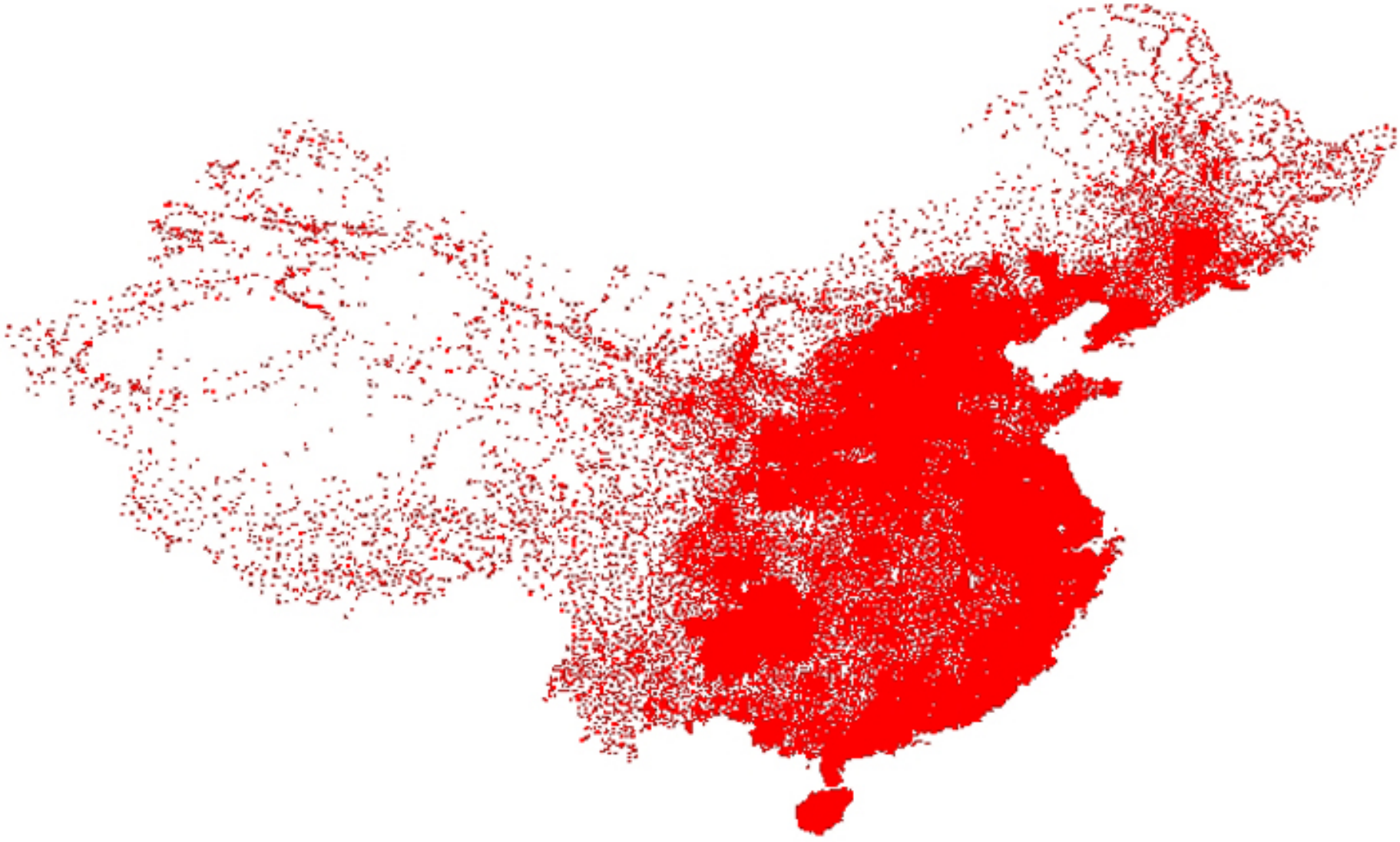
Interesting problems are hard!

Optimal Tour around London



Optimal Tour around China?



Almost Optimal Tour around China!

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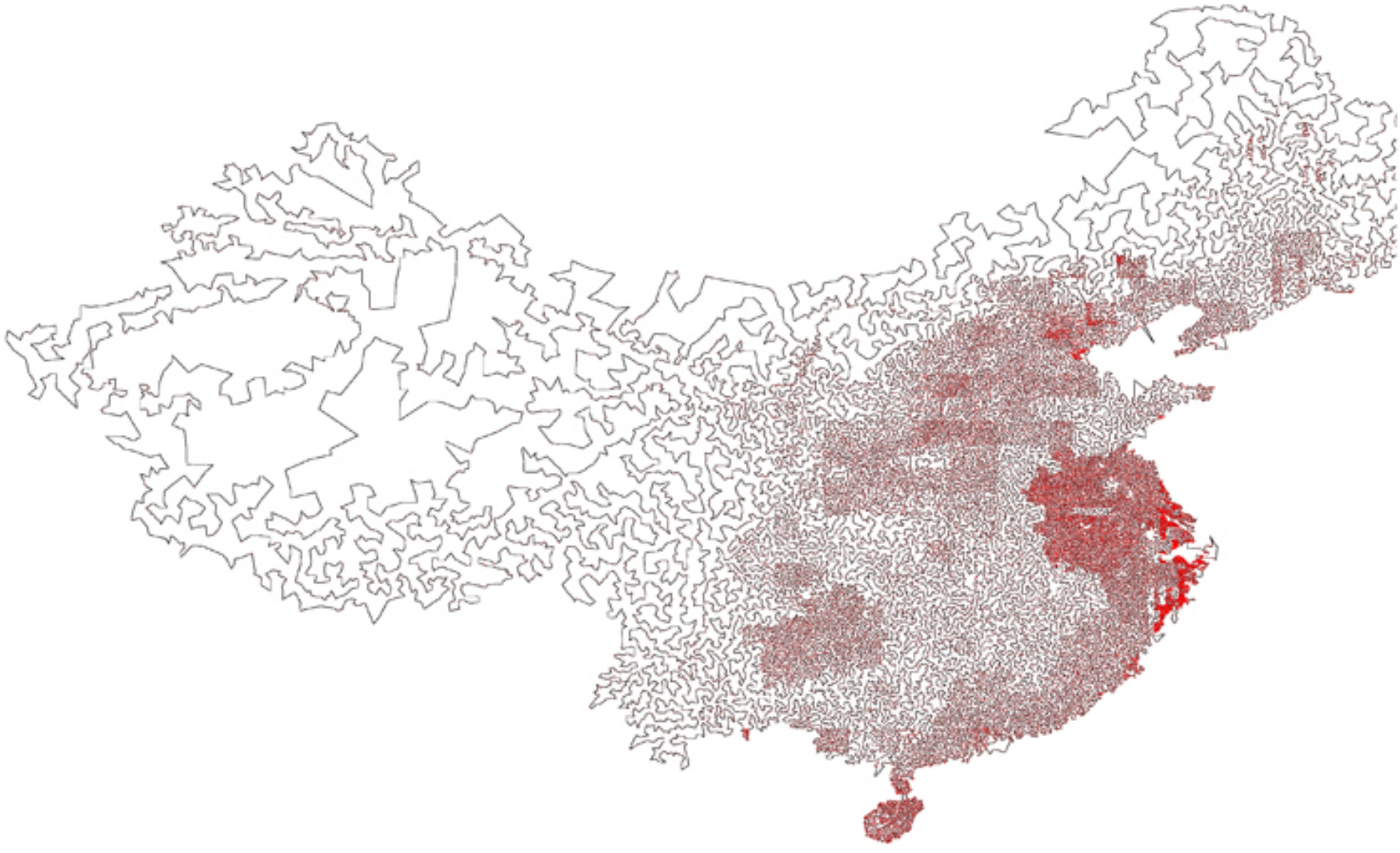

How to Cope with Hardness?

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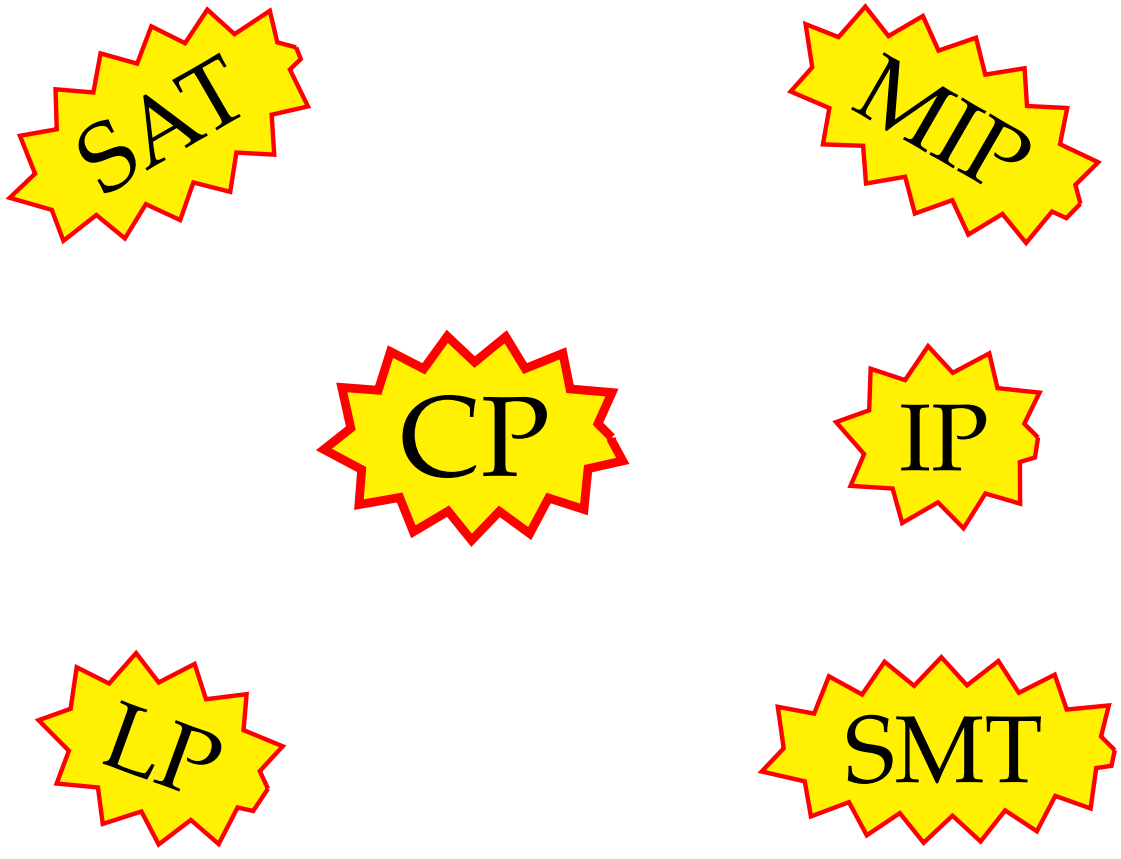

Decision vs Optimisation

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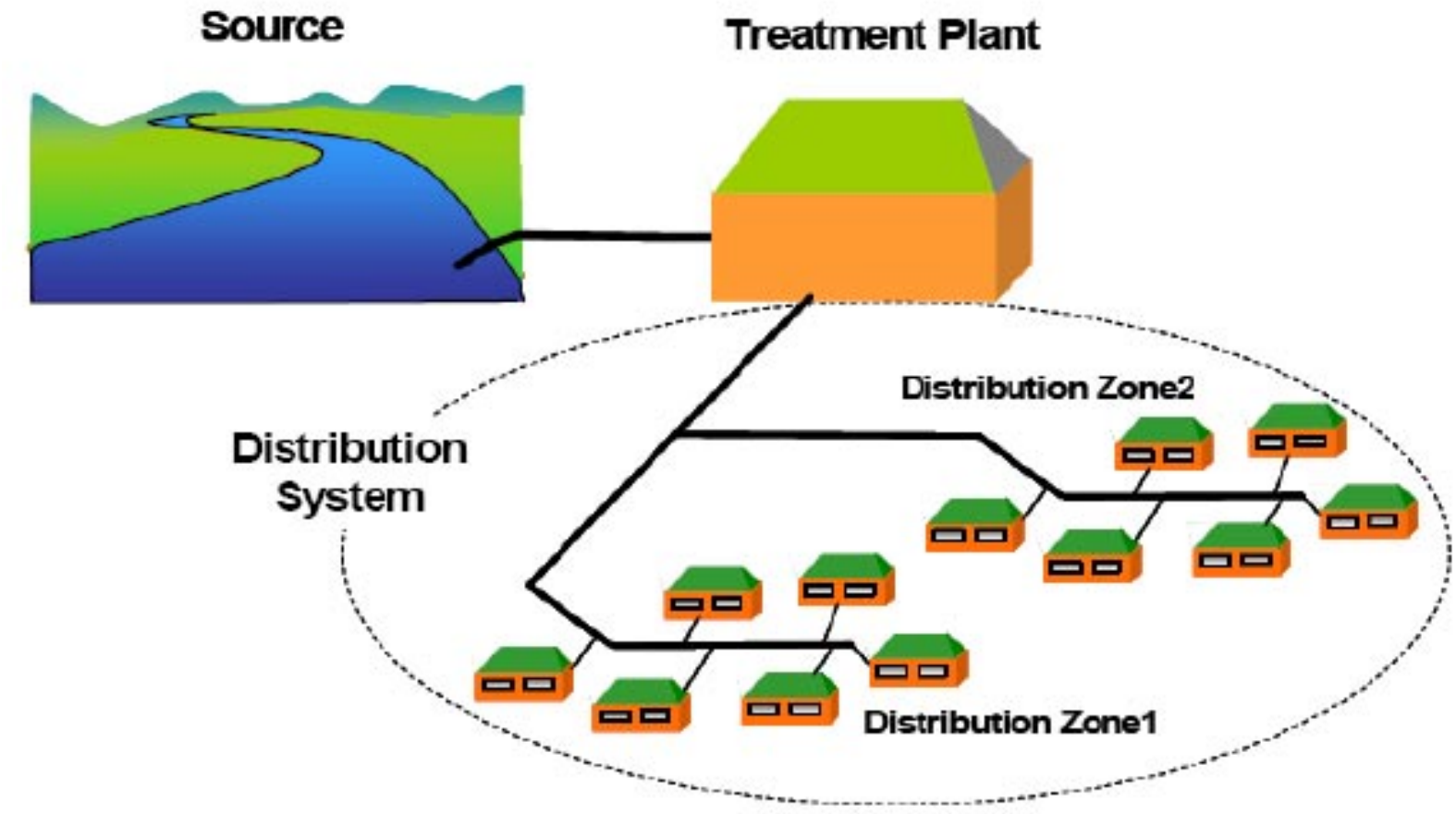
CP deals with decision problems.

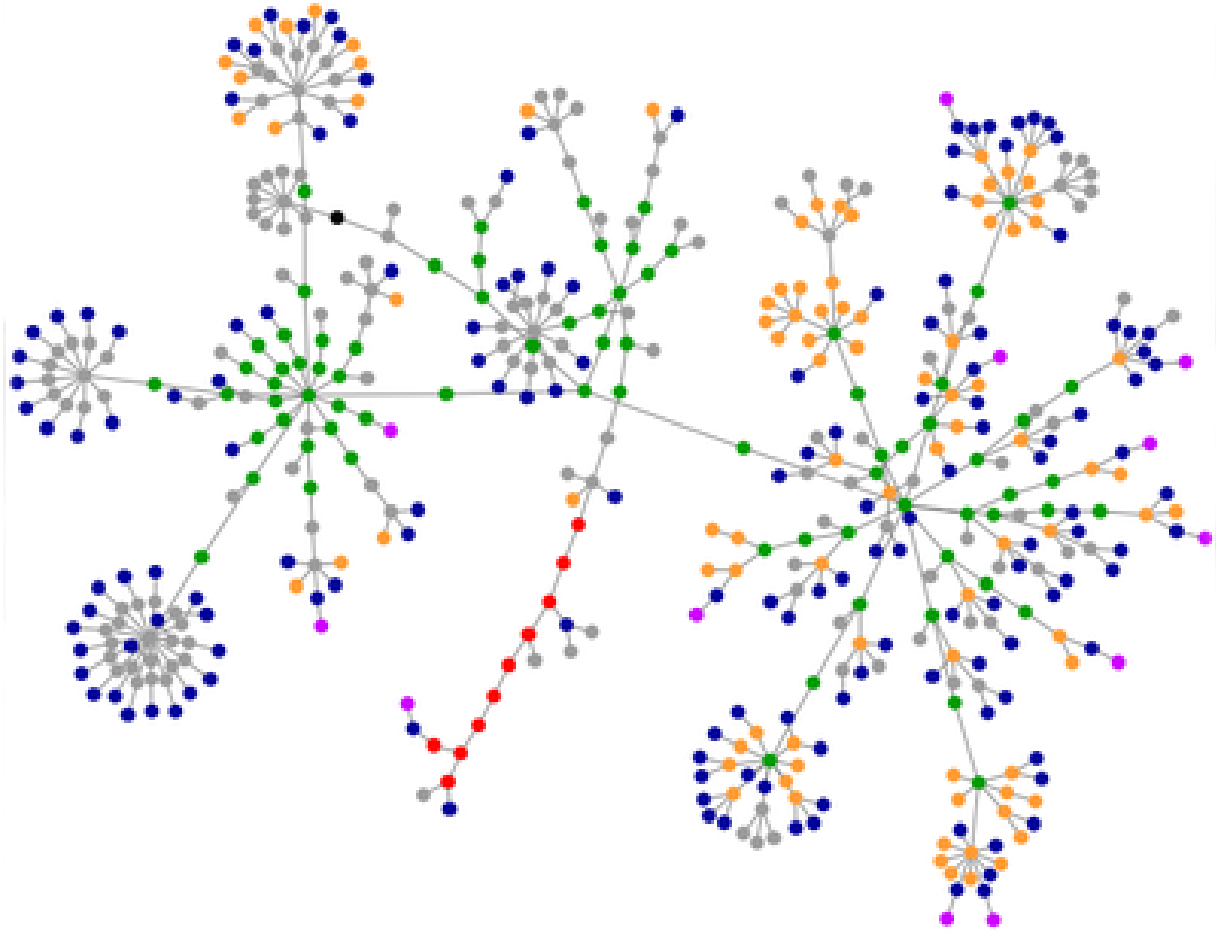
Many problems involve optimisation!

Example 1: Sustainability



Where to place sensors to quickly detect contamination in water distribution networks?

Example 2: Blogs



Which blogs on the Web do you read to learn about the biggest stories and yet read only few?

Soft Constraints

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$$\text{Constraint} \quad f : D^k \rightarrow \{0, \infty\}$$

Soft Constraints

Constraint $\quad f : D^k \rightarrow \{0, \infty\}$

$D = \{0, 1\}$
$k = 3$

$\mathbf{t}$	$f(\mathbf{t})$
000	0
001	∞
010	0
011	0
100	∞
101	∞
110	0
111	0

Soft Constraints

$$\text{Constraint} \quad f : D^k \longrightarrow \{0, \infty\}$$
$$\text{Soft Constraint} \quad f : D^k \longrightarrow \{0, \infty\} \cup \mathbb{Q}_+$$

$D = \{0, 1\}$
$k = 3$

$\mathbf{t}$	$f(\mathbf{t})$
000	1
001	30
010	0
011	0.2
100	∞
101	∞
110	4
111	$\frac{3}{2}$

Soft Constraints

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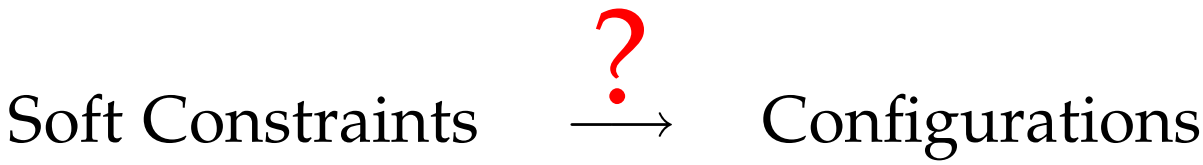
Goal: to minimise the sum of all soft constraints

Configurations



Area 1: Algebraic Theory

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Algebraic theory of complexity for soft CSPs parametrised by the set of allowed constraint types [MFCS'11].

Classification of Boolean soft CSPs [CP'11].

Area 2: Conservative Soft CSPs

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Hardness technique for studying certain classes of soft CSPs.

Classification of conservative soft CSPs [SODA'12].

(including all unary constraints $u : D \to \{0, 1\}$)

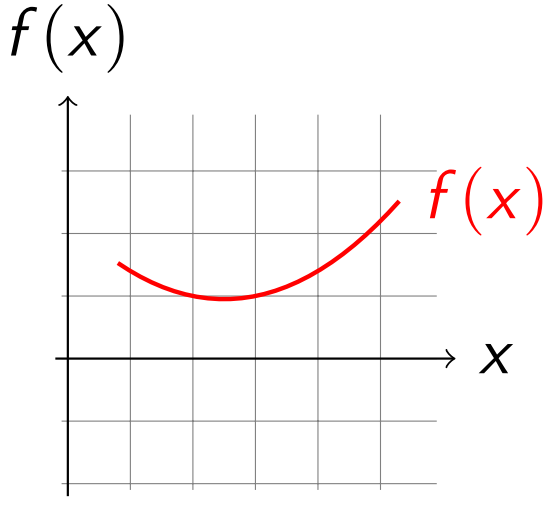
Area 3: Expressibility

Usefulness of a constraint system via what it can express.

Expressibility of various soft CSPs [CP'07,TCS'08,IPL'09].

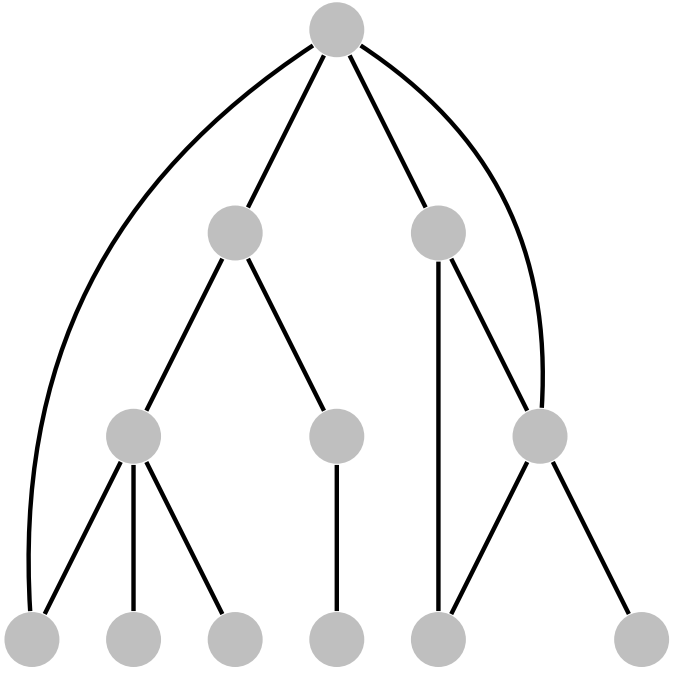
Area 4: Submodularity

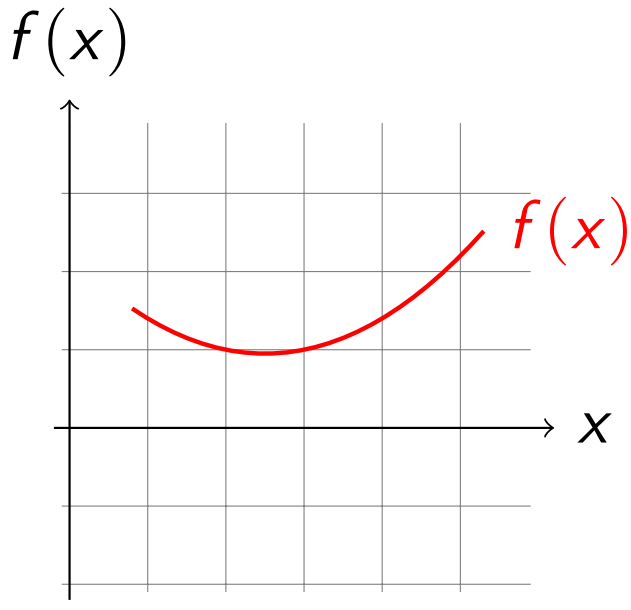
Exploiting submodularity.



Which submodular soft CSPs are solvable by min-cut max-flow [CP'08,MFCS'09,DAM'09,Constraints'10]?

Area 5: Hybrid Soft CSPs





Tractable soft CSPs without a tree-like structure or a condition on soft constraints [CP'10,AIJ'10,CP'11].

Summary

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Could these be useful to configurations?

1. algebraic techniques
2. conservativity
3. notion of expressibility
4. submodularity
5. hybrid tractability

Thank you

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Questions?

(now or over dinner @ Balliol College)

`http://zivny.cz/`