

The CS720 course varies substantially each year. In 2017 it had two parts.

The first part is taught by Mark Wilson and will cover connections between algorithms and complexity, on the one hand, and economics on the other. More specifically, topics from computational social choice theory. Even more specifically, we will cover algorithms for 1- and 2-sided matching (e.g. house allocation, assigning students to schools). There will be 3 assignments.

The second part is taught by Michael Dinneen and will have three parts, each with its own assignment. We start with the study of basic combinatorial algorithms (how to enumerate objects and rank/hash them). Then we study some advanced topics in graph algorithms such as linear-time dynamic programs for graphs of bounded treewidth, branchwidth and pathwidth. Finally we will cover fixed-parameter techniques for coping with NP-hard problems.

For this course, 40% of marks are earned from assignments and 60% from the final exam. Assignments involve written work and (likely) some programming.

FPT algorithmic techniques



- ⑥ Significant advances in the past 20 years or so (especially in recent years).
- ⑥ Powerful toolbox for designing FPT algorithms:

Bounded Search Tree

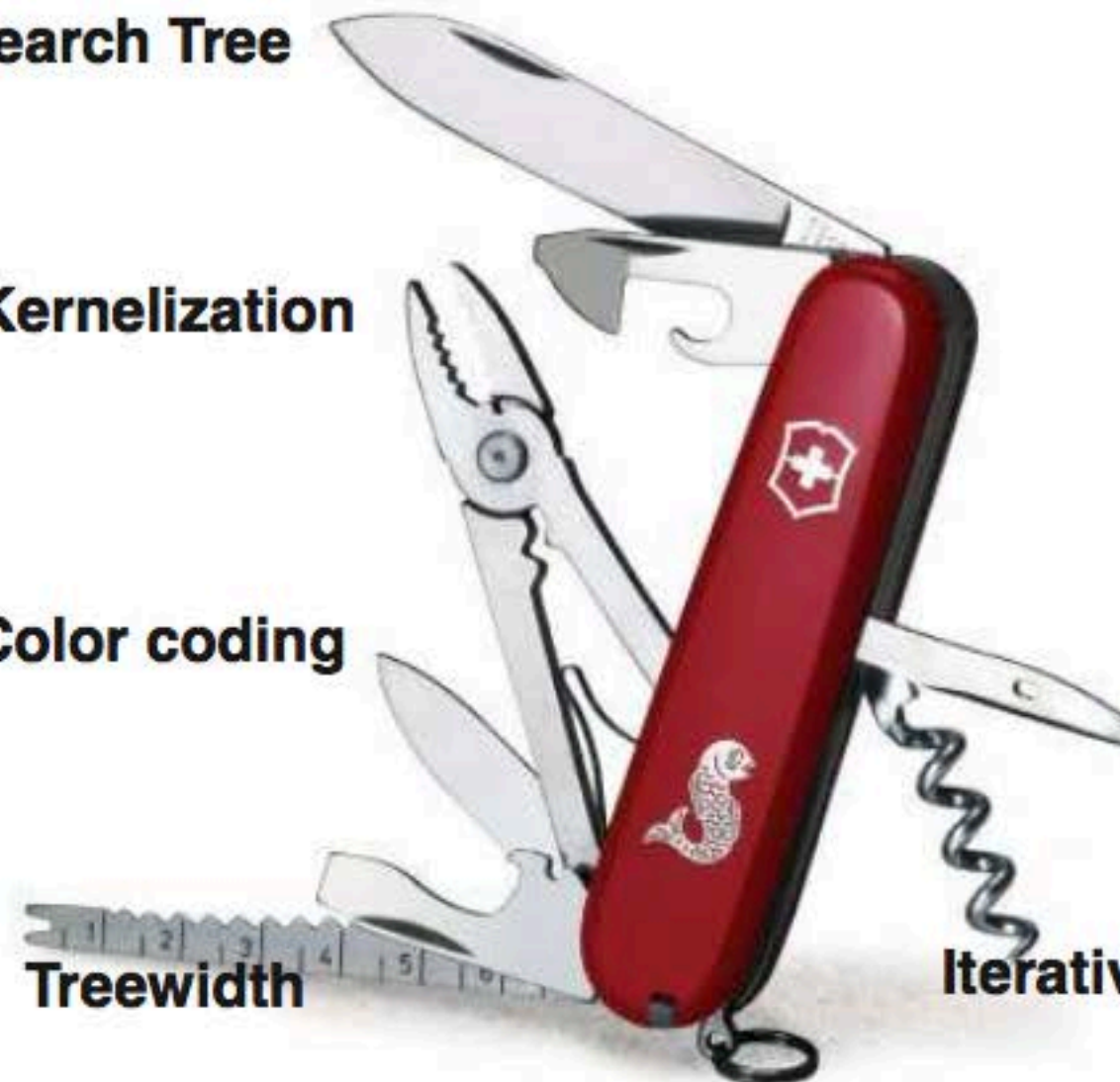
Kernelization

Color coding

Treewidth

Graph Minors Theorem

Iterative compression



Special CS720 Topics (Michael's Part)

Combinatorial Enumeration/Ranking/Unranking

Approximation Algorithms

Quantum Computing

Computing Obstruction Sets

Parallel Algorithms (Multi-Core and GPU Programming)

Randomized Algorithms

Grand Challenge Scientific Computing

Computational Geometry

Examples

- How can we show algorithmically that the identity

$$\sum_{k=0}^n (-1)^k \binom{n}{k} \binom{2k}{k} 4^{n-k} = \binom{2n}{n}$$

holds?

- Such sums arise in many areas including the analysis of algorithms and discrete probability theory.
- We will learn about useful data structures for sequences (e.g. generating functions) and powerful algorithms (e.g. Wilf-Zeilberger) for proving identities, simplifying sums, and maybe a lot more (depending on how hard you want to work).
- This is an exciting area on the border of mathematics and computer science, never before taught at UoA.
- A side benefit will be developing familiarity with the powerful open-source computer algebra system Sage (sagemath.org).

References

We will cover only a small part of these books.

- Graham, Knuth, Patashnik, Concrete Mathematics.
- Kauers, Paule: The Concrete Tetrahedron.
- Wilf, Zeilberger, Petkovsek: $A = B$.