



Research Methodology

Computer Science as Experimental Science

Lecture, 1. October, 2007



Research in Computer Science

- 1. Pick a relevant research question**
- 2. Work on it and make some progress**
- 3. Make sure your work is solid and well supported**
4. Write scientific paper about work
5. Submit paper to conference, workshop, journal,...
6. If paper is accepted
 - Update CV, Present Paper, goto Step 1 or 2
7. Else Go To Step 1, 2, 3, 4 or 5



Research in Computer Science

- Can we do X?
- If not, why not?
- If we can, how?
- How fast can we do X?
- How well can we do X?
- Theoretical analysis
- Experimental analysis



Role of theoretical analysis

- Determine bounds
 - What can be computed
 - What is an upper or lower bound
- Determine correctness
 - Ensure computations are correct
- And more



Experimental approach needed

- Theoretical analysis incomplete
 - Upper or lower bounds are loose
 - Based on ideal notions
 - Ignores constant factors
- Real problem set is different
 - Real-world problems not average or all
 - Constant factors and degree matter



Experimental methods

- Side-by-side comparisons
 - Apply multiple methods to same problems
- Absolute comparisons
 - Apply new technique to problem set
 - Compare to established reference
- Can-do demonstrations
 - Show something is possible
- Subjective evaluations



Shared experiment data

- Challenge problems
 - E.g. DIMACS
- Competitions
 - E.g., Robo-CUP
- Problem sets within field
 - E.g., large sets of SAT problems
- Randomly generated data



Key issues in methodology

- Sources of data – especially random
- Implementation differences
- Quality vs speed comparisons
- Variance in results
- Statistical analysis
- Usability and subjective analysis
- CS does not follow standard methods



The silver lining

- Most CS experiments work well
 - Can be repeated fairly easily
 - Or at least should be
 - Observation rarely impacts outcome
- Moving in the right direction
 - More rigorous methods appearing
 - More standardized approaches being used