Advanced Algorithms
– Course Presentation –

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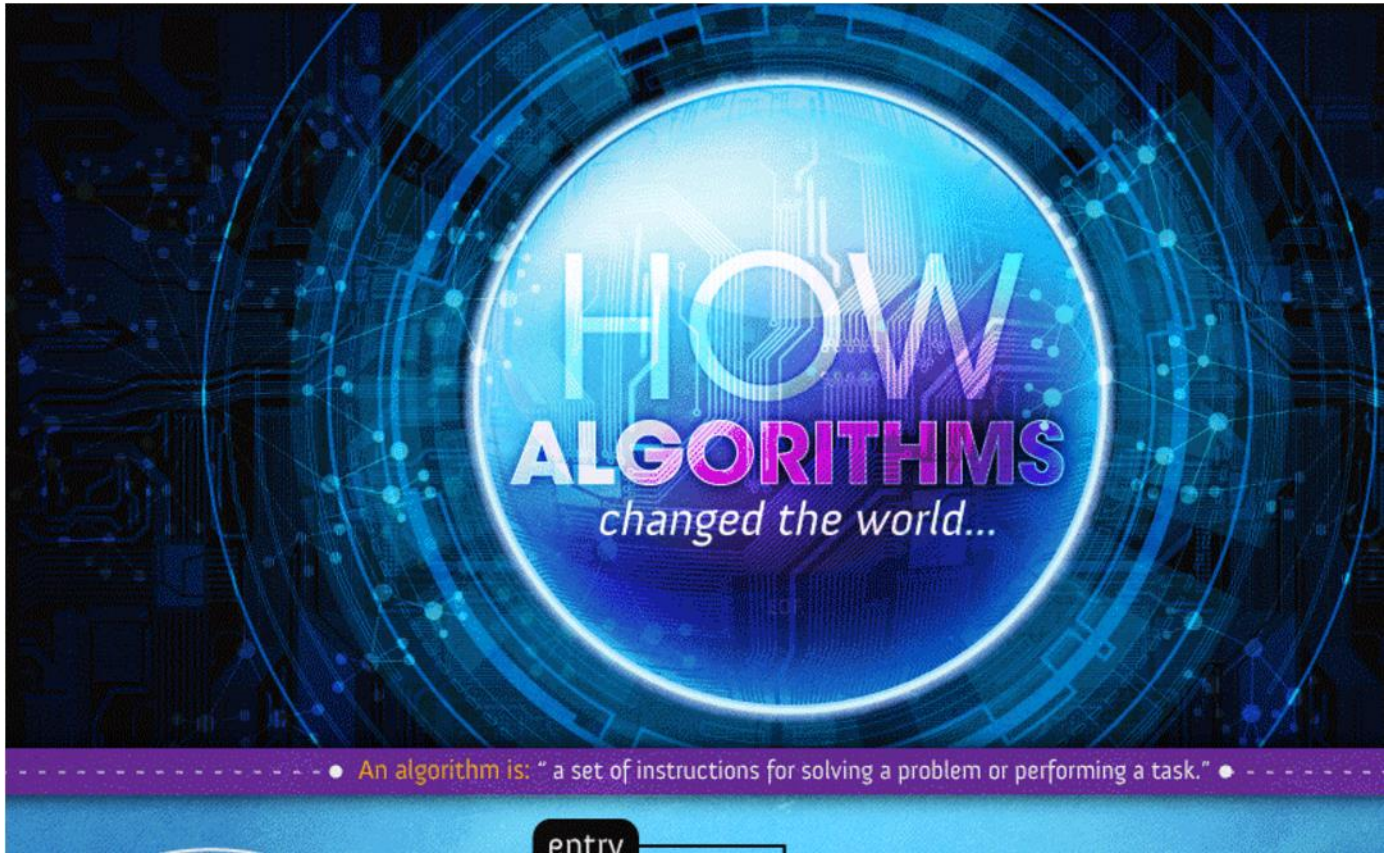
Version 0.2 – September 2018

Algorithms have changed the world !

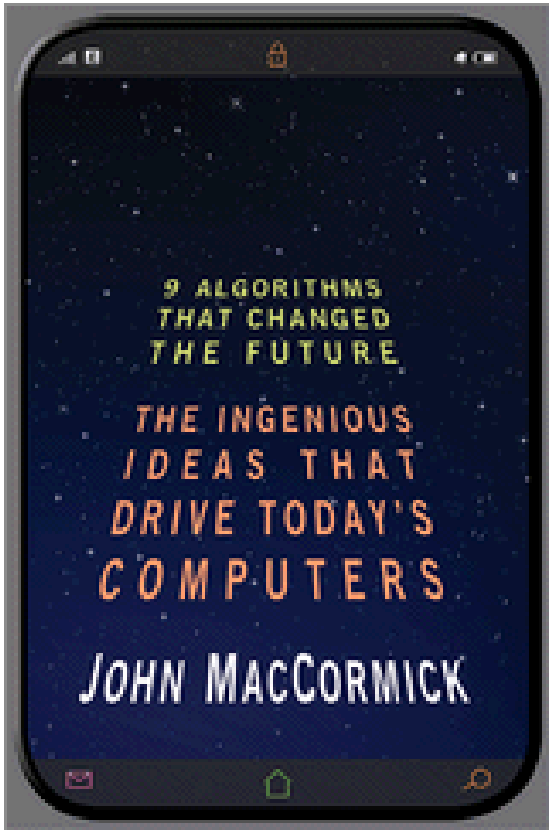


Check the infographic on the Web

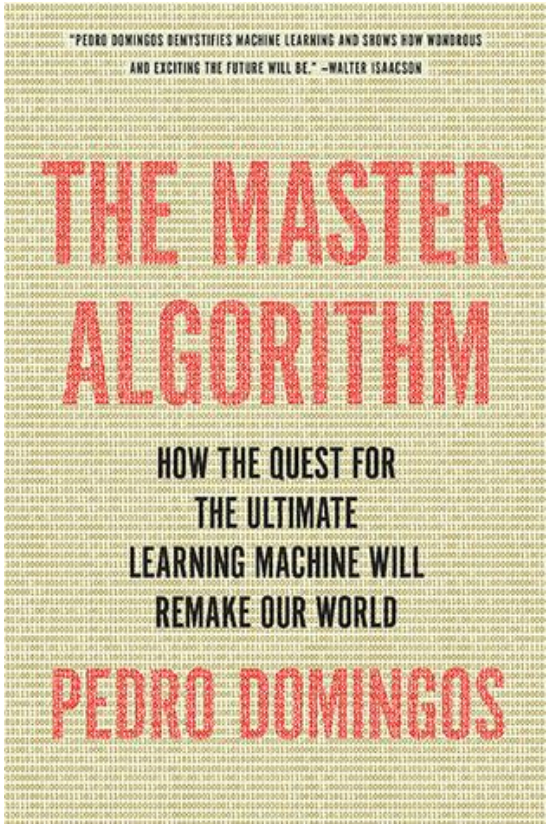
Top 10 algorithms of the 20th century

Special issue of IEEE CiSE, Jan/Feb 2000

There are even best-sellers !!



[2012]



[2015]

Algorithm failures !!

11 May 2018 | 17:40 GMT

450,000 Women Missed Breast Cancer Screenings Due to "Algorithm Failure"

A disclosure in the United Kingdom has sparked a heated debate about the health impacts of an errant algorithm

By **Robert N. Charette (/author/charette-robert-n)**

Nearly half a million elderly women in the United Kingdom missed mammography exams because of a scheduling error caused by one incorrect computer algorithm, and several hundred of those women may have died early as a result.

[https://spectrum.ieee.org/riskfactor/computing/it/450000-woman-missed-breast-cancer-screening-exams-in-uk-due-to-algorithm-failure]

Goals

- Review main algorithm design strategies
- Introduce probabilistic / randomized algs.
- Apply probabilistic methods to large-scale (big-data) problems
- Explore problems from different application areas

Goals

- BUT, course contents and depth can be somewhat adapted to your background and interests…

- Today's lecture and the first weeks should show us how we can proceed…

Why Big-Data ?

- Many of today's data sets cannot be processed by conventional methods
  - Within a reasonable amount of time !

- Why?
  - Volume – Huge data volumes
  - Variety – Different data modalities
  - Velocity – Rapid generation and/or growth

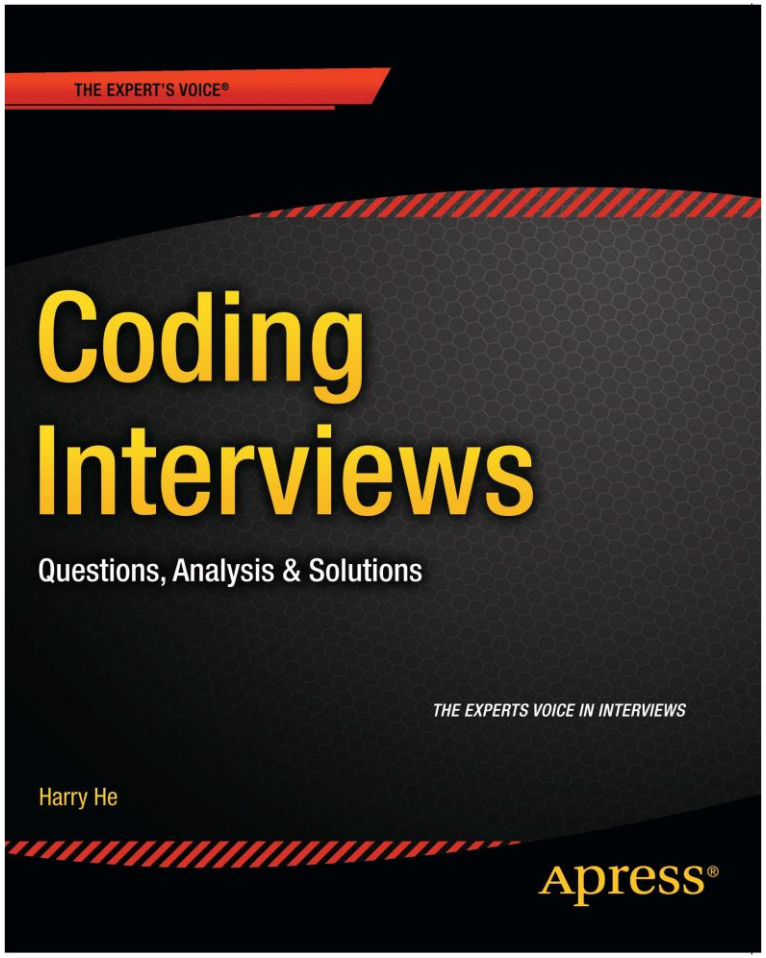
Tentative Syllabus

- Algorithm complexity analysis – Review
  - Complexity classes / Formal and empirical analysis
- Algorithm design strategies – Review
  - Brute-force / Divide-and-Conquer / …
- Deterministic vs Probabilistic algorithms
  - Las Vegas and Monte Carlo algorithms
- Probabilistic counting
- Sets and membership
- …

Technical Job Interviews – Skills

- Basic programming knowledge, including understanding of programming languages, data structures, and algorithms
- Abilities to write clean, complete, and robust code
- Capabilities to analyze and solve complex problems
- Abilities to improve time and space efficiencies
- Skills involving communication, learning, divergent thinking, etc.

Harry He's book



Programming Language

- Python 3 !!
- If you are at ease with it, that's great !!
- Otherwise, it is easy to learn the basics and start coding quickly…
  - And it will be an important addition to your portfolio !

IEEE Spectrum – Top prog. languages

[https://spectrum.ieee.org/static/interactive-the-top-programming-languages-2018]

Grading / Assessment

- Mixed grading
  - 60% – Individual assignments / projects
    - Code + Report + Presentation / Analysis
  - 10% – Class participation / work
    - Programming + Analysis
  - 30% – Final written examination
    - Multiple-choice + True / False questions
    - Algorithm development (?)

Class Organization

- 1st part (approx. 1 hour) : Lecture / presentation
- (Very) Short break ☺
- 2nd part : Design / programming / testing

- Bring your own computer !
- Individual work during classes !

Bibliography – The basics

- T. H. Cormen et al., *Introduction to Algorithms*, 3rd Ed., MIT Press, 2009
- J. Kleinberg and E. Tardos, *Algorithm Design*, Pearson, 2006
- D. Vrajitoru and W. Knight, *Practical Analysis of Algorithms*, Springer 2014
- …

Bibliography

- J. Hromkovic, *Design and Analysis of Randomized Algorithms*, Springer, 2005
- J. Leskovec, A. Rajaraman and J. D. Ullman, *Mining of Massive Datasets*, 2nd Ed., C. U. Press, 2014
- …