# On hypotheses under which P=NP

Minha Lee, Soyeon Jeong, Seongbin Park

Korea University, Seoul, Korea

#### Contents

- Research problems
- Motivation of the research
- Related work
- Current ongoing work
- Conclusion and future directions

### Research problems (1/2)

#### Research problem (2/2)

### Motivation of the research (1/2)

```
1. Consider the following statements.
 (1) SATEP
 (2) SAT E P-sel, in which P-sel
        is the set of all p-selective sets.
  It is known that PCP-sel, but
   P-sel is not a subset of P.
  Therefore, (2) is easier to prove
  than (1). But, is this intuition
  correct? Is there a way by
  which the difficulty of a statement
  can be measured?
```

## Motivation of the research (2/2)

2. There are structures in which p=NP. (1) Puersus NP and Computability theoretic constructions in complanty theory over algebraic structures, Gunther Mainhardt, The Journal of Symbolic Logic, Vol 69, No 1, March 2004 (2) A structure with P=NP, Christine GaBner Computer Science Report Sevies, University of Wales Swansea, CSR7, 2006 These are methematical "worlds". In threre worlds both SATEP and SAT is p-selective are true. But is it possible to define a "physical" world in which these statements are true?

#### Related work (1/3)

Algorithmic Complexity of Mathematical problems: An overview of Results and Open problems, cristian S. Calude, Elena Calude, Int. Journal of Un conventional Computing, Vol 9, 2013 (1) The complexity of a TT, problem TC = Un P(n): the size of the smallest program that systematically searches for a counter- Hample for Tu

#### Related work (2/3)

Related work (3/3)

(3) (u(te) is not computable. Classification of II, problems Cu, n = 5 Tc Tc is a Tr, pushleur, Cu(TL) < 200. n } Some known results (The complanty of mathematical statements, Melissa S. Queen, https://www.cs.dartmonth.edu/~ac/ Pubs/Students/mg-thesis-final.pdf) Legendre's Conjecture Fermat's Last Theorem Goldhach's Conjecture

#### Current ongoing work (1/5)

```
(andidate hypotheses (not grhaushive)
SATEP.
SAT is p-selectice.
there is an NP complete sparse language.
There is an NP complete tally language.
There is an oracle for TQBF.
```

#### Current ongoing work (2/5)

SAT EP Yx Por, where x: a boolean formula

x: a boolean formula

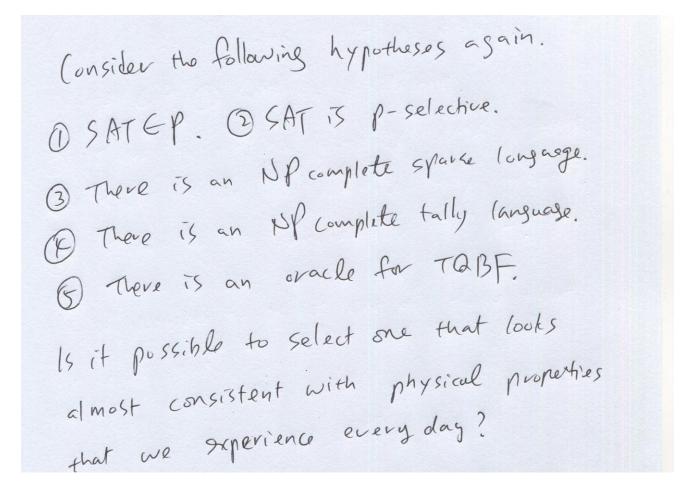
p(x): a predicate that is true

if x is decidable in polynomial time, no otherwise Construct TISAT

Current ongoing work (3/5)

p(x) is semidecidable - for all possible pairs of programs p, and polynomials &, determine whether or is decided correctly by p in of steps. ( Using the technique in Inductive complexity of the Puersus NP problem, Christian S. Calude, Elena Calude, Melissa S. Queen, Parallel Processing Letters, 2013)

### Current ongoing work (4/5)



### Current ongoing work (5/5)

We can define a formal system in which each is an axiom. Then, we can have different worlds (= formal systems). Each world is characterized by the set of all theorems provable in each formal system

#### Conclusion and future directions

```
1. It is possible to rank different
    hypotheses under which P=NP
    according to their difficulties.
2. There may be differt worlds (=
     formal systems) in which p=NP.
 3. Is it possible to select a world
      that is almost consistent with
      physical properties that we
      orperience everyday?
```