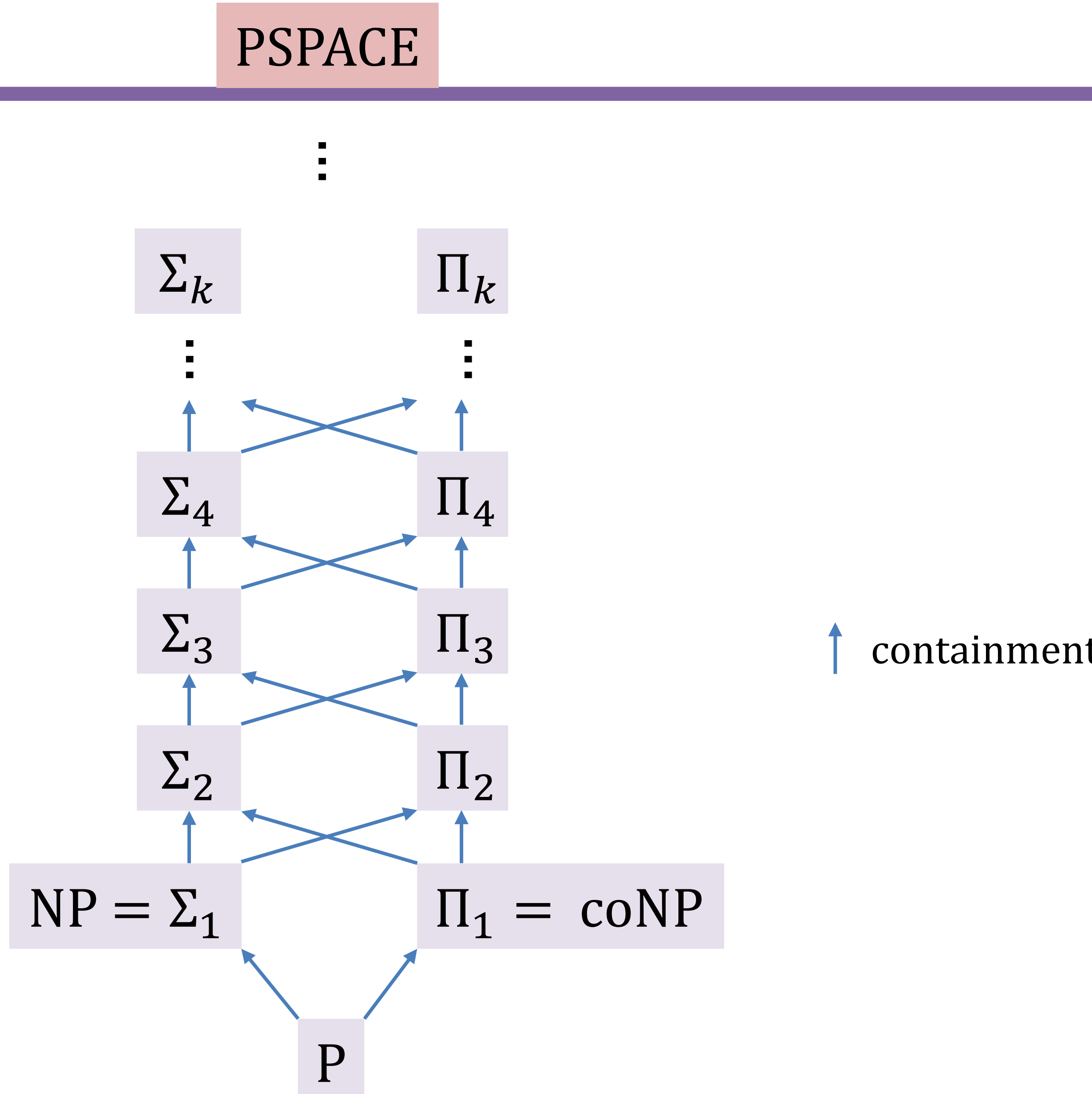
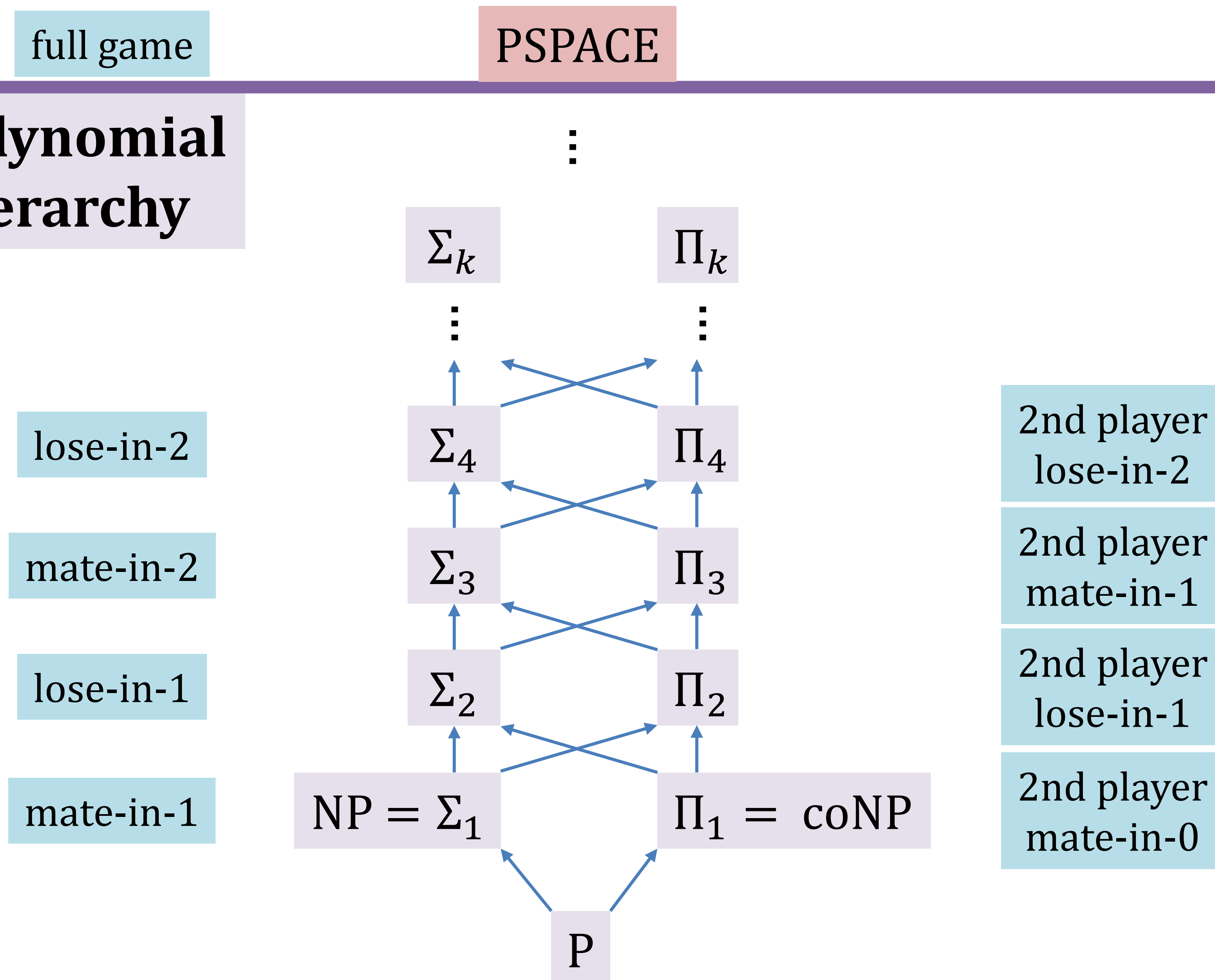
Polynomial Hierarchy



Polynomial Hierarchy



∃ℝ-complete Problems

Computational Geometry Column 62

Jean Cardinal*

November 4, 2015

Other complete problems for the existential theory of the reals include:

- the art gallery problem of finding the smallest number of points from which all points of a given polygon are visible.[22]
- recognition of unit distance graphs, and testing whether the dimension or Euclidean dimension of a graph is at most a given value.[9]
- stretchability of pseudolines (that is, given a family of curves in the plane, determining whether they are homeomorphic to a line arrangement);[4][23][24]
- both weak and strong satisfiability of geometric quantum logic in any fixed dimension >2;[25]
- the algorithmic Steinitz problem (given a lattice, determine whether it is the face lattice of a convex polytope), even when restricted to 4-dimensional polytopes;[26][27]
- realization spaces of arrangements of certain convex bodies[28]
- various properties of Nash equilibria of multi-player games[29][30][31]
- embedding a given abstract complex of triangles and quadrilaterals into three-dimensional Euclidean space;[17]
- embedding multiple graphs on a shared vertex set into the plane so that all the graphs are drawn without crossings;[17]
- recognizing the visibility graphs of planar point sets;[17]
- (projective or non-trivial affine) satisfiability of an equation between two terms over the cross product;[32]
- determining the minimum slope number of a non-crossing drawing of a planar graph.[33]

Based on this, the complexity class ∃ℝ has been defined as the set of problems having a polynomial-time many-one reduction to the existential theory of the reals.[4]

https://en.wikipedia.org/wiki/Existential_theory_of_the_reals#Complete_problems

A General Theory of Motion Planning Complexity: Characterizing Which Gadgets Make Games Hard

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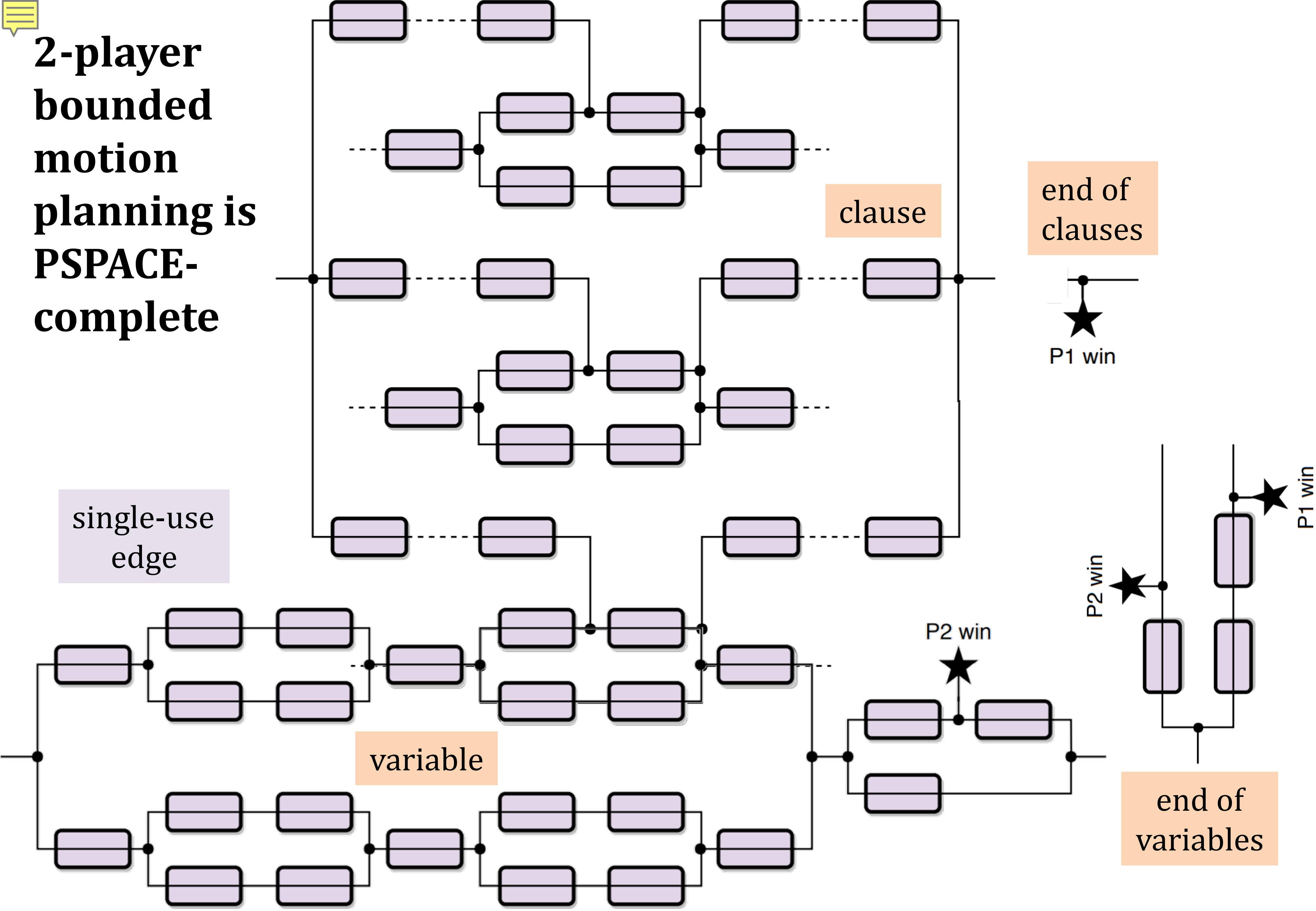
https://arXiv.org/abs/1812.03592

Abstract

We build a general theory for characterizing the computational complexity of motion planning of robot(s) through a graph of "gadgets", where each gadget has its own state defining a set of allowed traversals which in turn modify the gadget's state. We study two families of such

	1-Player Game	2-Player Game	Team Game
Polynomially Bounded (DAG)	**NL** vs. **NP-complete**: full characterization [§5]	**P** vs. **PSPACE-complete**: full characterization [§6]	**P** vs. **NEXPTIME**: full characterization [§7]
Polynomially Unbounded (reversible, deterministic gadgets)	**NL** vs. **PSPACE-complete**: full characterization [§2] **Planar**: equivalent [§2.3]	**P** vs. **EXPTIME-complete**: partial characterization [§3]	**P** vs. **RE-complete** (⇒ **Undecidable**): partial characterization [§4]

2-player bounded motion planning is PSPACE-complete



[Demaine, Hendrickson, Lynch 2018]