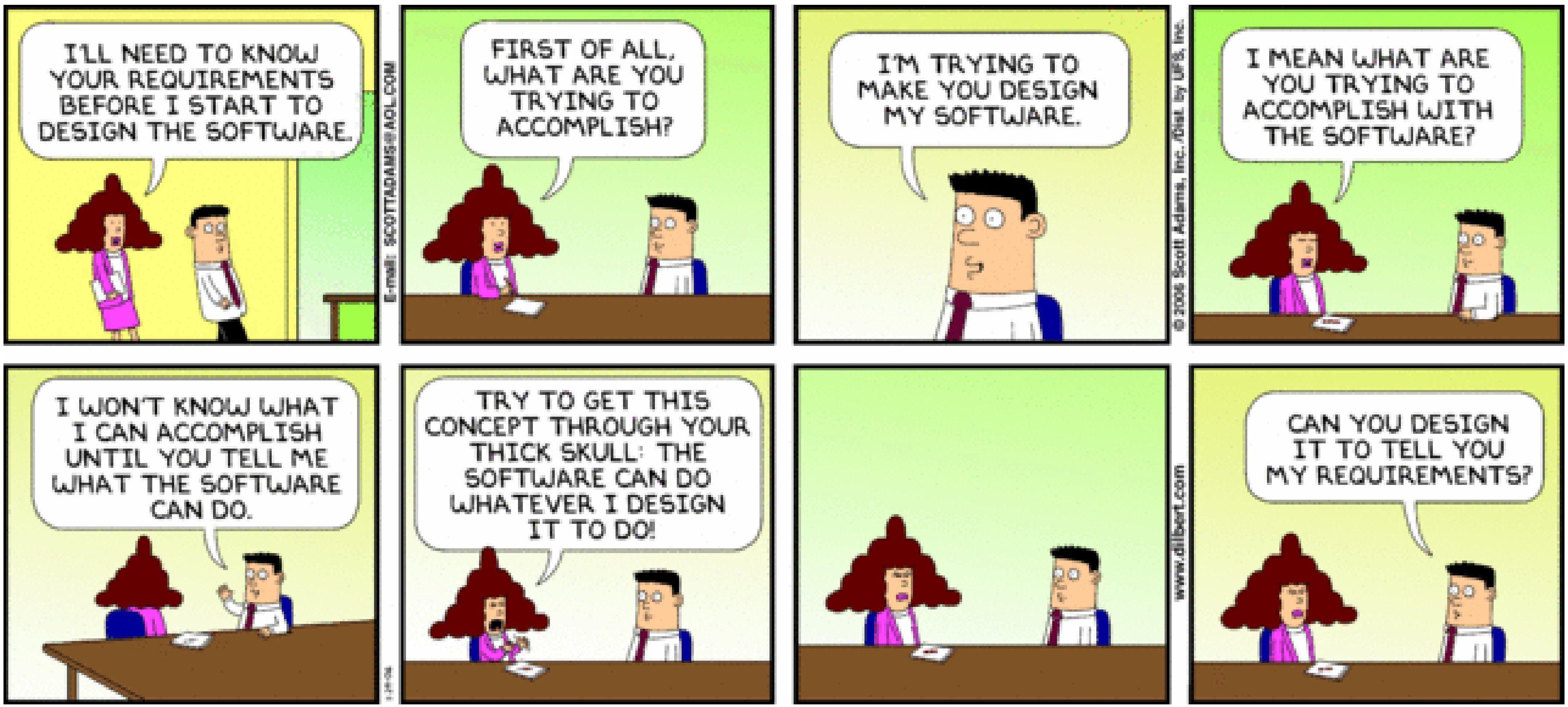
CSC 425/520: Fall 2016

Dr. Wendy Myrvold, ECS 552

wendym@csc.uvic.ca



Natural Sciences and Engineering Research Council of Canada

www.nserc-crsng.gc.ca

Canada Graduate Scholarship – Master's (CGS-M) ($17, 500)

APPLICATION DEADLINE: DEC. 1, 2016

Students must be a Canadian citizen or a permanent resident of Canada.

To qualify for an award from UVic, students must be:

- enrolled in the 1st year of an eligible Master's program; OR,
- have applied for admission to an eligible UVic Master's program admission deadline (January 15 for UVic Computer Science program).

Send me e-mail for more info: wendym@cs.uvic.ca

NSERC Masters INFO– Wed., Oct. 12, 2016 (1pm-3pm)
Cornett Bldg., Room A121 with Dr. Robin Hicks

MIDTERM CHANGED: to FRI. OCT. 14 so you can attend.

Natural Sciences and Engineering Research Council of Canada

www.nserc-crsng.gc.ca

NSERC Doctoral Scholarship -- ($21,000 - $35,000)

APPLICATION DEADLINE: OCTOBER 3, 2016

Eligibility:

- be a Canadian citizen or a permanent resident of Canada
- hold, or expect to hold (at the time you take up the award), a degree in science or engineering from a university whose standing is recognized by NSERC
- intend to pursue, in the following year, full-time graduate studies and research at the doctoral level in an eligible program in an NSERC-supported field
- have obtained a first-class average (a grade of "A-") in each of the last two completed years of study (full-time equivalent).

Send me e-mail for more info: wendym@cs.uvic.ca

VERY IMPORTANT:

Grantcrafting & Application Workshop –

Friday, Sept. 9, 2016, (11am-1pm) David Strong Bldg. C116

with Dr. Robin Hicks

Combinatorial Algorithms Group Talk

Classifying Graphs by Degree

Stephen Hedetniemi

3:30pm, Friday September 9, ECS 660

Let $G = (V,E)$ be a connected graph and let v be a vertex in V. The degree of v, deg(v), equals the number of vertices u that are adjacent to v. The type of vertex v is determined by how deg(v) compares with the degrees deg(u) of all vertices u adjacent to v, that is, does v have any neighbors u whose degree is less than, equal to, or greater than the degree of v? Using this measure, there are 7 possible types of vertices. One can then classify any graph by the number of distinct types of vertices it has. We show that there are 71 classes of connected graphs and 46 classes of trees, as measured by the different types of vertices that they contain. We then raise a number of open questions suggested by this classification of graphs.

This is joint work with Jason T. Hedetniemi (Department of Mathematics, St. Anselm College), Sandra M. Hedetniemi (School of Computing, Clemson University), and Thomas M. Lewis (Department of Mathematics, Furman University).

CSC Advising Office (undergrads)

Drop-in appointment times:
Monday, Wednesday, Friday - 10 am - 12 pm
Tuesday, Thursday - 1:30 - 3:30 pm
If you are close to graduating it is a good idea to ensure you have met all the requirements.

New CSC Honours Program Starting Sept. 2016:

Honours Degree in Computer Science with the Software Engineering Option.
Computer Science students who meet the honours criteria can apply for this program as early as September, 2016.

Some course materials will be on connex and you need access to submit assignments. Please make sure NOW that you can login to connex.

https://connex.csc.uvic.ca/portal

On connex there are links to:

***Activate your Computer Science Account* - First year students taking a Computer Science** *course for the first time and individuals who have been been absent from CSc for an extended period of time (+6 months) must activate their CSc Account.*

Late course registration *- changes to course registration data are processed nightly. If you registered for a course today, please allow overnight for your registration information to be imported into conneX.*

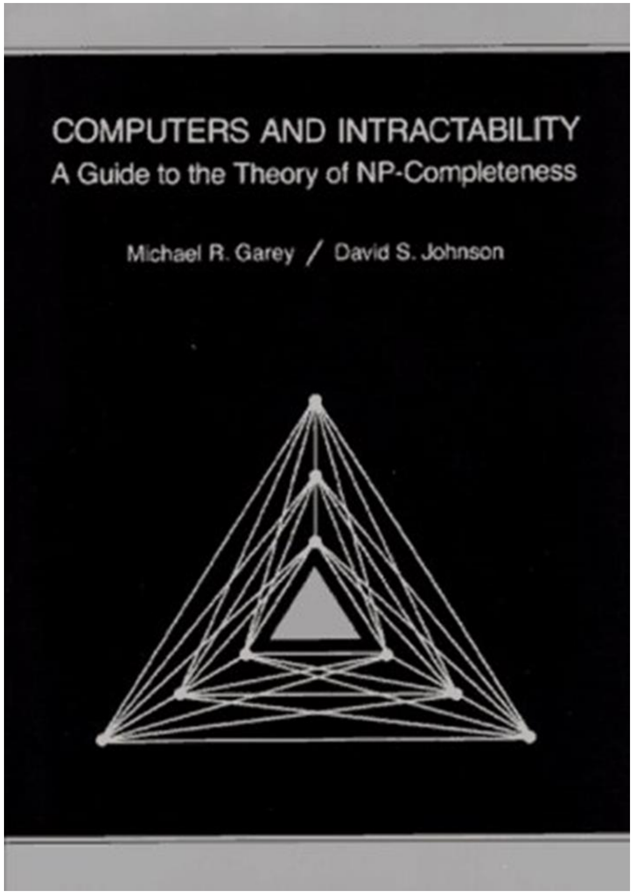
Update Your Email Address: *To fully participate in conneX forums, notifications, and receive assignment notifications from instructors, you must update your preferred email address using the following link: update conneX email address*

Prerequisite:
CSC 320: Theory of Computation
Only need short section
(about 1-2 weeks on NP-completeness).

BUT you do need the prerequisites for CSC 320: CSC 225 and CSC 226 or equivalents.

Bible for NP-completeness:

M. R. Garey and D. S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completness*, W. H. Freeman, 1st ed. (1979).



Talk to me if you are missing prerequisites.

Class Materials and Announcements

Connex: calendar, electronic assignment/project submissions, feedback on some electronic submissions, links to assignments, model solutions, any class notes using material subject to copyright, and other private class resources, sending e-mail announcements to the class.

Course web pages: assignments, project requirements, projected schedules, class notes (if not private). No password required to access, accessible when connex is down.

Outline for Lecture 1

- Who is the instructor?
- My research interests
- Logistics for CSC 425/520
- Description of grading scheme and class project components
- Brief overview of course content- don't worry about taking notes today

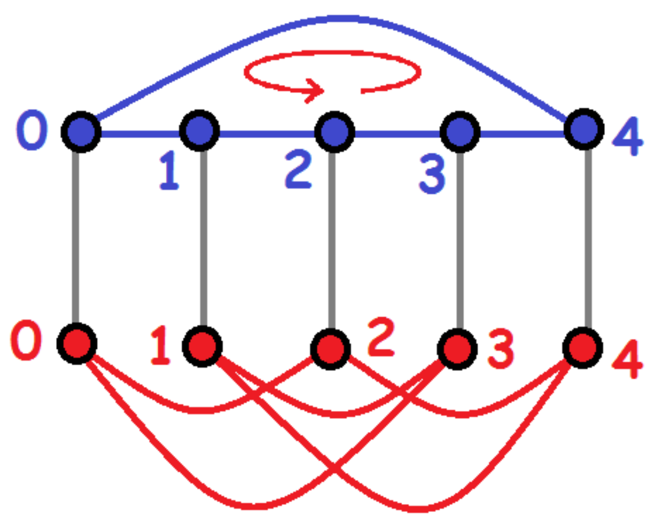
About me:

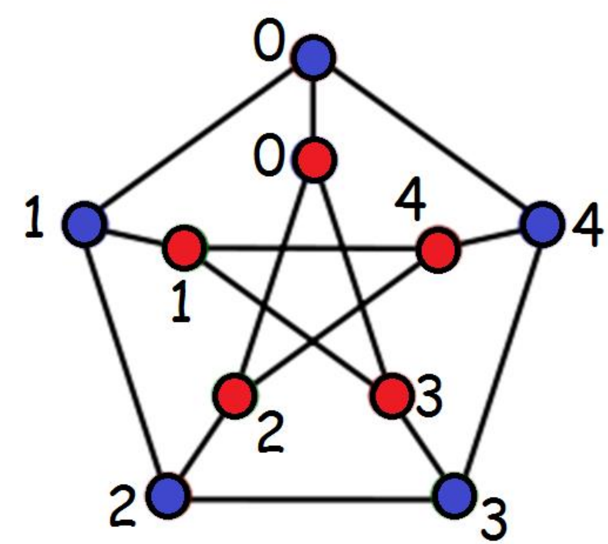
B.Sc. : Computer Science, McGill University, 1983

M.Math. : Combinatorics and Optimization, University of Waterloo, 1984

Ph.D. in Computer Science: Waterloo, 1988

University of Victoria: started in 1988, currently a full professor.





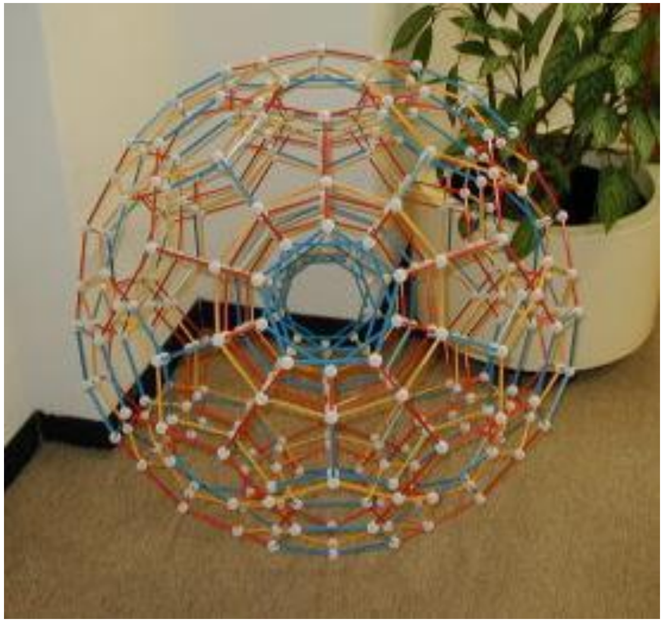
Bring your parents to work day at Google.

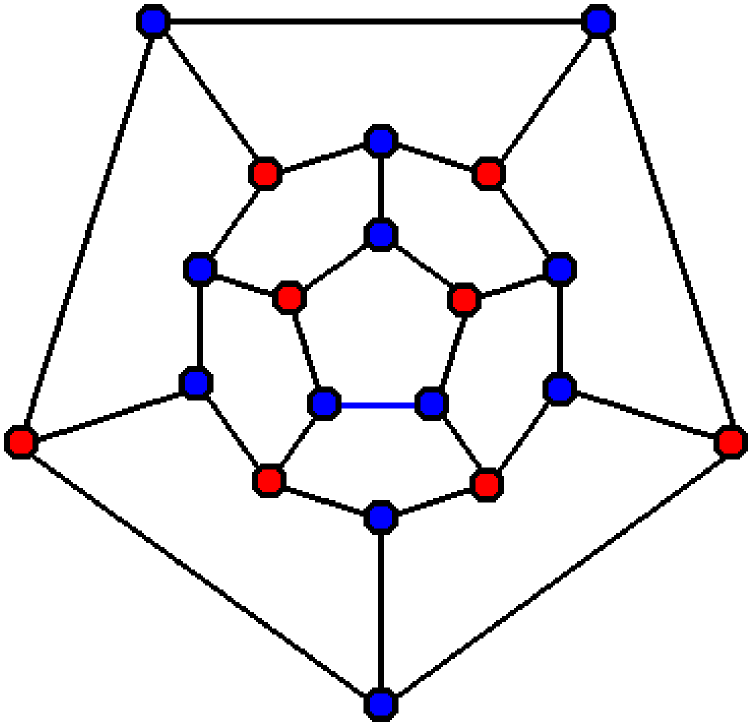

CCM

My Research: Large Combinatorial Searches

Independent Set:

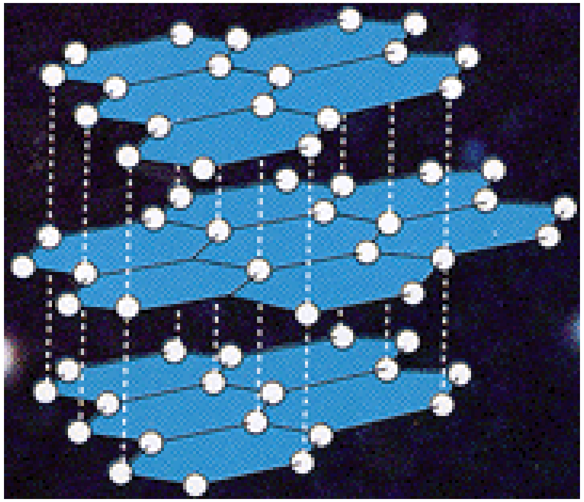
Set of vertices which are pairwise non-adjacent



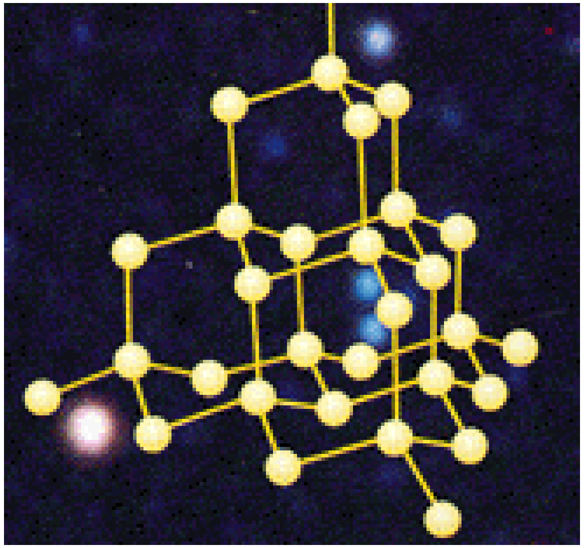


Fullerenes:

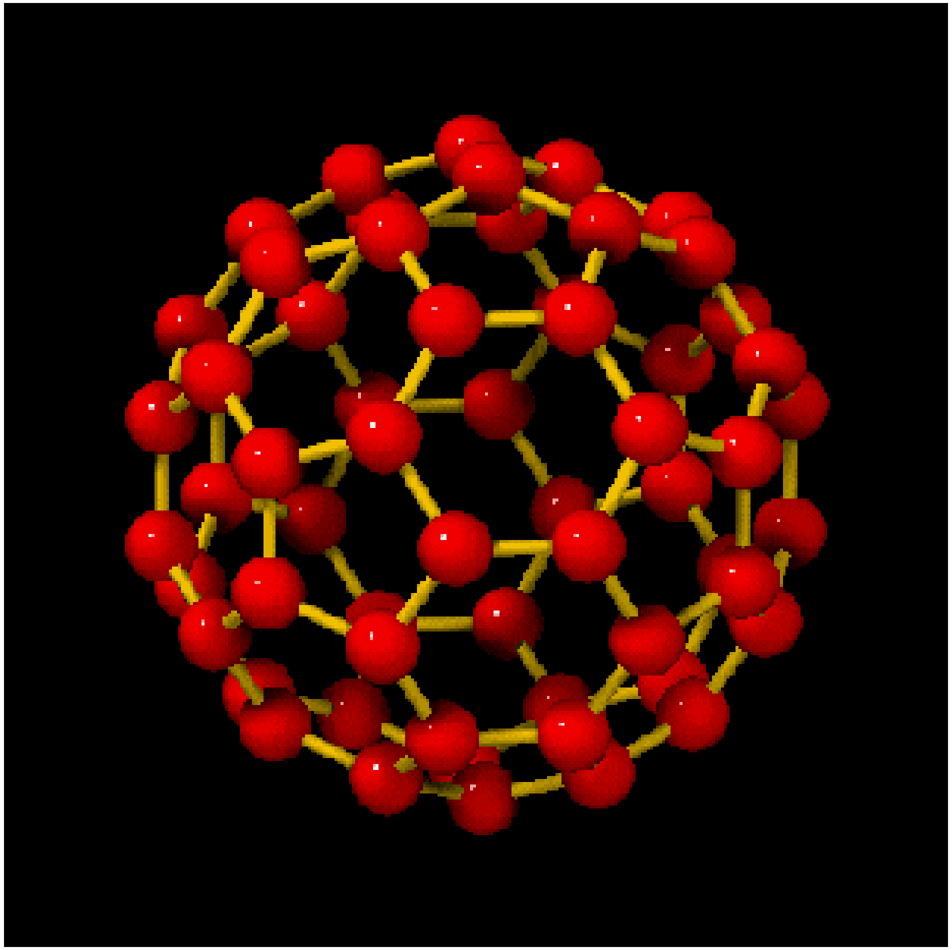
Working with Patrick Fowler (chemist)



Graphite

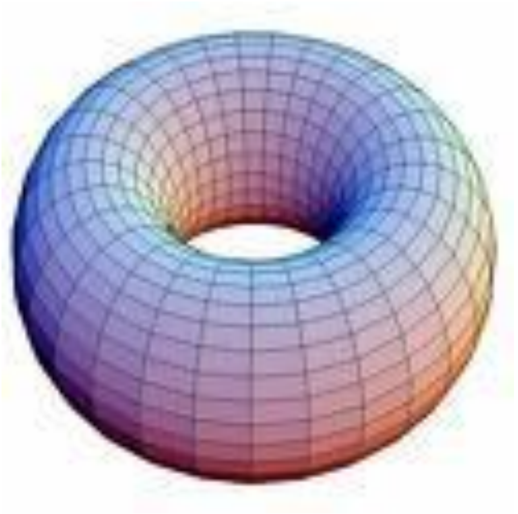


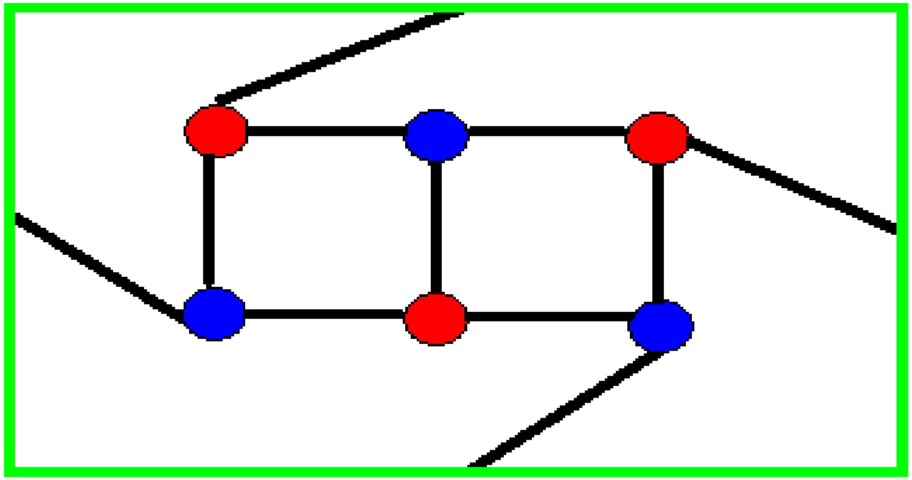
Diamond

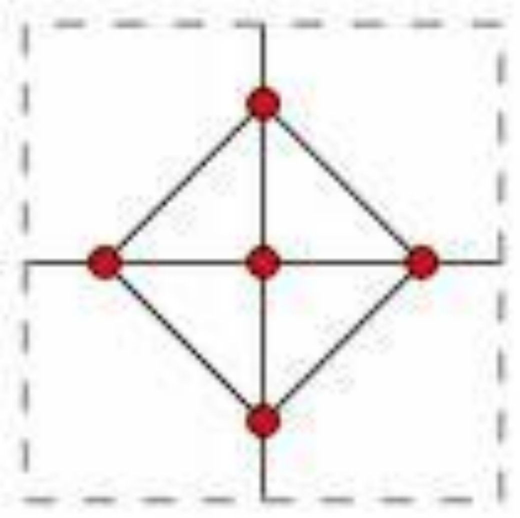


Topological Graph Theory:

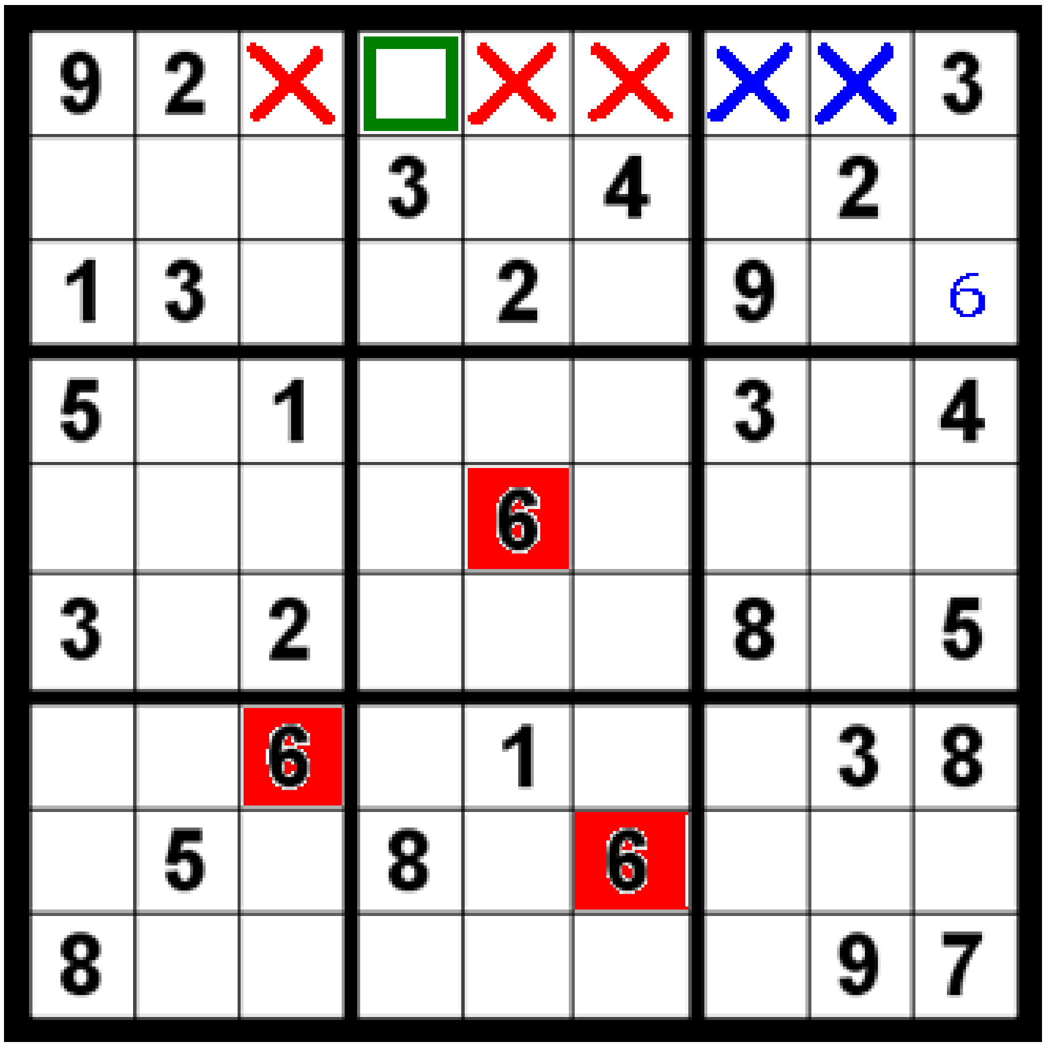
Algorithms and Obstructions





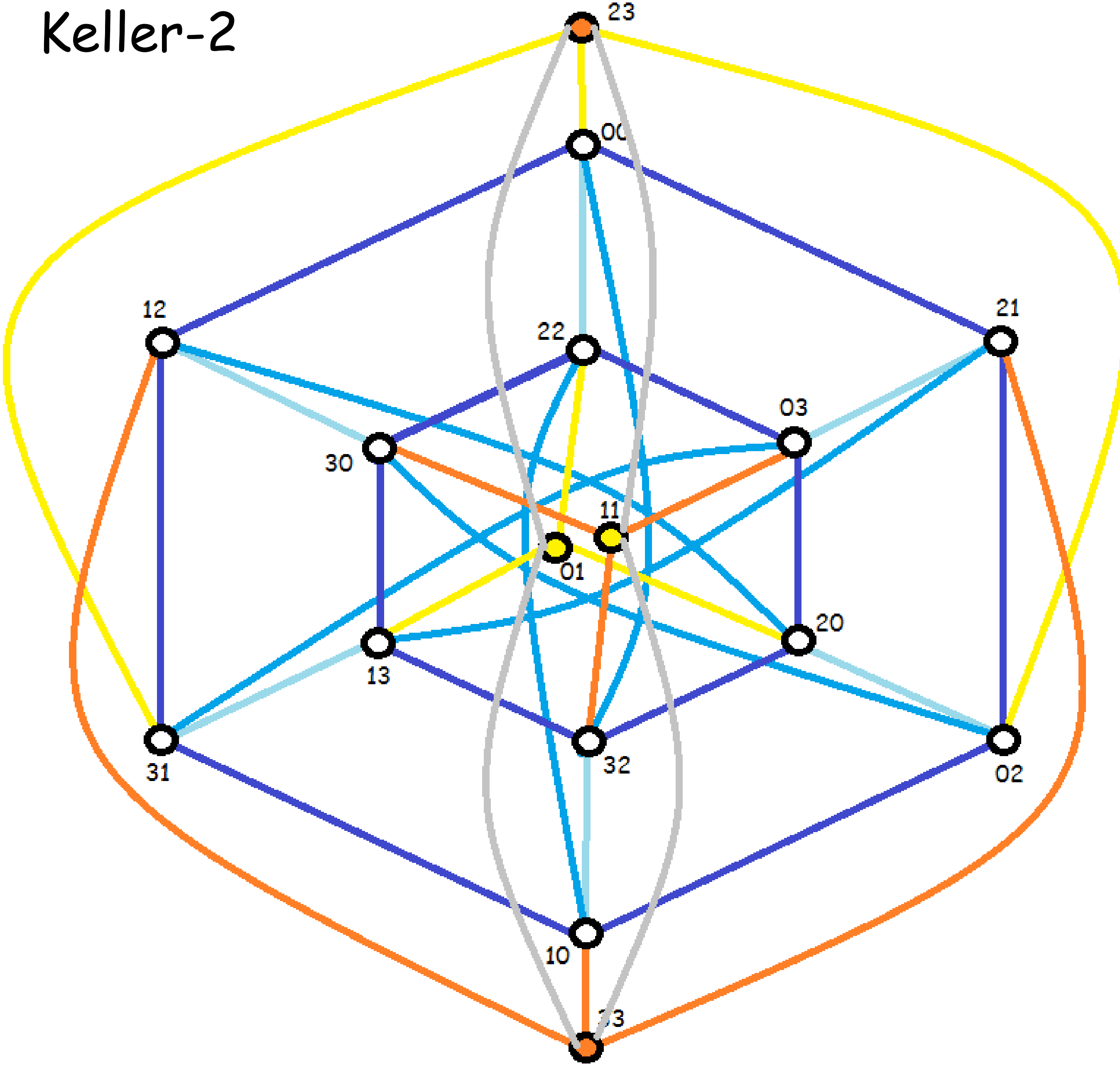


Latin Squares



Please come talk to me if you are looking for Honours project research topics or for an NSERC undergraduate research project.

Keller-2

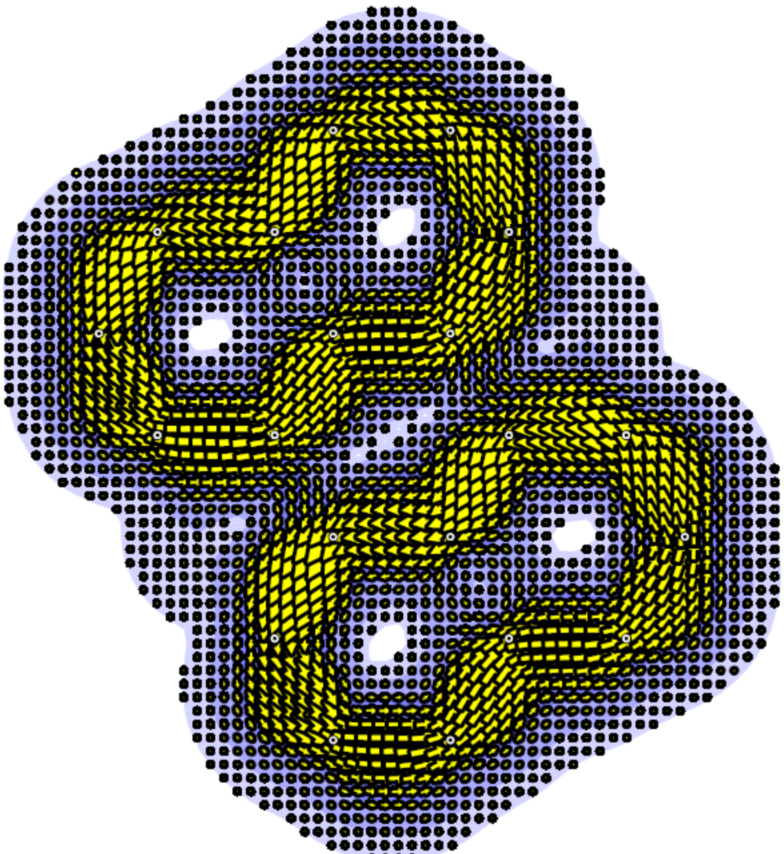


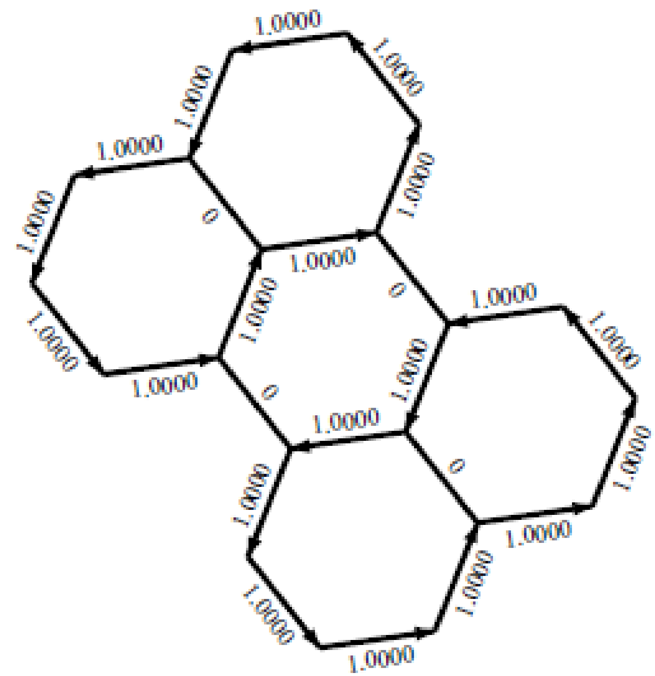
Found the maximum clique order in Keller-7.

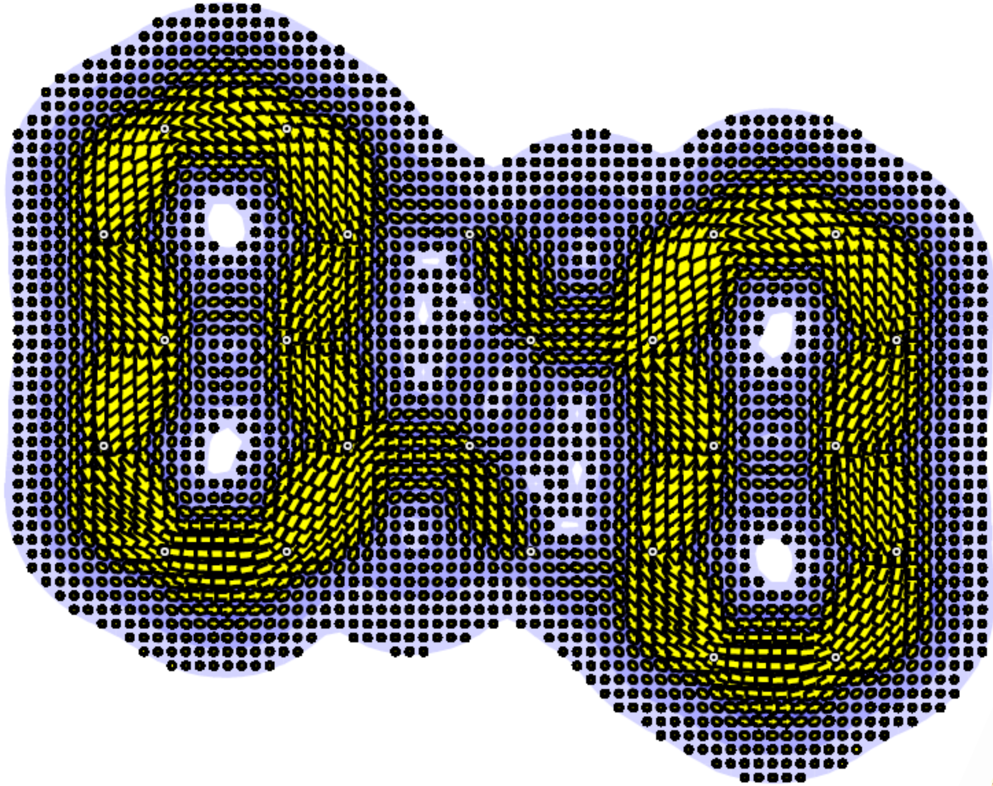
Interested in coloring the complements of Keller-5, Keller-6, and Keller-7.

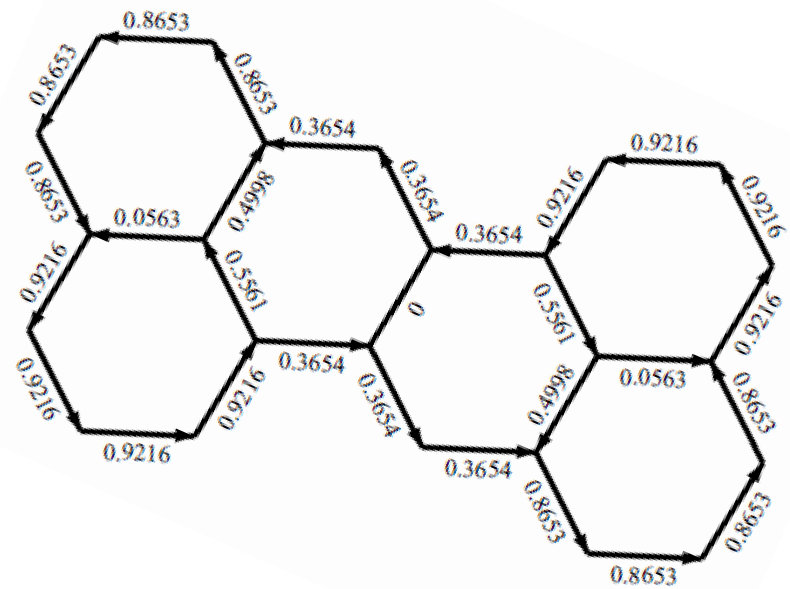
Recent work: currents in benzenoids

Perylene:





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COMBINATORIAL ALGORITHMS GROUP
University of Victoria

http://www.cs.uvic.ca/~wendym/cag

Our research interests include:

Graph Theory and Graph Algorithms
Combinatorics
Combinatorial Algorithms
Computational Geometry
Randomized Algorithms
Computational Complexity
Network Reliability
Topological Graph Theory
Computational Biology
Cryptography
Design Theory

Join our listserv to get information about conferences and research talks.

Undergrads are welcome to all events.

CSC 425/520 Logistics

Course Website: http://www.cs.uvic.ca/~wendym/425.html

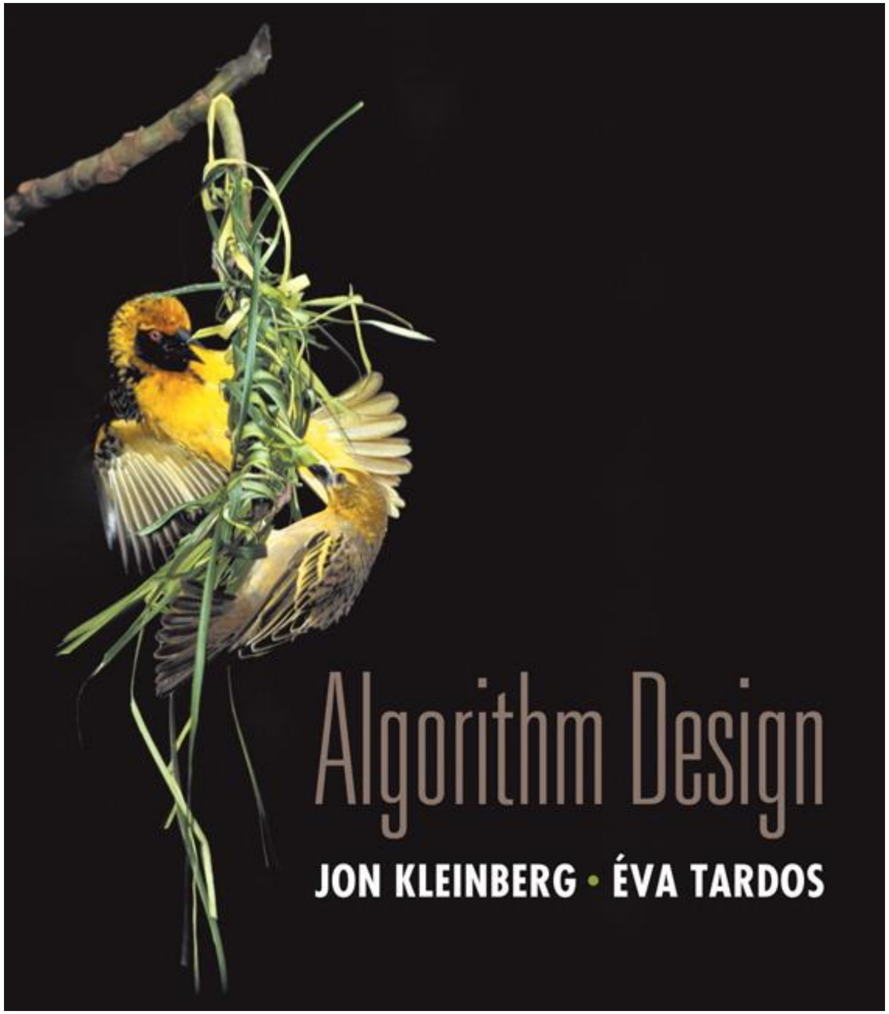
Instructor: Dr. Wendy Myrvold
Email: wendym@cs.uvic.ca

I answer all student e-mails. If you do not get a response in a reasonable time frame please find out why the e-mail did not work.

Office: ECS 552
Phone Number: 472-5783 (use e-mail for a faster response)
Office Hours: TWF 10:45 a.m. - 12:10 p.m.

Please tell me if you plan to come by.

Course Textbook



I will cover many sections of this book augmented by information about the project, and sometimes additional topics.

This is a wonderful algorithms text that is worth owning.

Grading Scheme:

Coursework	CSC 425	CSC 520
Assignments (4)	20%	20%
Midterm exam (Wed. Oct. 12, in class)	20%	20%
Final exam (to be scheduled by the university)	40%	30%
Project	20%	30%

There will be 4 assignments of equal weight worth 20%. Please see the course web page for up to date deadlines for assignments. The projected deadlines are:

- Assignment #1: due Friday Sept. 23.
- Assignment #2: due Friday Oct. 7.
- Assignment #3: due Tuesday Nov. 8.
- Assignment #4: due Friday Dec. 2.

Project:

Students will have 3 opportunities to submit their programs to be evaluated for correctness, running time, and quality of solutions found. Project submission 1 is worth 5%, and project submission 2 is worth 5%.

The projected deadlines are:
- Project submission 1: due Friday Oct. 21.
- Project submission 2: due Friday Nov. 18.

The final project submission is worth 10% (CSC 425) or 20% (CSC 520) and is due on Monday December 12 at 11:59 pm.

Late policy for Assignments and Project submissions: Assignments (with the exception of the last assignment) and Project Submissions can be handed in up to 4 days late with a 10% penalty for each day past the deadline. Late submissions for the final assignment must be handed in at most 4 days late with a 10% penalty for each day it is late but will not be accepted any later than 2 days before the final exam.

Coursework Mark Appeals: Mark appeals can be done at any time and you are strongly encouraged to appeal if you feel your course work has been misgraded. Express your concern in writing on your submission and hand it to me for reconsideration. Appeals are accepted any time but please so them asap.

Keys to Success

Attend all classes.

Do all your homework.

Don't wait until the night before your work is due to start working on it.

Submit something if you have done some of the work.

Come see me (early and often) if you need help. I love working with students. Ask questions in class as well.

Join a study group but prepare your final submissions independently.

Come to class with your "brain open".

Be creative as you are solving problems.

Look for answers that come from "The Book".

Paul Erdős

Students with a disability

Please let me know as soon as possible how I can accommodate your disability.

Algorithm.

- [webster.com] A procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation.

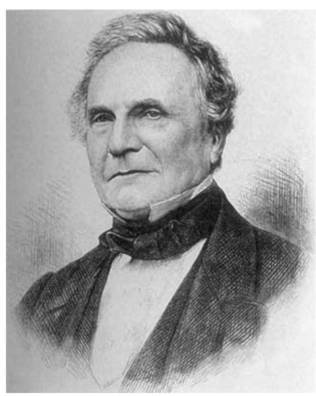
- [Knuth, TAOCP] An algorithm is a finite, definite, effective procedure, with some input and some output.

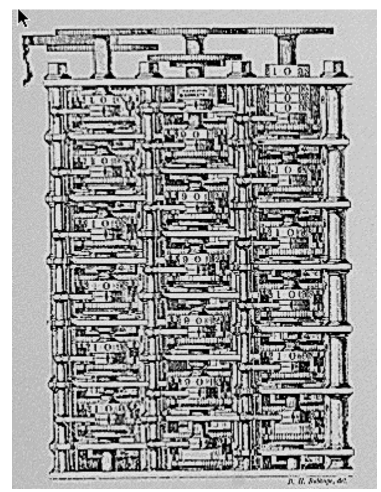
> Great algorithms are the poetry of computation. Just like verse, they can be terse, allusive, dense, and even mysterious. But once unlocked, they cast a brilliant new light on some aspect of computing. - *Francis Sullivan*

Slide author: Kevin Wayne (KW)

Theory of Algorithms

"As soon as an Analytic Engine exists, it will necessarily guide the future course of the science. Whenever any result is sought by its aid, the question will arise - By what course of calculation can these results be arrived at by the machine in the *shortest time*? *- Charles Babbage*





KW

Algorithmic Paradigms

Design and analysis of computer algorithms.

- Greedy.
- Divide-and-conquer.
- Dynamic programming.
- Network flow.
- Randomized algorithms.
- Intractability.
- Coping with intractability.

Critical thinking and problem-solving.

KW

Their impact is broad and far-reaching.

Internet. Web search, packet routing, distributed file sharing, ...

Biology. Human genome project, protein folding, ...

Computers. Circuit layout, file system, compilers, ...

Computer graphics. Movies, video games, virtual reality, ...

Security. Cell phones, e-commerce, voting machines, ...

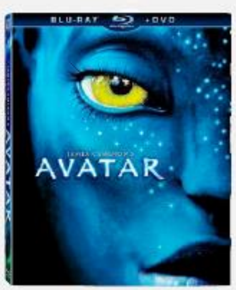
Multimedia. MP3, JPG, DivX, HDTV, face recognition, ...

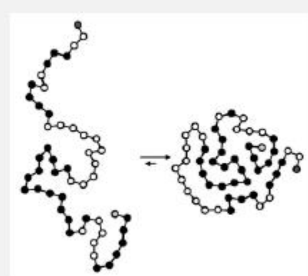
Social networks. Recommendations, news feeds, advertisements, ...

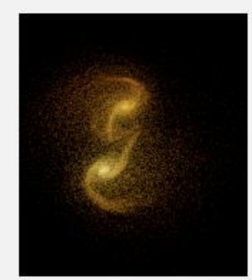
Physics. N-body simulation, particle collision simulation, ...

KW

...





Applications

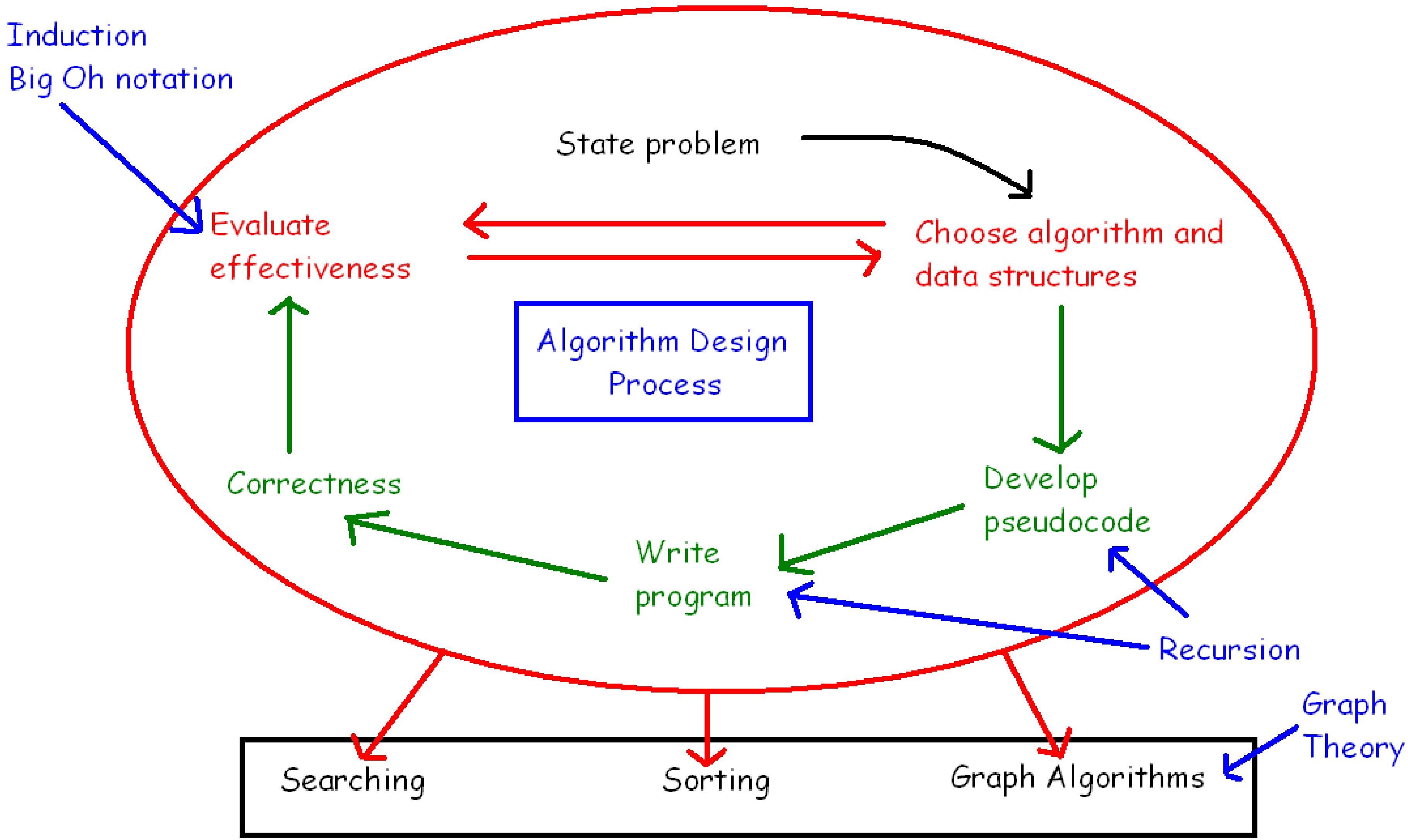
Wide range of applications.

- Caching.
- Compilers.
- Databases.
- Scheduling.
- Networking.
- Data analysis.
- Signal processing.
- Computer graphics.
- Scientific computing.
- Operations research.
- Artificial intelligence.
- Computational biology.
- . . .

We focus on algorithms and techniques that are useful in practice.

KW

CSC 225:



Applications to demonstrate how the process works

CSC 425/520 continues the study of algorithm design from CSC 225.

Main differences:

Some of the problems presented will be messier and it will be up to you to formalize them into a precise problem statement and select algorithms for them.

More emphasis on problem solving.

More emphasis on algorithm design tactics.

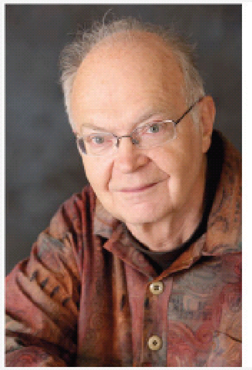
CSC 225 covered only very simple problems solvable in polynomial time. We will cover harder problems where no polynomial time algorithms are currently know and investigate strategies for tackling them.

Slide by: Kevin Wayne
Princeton University

Why study algorithms?

For intellectual stimulation.

> " *For me, great algorithms are the poetry of computation. Just like verse, they can be terse, allusive, dense, and even mysterious. But once unlocked, they cast a brilliant new light on some aspect of computing.* " — *F. Sullivan*

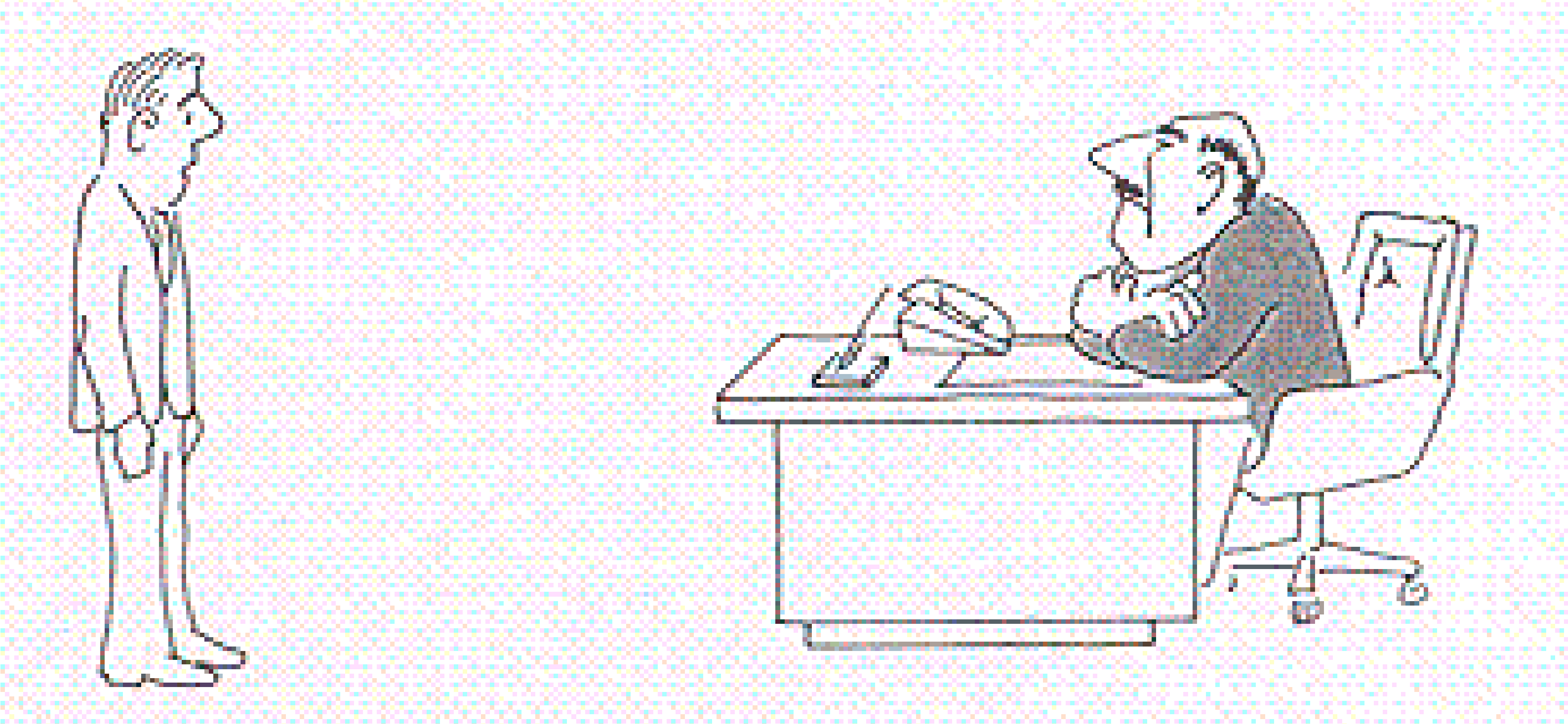


> " *An algorithm must be seen to be believed.* " — *D. E. Knuth*

Skills to be developed/enhanced:

- getting to the mathematical core of problems,
- improving mathematical and algorithmic writing,
- enhancing programming skills,
- performing a literature review for a problem,
- preparing visual aids and presenting a talk,
- identifying appropriate algorithms and data structures,
- analysis of algorithms for time and space complexity,
- understanding of algorithm design methodologies,
- identification of difficult questions and finding strategies to cope with them.

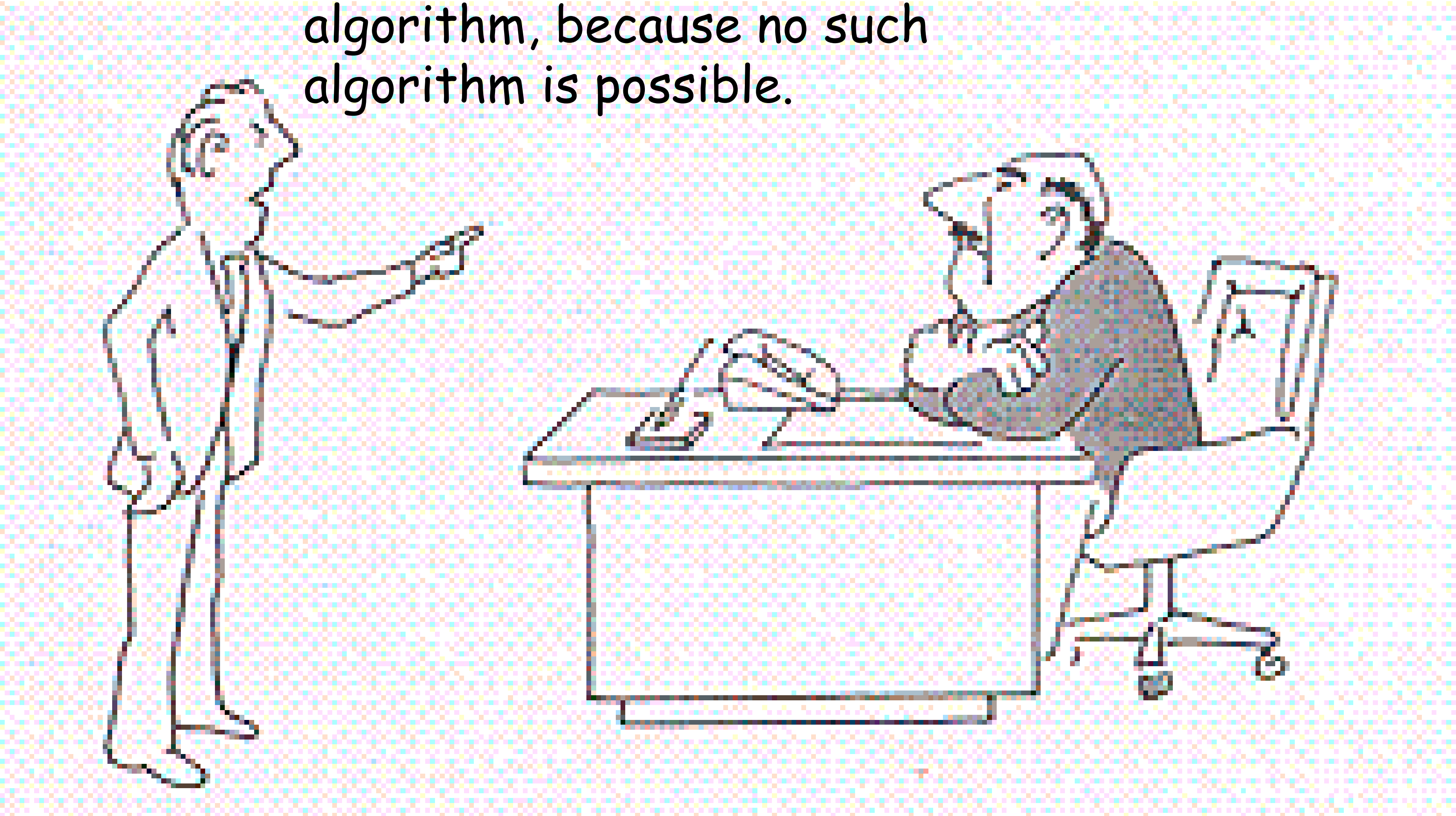
NP-completeness

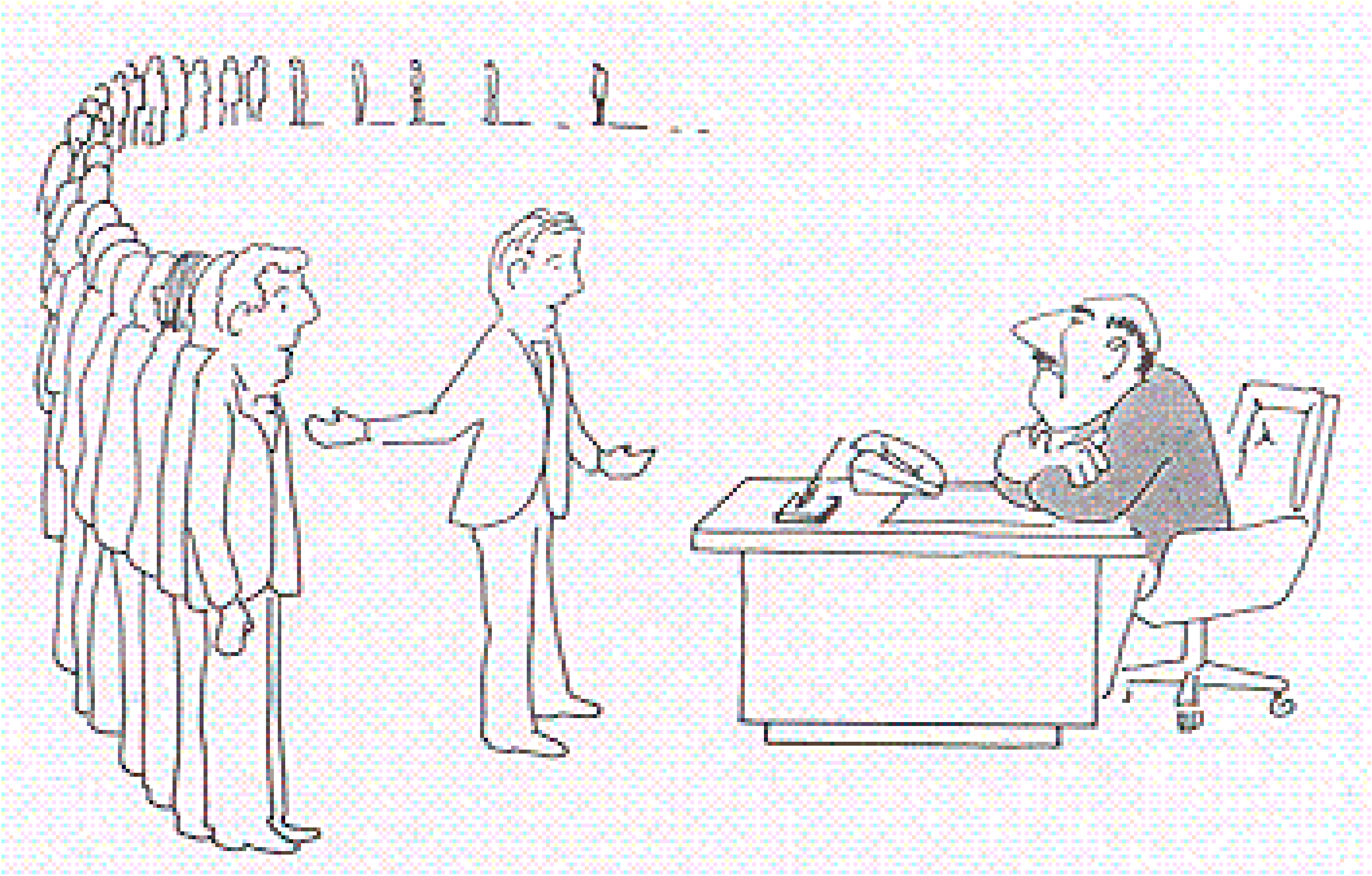


I can't find an efficient algorithm,

I guess I'm just too dumb.

I can't find an efficient
algorithm, because no such
algorithm is possible.

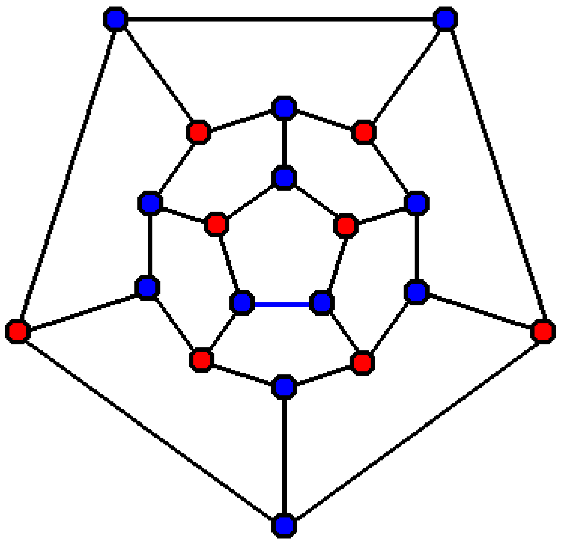




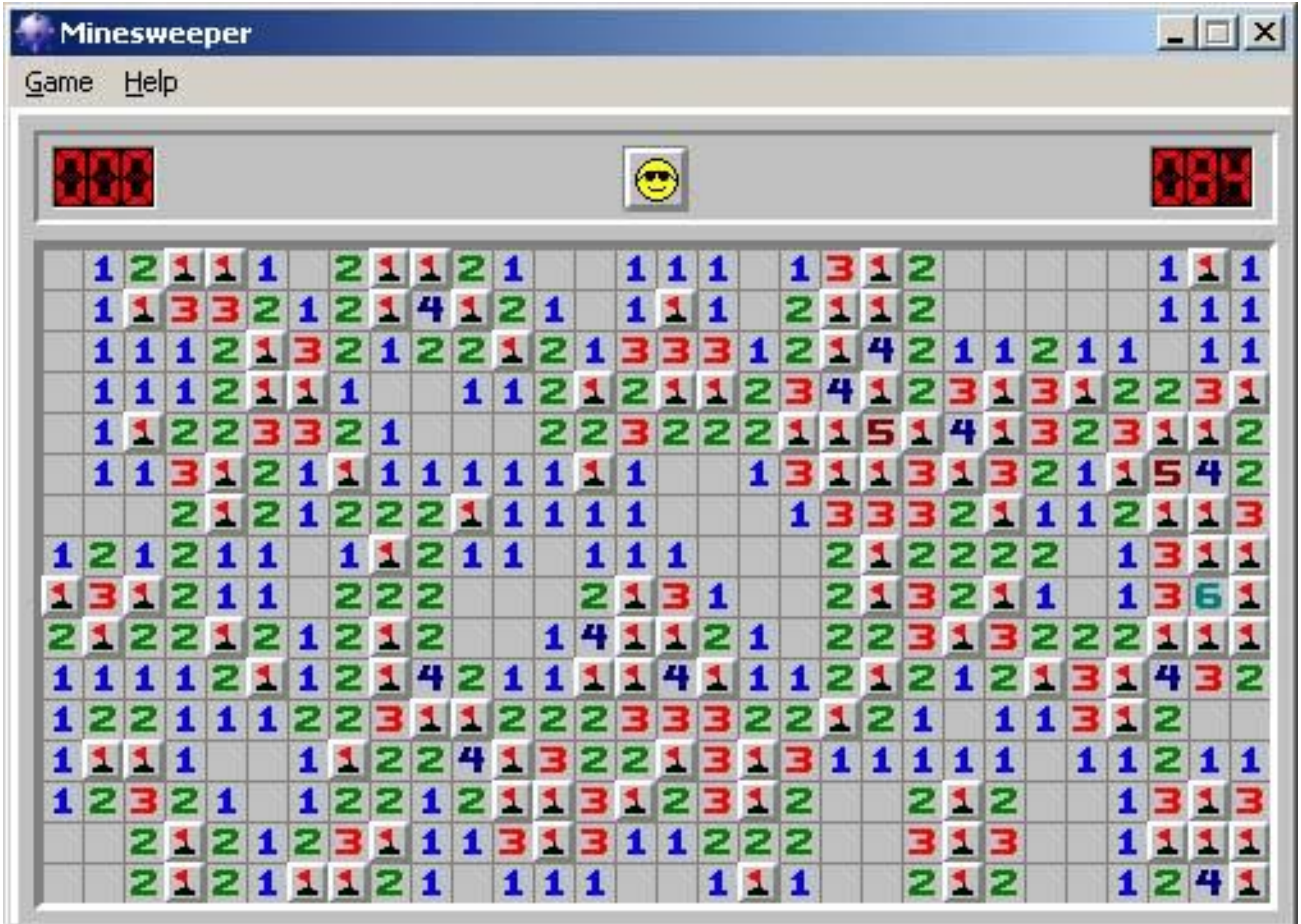
I can't find an efficient algorithm, but neither can all these famous people.

Some NP-complete Problems

- Graph 3-colouring
- Travelling Salesman Problem
- Independent Set
- Boolean Satisfiability
- Bin packing
- Scheduling



Either all of these of none of them has a polynomial time ($O(n^k)$ for a constant k) algorithm. There is a million dollars for the first person to prove this either way.


Minesweeper
Game
Help

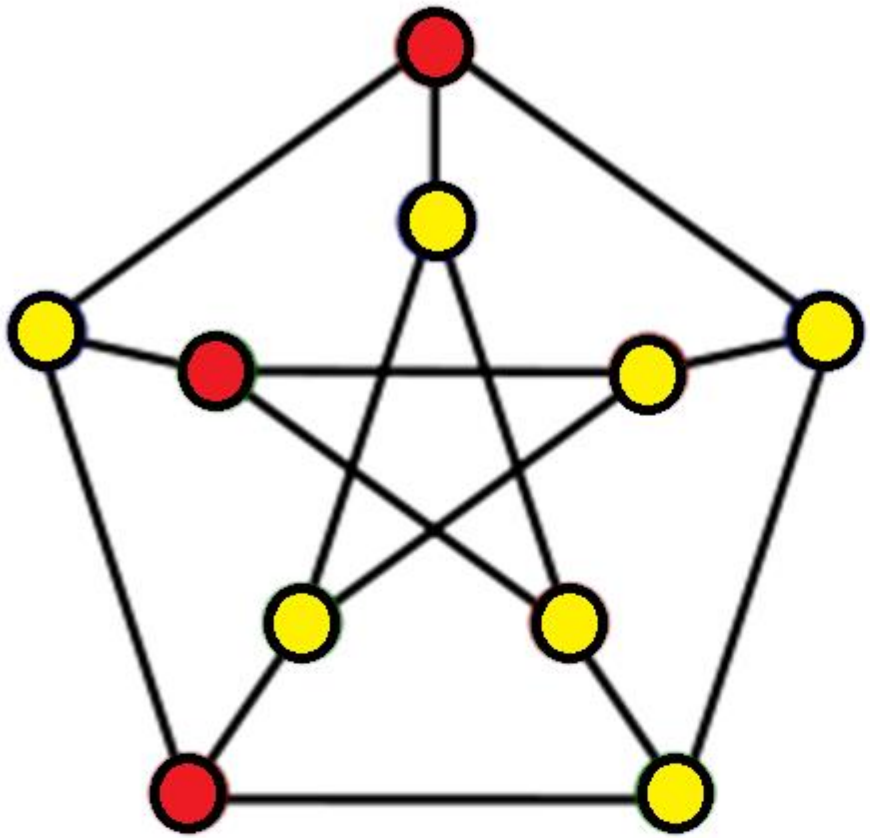
Ian Stewart on Minesweeper:

It's not often you can win a million dollars by analysing a computer game, but by a curious conjunction of fate, there's a chance that you might. However, you'll only pick up the loot if all the experts are wrong and a problem that they think is extraordinarily hard turns out to be easy.

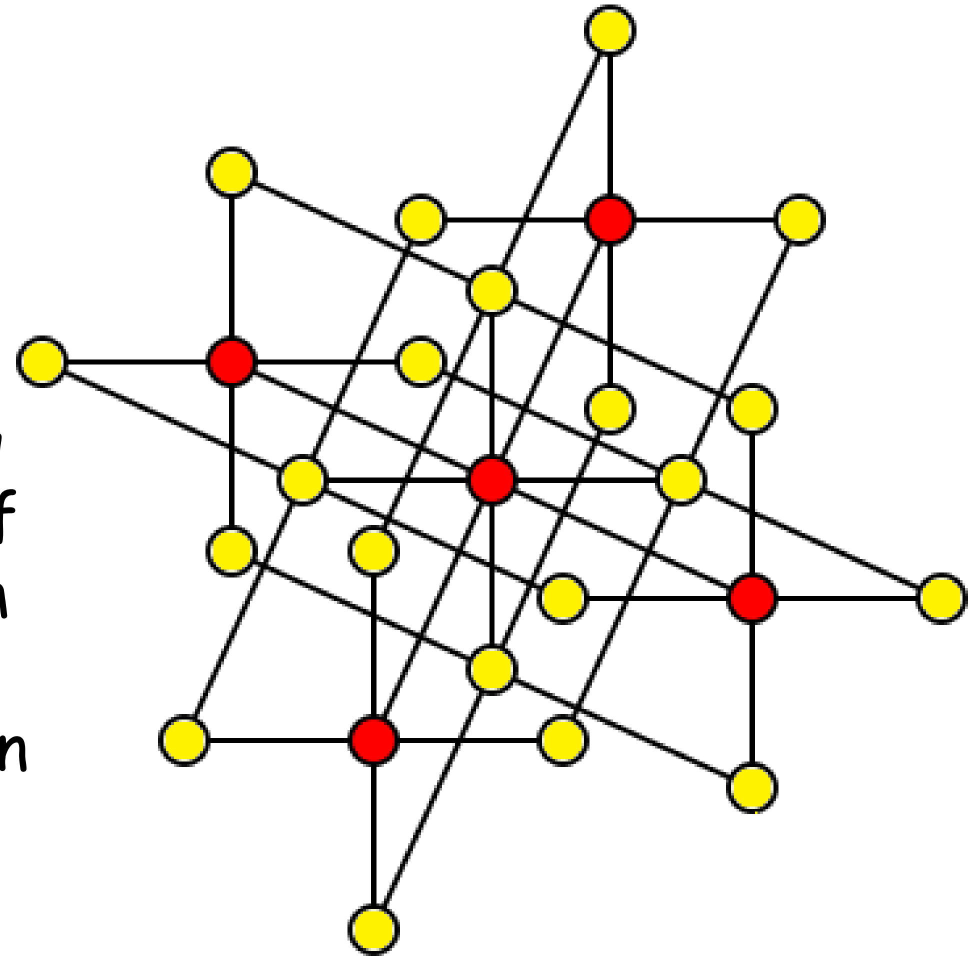
The prize is one of seven now on offer from the newly founded Clay Mathematics Institute in Cambridge MA, set up by businessman Landon T. Clay to promote the growth and spread of mathematical knowledge, each bearing a million-buck price-tag. The computer game is Minesweeper, which is included in Microsoft's Windows operating system, and involves locating hidden mines on a grid by making guesses about where they are located and using clues provided by the computer. And the problem is one of the most notorious open questions in mathematics, which rejoices in the name 'P=NP?'.

You won't win the prize by winning the game. To win the prize, you will have to find a really slick method to answer questions about Minesweeper when it's played on gigantic grids and all the evidence suggests that there isn't a slick method. In fact, if you can prove that there isn't one, you can win the prize that way too.

A *dominating set* of a graph G is a subset D of the vertices of G such that every vertex v of G is either in the set D or v has at least one neighbour that is in D.

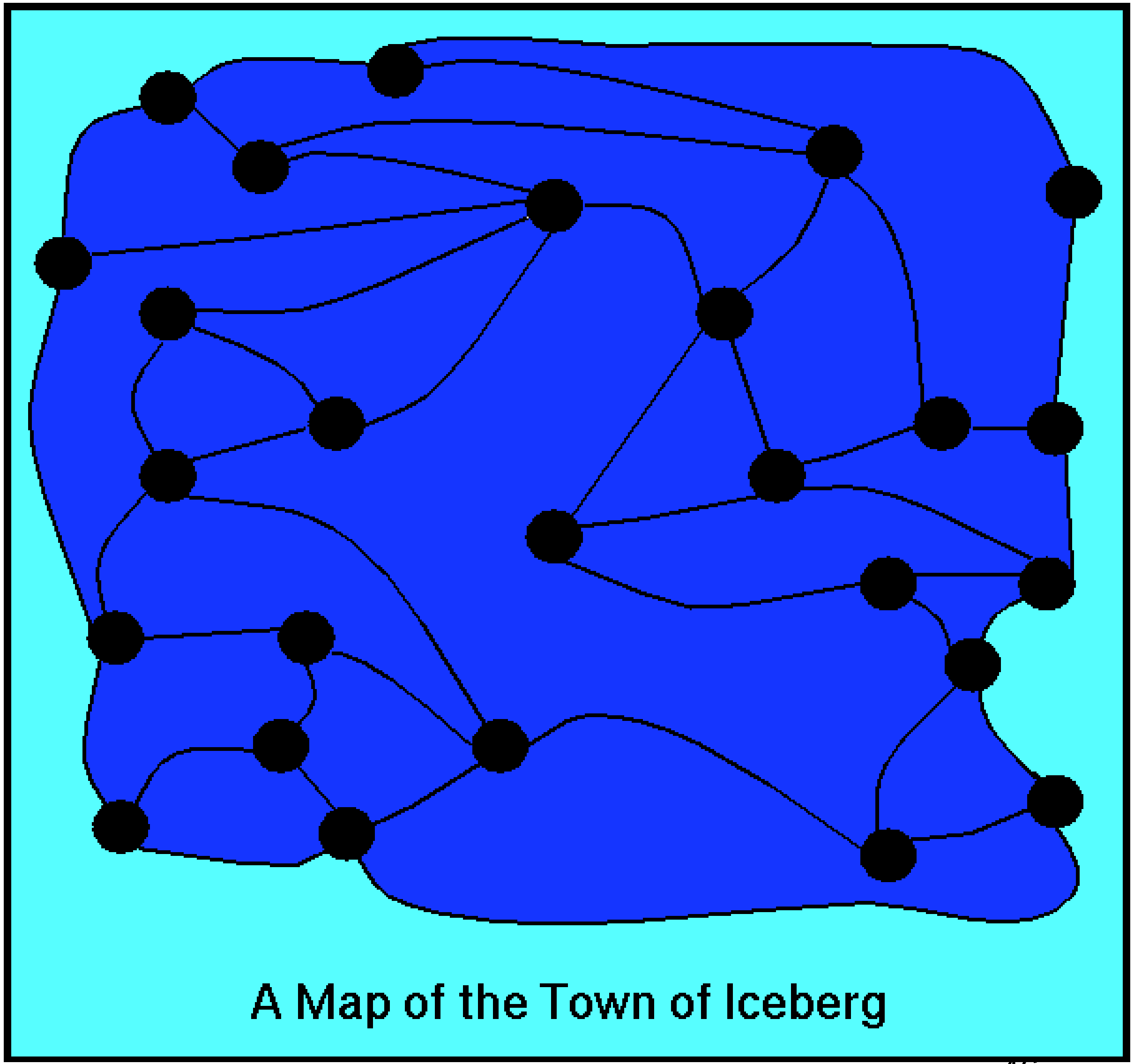


Vizing's conjecture concerns a relation between the domination number and the cartesian product of graphs. This conjecture was first stated by Vadim G. Vizing (1968), and states that, if $\gamma(G)$ denotes the minimum number of vertices in a dominating set for G, then $\gamma(G \square H) \geq \gamma(G)\gamma(H)$.

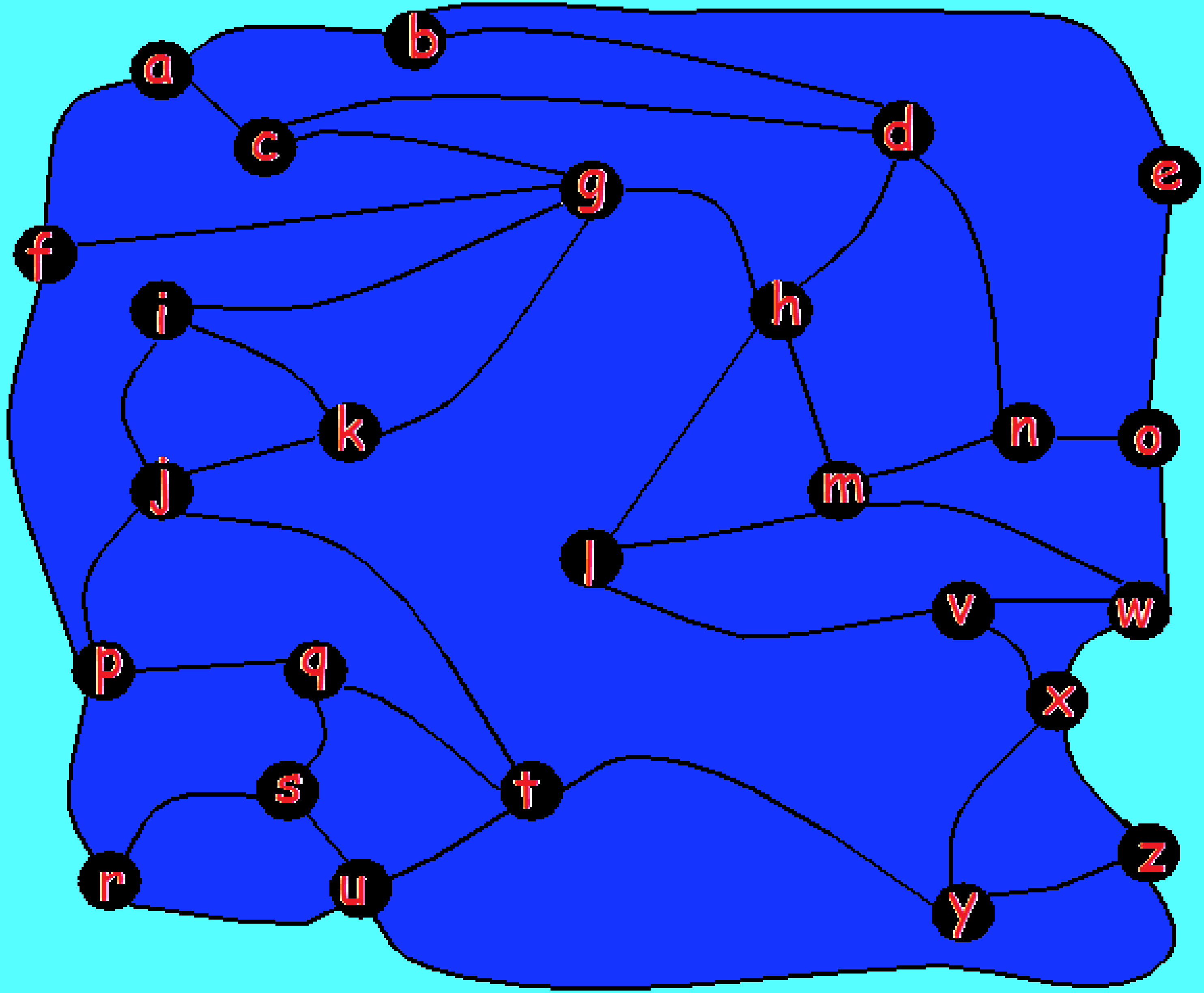


Conjecure predicts ≥ 1 for this graph so it is not tight.

http://en.wikipedia.org/wiki/Vizing's_conjecture http://www.bad-perm.com/2012/01/man-gets-hit-by-ice-cream-truck-while-doing-the-dougie/



http://www.ccs3.lanl.gov/mega-math/workbk/dom/dom1.gif



A Map of the Town of Iceberg