

POCOCOP

POLYNOMIAL-TIME COMPUTATION:
OPENING THE BLACKBOXES IN CONSTRAINT PROBLEMS



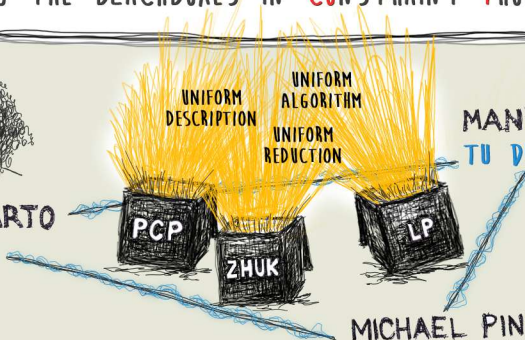
MANUEL BODIRSKY
TU DRESDEN



MICHAEL PINSKER
TU VIEN



LIBOR BARTO
CU PRAGUE



POCOCOP: FUNDAMENTAL QUESTION

WHAT COMPUTATIONAL PROBLEMS ARE IN P ?

POCOCOP: FUNDAMENTAL QUESTION

WHAT COMPUTATIONAL PROBLEMS ARE IN P ?

LP

FIND NUMBERS $x, y, z, \dots$
SUBJECT TO CONSTRAINTS

$$x + 2y - 3z \geq 3$$

$$2x - y \leq 5$$

...

3SAT

FIND TRUTH VALUES $x, y, z, \dots$
SUBJECT TO CONSTRAINTS

$$x \text{ OR } \neg y \text{ OR } z$$

$$z \text{ OR } \neg x$$

...

POCOCOP: FUNDAMENTAL QUESTION

WHAT COMPUTATIONAL PROBLEMS ARE IN P ?

POLYNOMIAL TIME:
SOLVABLE IN
(INPUT SIZE)^{CONSTANT}
STEPS

POCOCOP: FUNDAMENTAL QUESTION

WHAT COMPUTATIONAL PROBLEMS ARE IN P ?

P IS IMPORTANT:



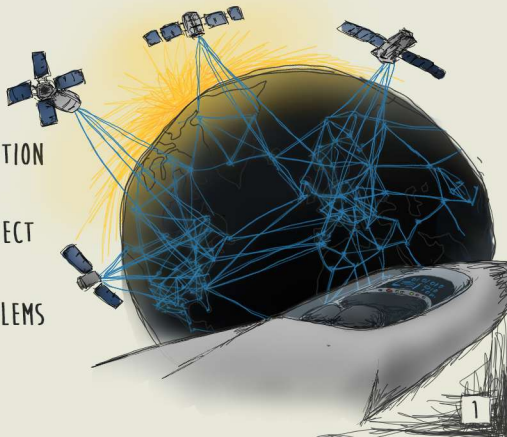
$P \sim$ EFFICIENT COMPUTATION



NEW MATHEMATICAL OBJECT



1 OF 7 MILLENIUM PROBLEMS



POCOCOP: FUNDAMENTAL QUESTION

WHAT COMPUTATIONAL PROBLEMS ARE IN P ?

P IS IMPORTANT:

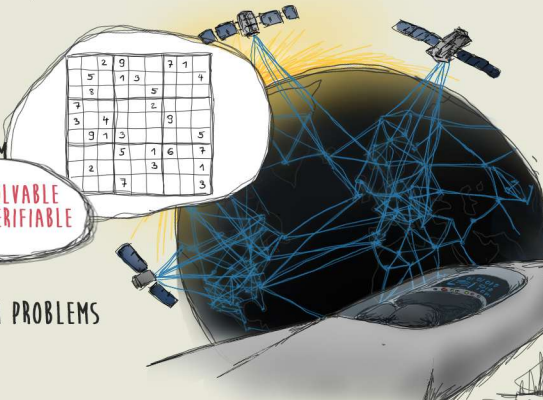
1011
0110
1001

$P \sim$ EFFICIENT COM

P = POLYNOMIAL-TIME SOLVABLE
 NP = POLYNOMIAL-TIME VERIFIABLE

$P \stackrel{?}{=} NP$

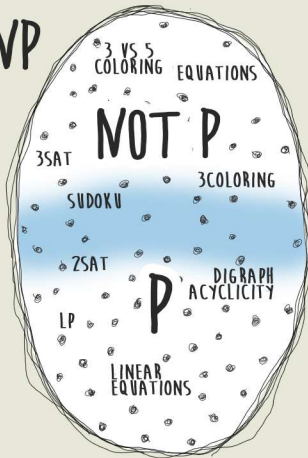
1 OF 7 MILLENIUM PROBLEMS



	2	9		7	1	
5		1	3			4
8				5		
7				2		
3	4				9	
9	1	3				5
		5	1	6	7	
2			3			1
		7				3

POCOCOP : GOALS

NP



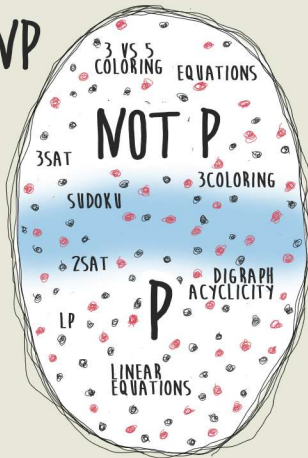
POCOCOP : GOALS

SCOPE

CONSTRAINT
SATISFACTION
PROBLEMS

GIVEN : VARIABLES
CONSTRAINTS
QUESTION: SOLUTION
EXISTS?

NP



POCOCOP: GOALS

SCOPE

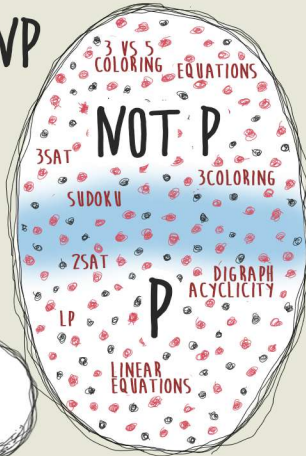
CONSTRAINT
SATISFACTION
PROBLEMS

DENSE WITHIN NP:

DIVERSITY
& APPLICABILITY!

- * DISCRETE & CONTINUOUS
- * FINITE & INFINITE
- * DECISION & OPTIMISATION
- * EXACT & APPROXIMATION

NP



POCOCOP : GOALS

SCOPE

CONSTRAINT
SATISFACTION
PROBLEMS

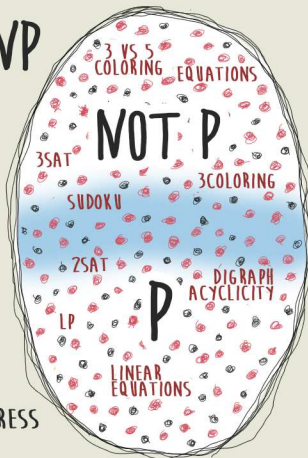
DENSE WITHIN NP:

DIVERSITY
& APPLICABILITY!

ACTIVE :

GROUNDBREAKING PROGRESS
IN TOP JOURNALS

NP



POCOCOP : GOALS

SCOPE

CONSTRAINT
SATISFACTION
PROBLEMS

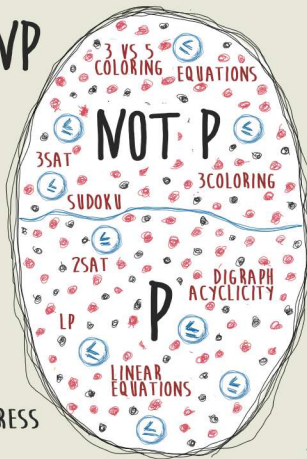
DENSE WITHIN NP:

DIVERSITY
& APPLICABILITY!

ACTIVE :

GROUND BREAKING PROGRESS
IN TOP JOURNALS

NP



GOALS



UNIFORM
DESCRIPTION



UNIFORM
ALGORITHM



UNIFORM
REDUCTION

POCOCOP: CUBE

FINITE-DOMAIN CSPs
3SAT



UNIFORM DESCRIPTION :

$$S(X, Y, X, Z) = S(Y, X, Z, Y)$$



UNIFORM ALGORITHM :

BULATOV, ZHUK



UNIFORM REDUCTION :

PP-CONSTRUCTIONS

POCOCOP: CUBE

FINITE-DOMAIN CSPs
3SAT



APPROXIMATION

POCOCOP: CUBE

FINITE-DOMAIN CSPs
3SAT

PROMISE CSPs
3 VS 5 COLORING

POCOCOP: CUBE

FINITE-DOMAIN CSPs
3SAT



PROMISE CSPs
3 VS 5 COLORING

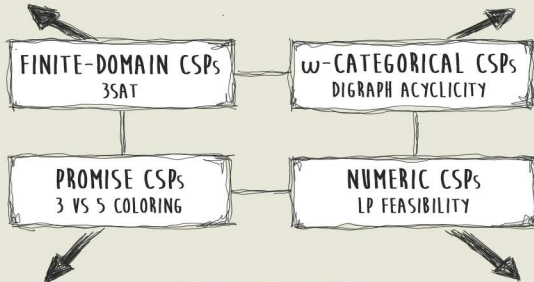


INFINITE DOMAINS

POCOCOP: CUBE

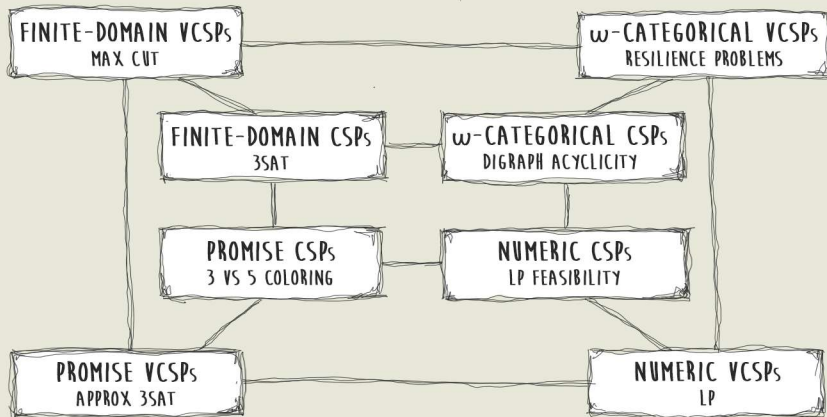


POCOCOP: CUBE

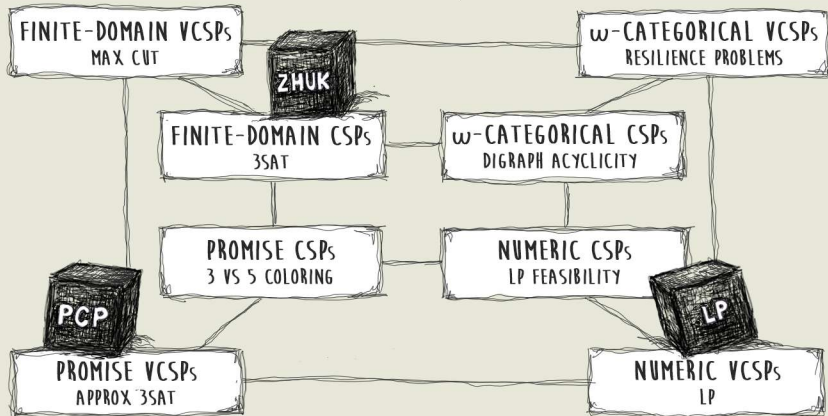


OPTIMISATION

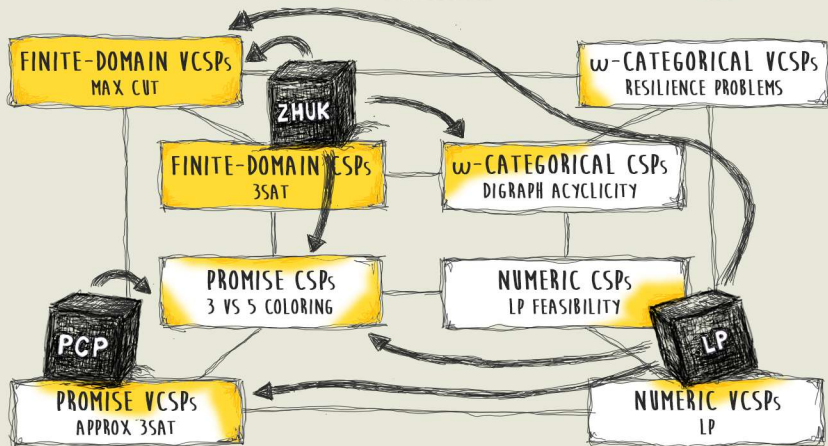
POCOCOP: CUBE



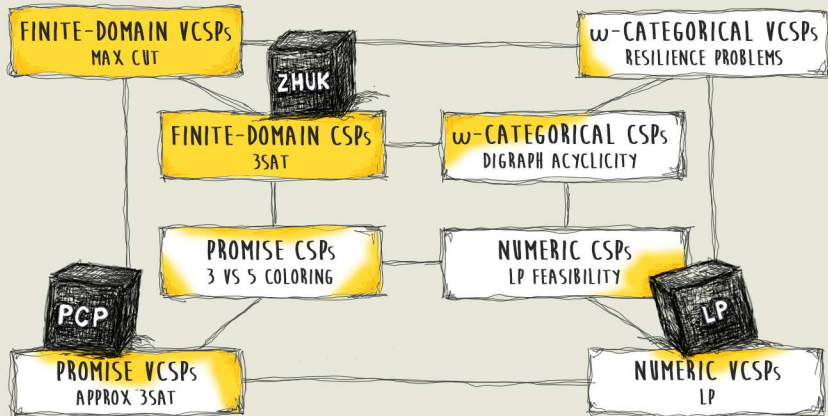
POCOCOP: BLACKBOXES



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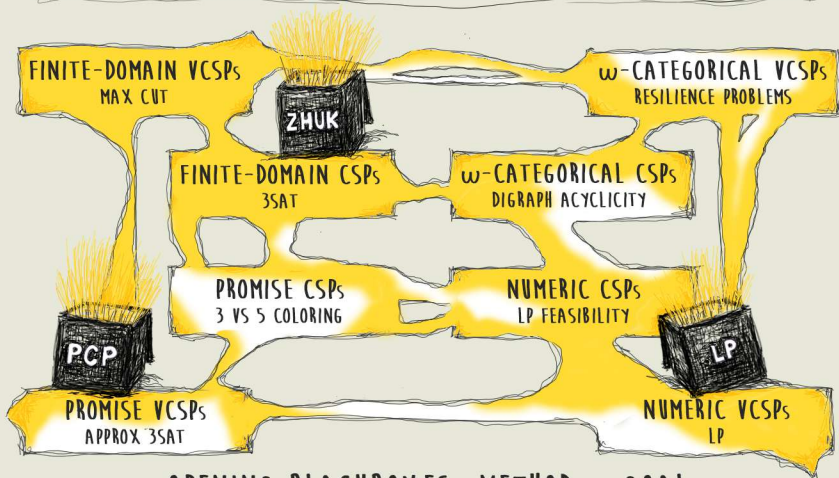


POCOCOP: BLACKBOXES



OPENING BLACKBOXES: METHOD + GOAL

POCOCOP: BLACKBOXES



OPENING BLACKBOXES: METHOD + GOAL

POCOCOP: BLACKBOXES

FINITE-DOMAIN VCSPs

MAX CUT



FINITE-DOMAIN CSPs

3SAT

ω -CATEGORICAL VCSPs

RESILIENCE PROBLEMS



ω -CATEGORICAL CSPs

DIGRAPH ACYCLICITY

PROMISE CSPs

3 VS 5 COLORING



PROMISE VCSPs

APPROX 3SAT

NUMERIC CSPs

LP FEASIBILITY

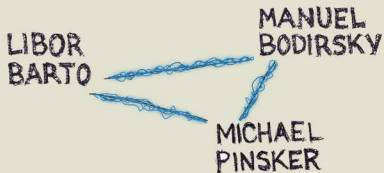


NUMERIC VCSPs

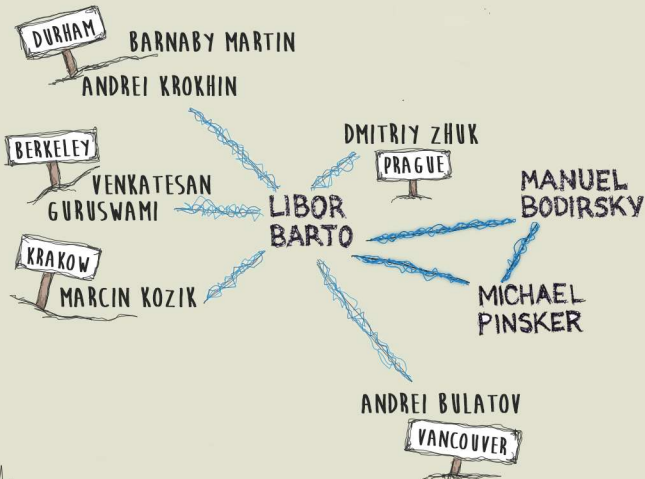
LP

OPENING BLACKBOXES: METHOD + GOAL

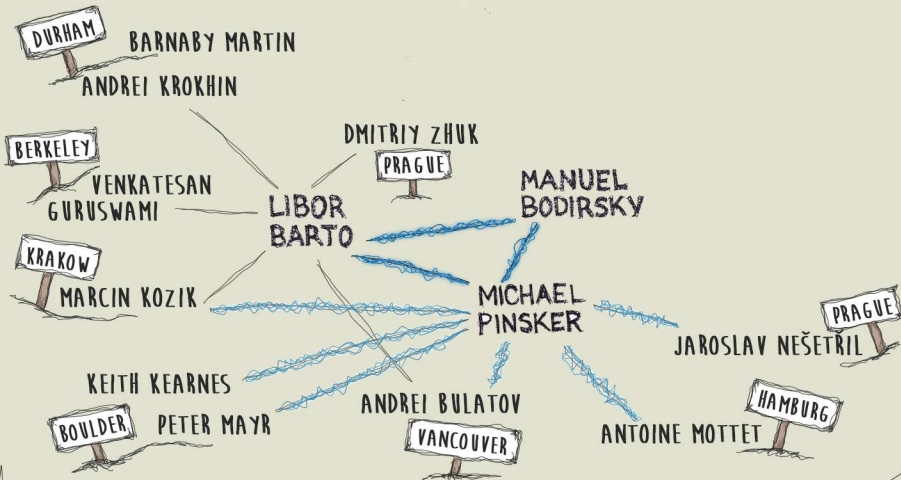
POCOCOP: NETWORK



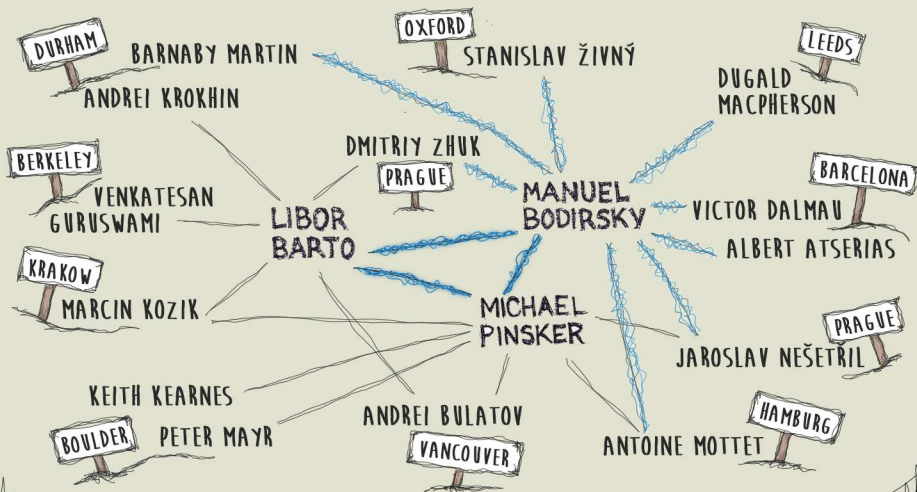
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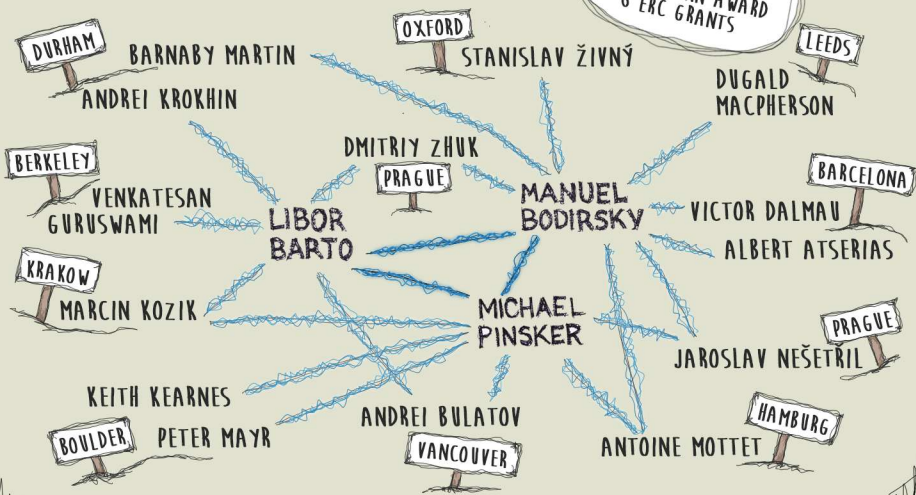


POCOCOP: NETWORK



POCOCOP: NETWORK

3 ICM INVITEES
1 PRESSBURGER AWARD
1 ACKERMANN AWARD
6 ERC GRANTS



POCOCOP: SYNERGY

CUBE

LB

ALGEBRAIC
TOPOLOGY

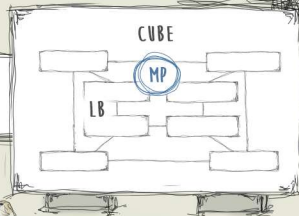
PROBABILISTIC
METHOD

LIBOR
BARTO

ANALYSIS

UNIVERSAL
ALGEBRA

POCOCOP: SYNERGY



ALGEBRAIC
TOPOLOGY

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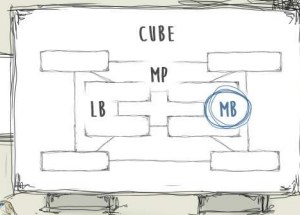
MICHAEL
PINSKER

RAMSEY
THEORY

MODEL
THEORY

TOPOLOGY

POCOCOP: SYNERGY



ALGEBRAIC
TOPOLOGY

PROBABILISTIC
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LIBOR
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FINITE MODEL
THEORY

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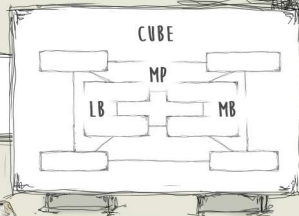
UNIVERSAL
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POCOCOP: SYNERGY



ALGEBRAIC
TOPOLOGY

UNIFORM
DESCRIPTION

UNIFORM
ALGORITHM

LISTIC

UNIFORM
REDUCTION

PCP

ZHUK

LP

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UNIVERSAL
ALGEBRA

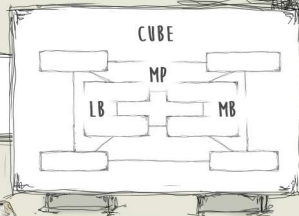
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THANK YOU!