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# List of Algorithms

A complete list of all major algorithms (300), in any domain. The goal is to provide a ready to run program for each one, or a description of the algorithm. Programming languages include Java, JavaScript and PHP, C, C++ either in direct form or generated from a Scriptol source.

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## Automata

- **Powerset construction.** Algorithm to convert nondeterministic automaton to deterministic automaton.
- **Todd-Coxeter algorithm.** Procedure for generating cosets.

## Artificial intelligence

- **Alpha-beta.** Alpha max plus beta min. Basic algo used to find the best move in board games.
- **Ant-algorithms.** The ant colony optimisation is a set of algorithms inspired by ant behavior to solve a problem, find the best path between two locations.
- **CLA.** Cortical Learning Algorithm. For robotic learning, based on three properties, sparse distributed representation, temporal inference, on-line learning. Code available through the [NuPic](#) project from Numenta.
- **DE** (Differential evolution). Solve the Chebyshev polynomial fitting problem, which applies to electronic filters.
- **Semi-Supervised Recognition of Sarcastic Sentences in Online Product Reviews.**  
Algorithm that recognize sarcasms or irony in a tweet or an online document. A such algorithm will be essential for [humanoid robots](#) programming too.
- **Sentiment analysis.** Actually a combination of algos, naive Bayes, maximum entropy and SVM (Support Vector Machine classifieur).

## Computer vision

- **Epitome.** Represent an image or video by a smaller one.
- **Counting objects in an image.** Uses the connected-component labeling algorithm to first label each object, and count then the objects.
- **Deep Dense Face Detector.** Farafade, Saberian and Li. Able to recognize face even with different angles.
- **Evolution-Constructed Features.** Brigham Young University. For the ability to identify known objects and add new objects to the knowledge base without human intervention.
- **O'Carroll algorithm.** From a mathematical conversion of insect vision, this algorithm evaluates how to get around avoiding objects.
- **Tracking-Learning Detection.** Detects moving objects and follows them.
- **Viola-Jones** object detection framework, simple and fast. Able to recognize human faces, it is implemented in OpenCV.

## Genetic algorithms

They uses three operator. selection (choose solution), reproduction (use choosen solutions to construct other ones), replacement (replace solution if better).

- **Fitness proportionate selection.** Also known as roulette-wheel selection, is a function used for selecting solutions.
- **Truncation selection.** Another method for selecting solutions, ordered by fitness.
- **Tournament selection.** Select the best solution by a kind of tournament.
- **Stochastic universal sampling.** The individuals are mapped to contiguous segments of a line, such that each individual's segment is equal in size to its fitness exactly as in roulette-wheel selection.

## Neural networks

- **Hopfield net.** Recurrent artificial neural network that serve as content-addressable memory systems with binary threshold units. They converge to a stable state.
- **Backpropagation.** Supervised learning technique used for training artificial neural networks.
- **Self-organizing map (Kohonen map).** Neural networks trained using unsupervised learning to produce low dimensional (2D, 3D) representation of the training samples. Good for visualizing high-dimensional data.

## Machine learning

- **PAVA** (Pool-Adjacent-Violators Algorithm). Leeuw, Hornik, Mair. Improve a function for a set of points. Optimize the isotonic regression. [C++ code](#).
- **Multiplicative Weights.** Assigns weights to different strategy to make a decision. This applies to objects recognition and is found also in natural genetics.

## Bioinformatics and Cheminformatics

- **Needleman-Wunsch.** Performs a global alignment on two sequences, for protein or nucleotide sequences.
- **Smith-Waterman.** Variation of the Needleman-Wunsch.
- **Ullmann's algorithm for subgraph isomorphism solving.** (1976). Determine if two graphs have isomorphic subgraphs.  
The maximum common subgraph isomorphism problem may be computed with a modular product graph.

## Compression

### Lossless compression algorithms

- **Burrows-Wheeler transform.** Preprocessing useful for improving lossless compression.
- **Deflate.** Data compression used by ZIP.

- **Delta encoding.** Aid to compression of data in which sequential data occurs frequently.
- **Incremental encoding.** Delta encoding applied to sequences of strings.
- **LZW.** (Lempel-Ziv-Welch). Successor of LZ78. Builds a translation table from the data to compress. Is used by the GIF graphical format.
- **LZ77 and 78.** The basis of further LZ variations (LZW, LZSS, ...). They are both dictionary coders.
- **LZMA.** Short for Lempel-Ziv-Markov chain-Algorithm.
- **LZO.** Data compression algorithm that is focused on speed.
- **PPM** (Prediction by Partial Matching). Adaptive statistical data compression technique based on context modeling and prediction.
- **Shannon-Fano coding.** Constructs prefix codes based on a set of symbols and their probabilities.
- **Truncated binary.** An entropy encoding typically used for uniform probability distributions with a finite alphabet. Improve binary encoding.
- **Run-length encoding.** Primary compression that replaces a sequence of same code by the number of occurrences.
- **Sequitur.** Incremental grammar inference on a string.
- **EZW** (Embedded Zerotree Wavelet). Progressive encoding to compress an image into a bit stream with increasing accuracy. May be lossy compression also with better results.

### **Entropy encoding**

Coding scheme that assigns codes to symbols so as to match code lengths with the probabilities of the symbols .

- **Huffman coding.** Simple lossless compression taking advantage of relative character frequencies.
- **Adaptive Huffman coding.** Adaptive coding technique based on Huffman coding.
- **Arithmetic coding.** Advanced entropy coding.
- **Range encoding.** Same as arithmetic coding, but looked at in a slightly different way.
- **Unary coding.** Code that represents a number n with n ones followed by a zero.
- **Elias delta, gamma, omega coding.** Universal code encoding the positive integers.
- **Fibonacci coding.** Universal code which encodes positive integers into binary code words.
- **Golomb coding.** Form of entropy coding that is optimal for alphabets following geometric distributions.
- **Rice coding.** Form of entropy coding that is optimal for alphabets following geometric distributions.

### **Lossy compression algorithms**

- **Linear predictive coding.** Lossy compression by representing the spectral envelope of a digital signal of speech in compressed form.
- **A-law algorithm.** Standard companding algorithm.
- **Mu-law algorithm.** Standard analog signal compression or companding algorithm.
- **Fractal compression.** Method used to compress images using fractals.
- **Transform coding.** Type of data compression for data like audio signals or photographic images.
- **Vector quantization.** Technique often used in lossy data compression.
- **Wavelet compression.** Form of data compression well suited for image and audio compression.

## **Cryptography**

### **Secret key (symmetric encryption)**

Use a secret key (or a pair of directly related keys) for both decryption and encryption.

- **Advanced Encryption Standard (AES),** also known as Rijndael.
- **Blowfish.** Designed by Schneier as a general-purpose algorithm, intended as a replacement for the aging DE.
- **Data Encryption Standard (DES),** formerly DE Algorithm.
- **IDEA** (International Data Encryption Algorithm). Formerly IPES (Improved PES), another replacement for DES. Is used by PGP (Pretty Good Privacy). Performs transformations on data splitted in blocks, using a key.
- **RC4** or ARC4. Stream cipher widely-used in protocols such as SSL for Internet traffic and WEP for wireless networks.
- **Tiny Encryption Algorithm.** Easy to implement block cipher algorithm using some formulas.
- **PES** (Proposed Encryption Standard). Older name for IDEA.

### **Public key (asymmetric encryption)**

Use a pair of keys, designated as public key and private key. The public key encrypt the message, only the private key permits to decrypt it.

- **DSA** (Digital Signature Algorithm). Generate keys with prime and random numbers. Was used by US agencies, and now public domain.
- **ElGamal.** Based on Diffie-Hellman, used by GNU Privacy Guard software, PGP, and other cryptographic systems.

- **RSA** (Rivest, Shamir, Adleman). Widely used in electronic commerce protocols. Use prime numbers.
- **Diffie-Hellman (Merkle) key exchange** (or exponential key exchange). Method and algorithm to share secret over an unprotected communications channel. Used by RSA.
- **NTRUEncrypt**. Make use of rings of polynomials with convolution multiplications.

### Message digest functions

A message digest is a code resulting of the encryption of a string or data of any length, processed by a hash function.

- **MD5**. Used for checking ISO images of CDs or DVDs.
- **RIPEMD** (RACE Integrity Primitives Evaluation Message Digest). Based upon the principles of MD4 and similar to SHA-1.
- **SHA-1** (Secure Hash Algorithm 1). Most commonly used of the SHA set of related cryptographic hash functions. Was designed by the NSA agency.
- **HMAC**. keyed-hash message authentication.
- **Tiger** (TTH). Usually used in Tiger tree hashes.

### Cryptographic using pseudo-random numbers

- See. [Random Number Generators](#)

### Techniques in cryptography

Secret sharing, Secret Splitting, Key Splitting, M of N algorithms.

- **Shamir's secret sharing scheme**. This is a formula based on polynomial interpolation.
- **Blakley's secret sharing scheme**. Is geometric in nature, the secret is a point in an m-dimensional space.

### Other techniques and decryption

- **Subset sum**. Given a set of integers, does any subset sum equal zero? Used in cryptography.
- **Shor's algorithm**. Quantum algorithm able to decrypt a code based on asymmetric functions such as RSA.

## Geometry

- **Gift wrapping**. Determining the convex hull of a set of points.
- **Gilbert-Johnson-Keerthi distance**. Determining the smallest distance between two convex shapes.
- **Graham scan**. Determining the convex hull of a set of points in the plane.
- **Line segment intersection**. Finding whether lines intersect with a sweep line algorithm.
- **Point in polygon**. Tests whether a given point lies within a given.
- **Ray/Plane intersection**.
- **Line/Triangle intersection**. Particular case of Ray/Plane intersection.
- **Polygonization of implicit surfaces**. Approximate an implicit surface with a polygonal representation.
- **Triangulation**. Method to evaluate the distance to a point from angles to other points, whose distance is known.

## Graphs

- **A\* tree search**. Search the optimal path between two nodes on a graph. Special case of best-first search that uses heuristics to improve speed.
- **3D Surface Tracker Technology**. Process to add images on walls in a video while hidden surfaces are taken into account.
- **Bellman-Ford**. Computes shortest paths in a weighted graph (where some of the edge weights may be negative).
- **Graph canonization**. Find a canonical form of a graph that is isomorphic to another graph. Used in cheminformatics.
- **Dijkstra's algorithm**. Computes shortest paths in a graph with non-negative edge weights.
- **Perturbation methods**. An algorithm that computes a locally shortest paths in a graph.
- **Floyd-Warshall**. Solves the all pairs shortest path problem in a weighted, directed graph.
- **Floyd's cycle-finding**. Finds cycles in iterations.
- **Johnson**. All pairs shortest path algorithm in sparse weighted directed graph.
- **Hopcroft-Karp algorithm**. From a bipartite graph, returns the maximum number of edges with no common endpoints. Alternatives are breadth-first and depth-first algos.
- **Kruskal**. Finds a minimum spanning tree for a graph.
- **Prim's**. Finds a minimum spanning tree for a graph. Also called DJP, Jarník or Prim-Jarník algorithm.
- **Boruvka**. Finds a minimum spanning tree for a graph.
- **Ford-Fulkerson**. Computes the maximum flow in a graph.
- **Edmonds-Karp**. Implementation of Ford-Fulkerson.

- **Nonblocking Minimal Spanning Switch.** For a telephone exchange.
- **Woodhouse-Sharp.** Finds a minimum spanning tree for a graph.
- **Spring based.** Algorithm for graph drawing.
- **Hungarian.** Algorithm for finding a perfect matching.
- **Coloring algorithm.** Graph coloring algorithm.
- **Nearest neighbour.** Find nearest neighbour.
- **Topological sort.** Sort a directed acyclic graph in such a manner that each node comes before all nodes to which it has edges (according to directions).
- **Tarjan's off-line least common ancestors algorithm.** Compute lowest common ancestors for pairs of nodes in a tree.

## Graphics

- **Bresenham's line algorithm.** Uses decision variables to plots a straight line between 2 specified points.
- **Colorization.** A process for coloring a picture or video in black and white, with a few strokes to mark the colors. [Examples](#).
- **Depixelizing Pixel Art.** Smoothing algorithm that converts an image in coarse pixels into a realistic picture. (Johannes Kopf and Dani Lischinski). [Demonstration](#). A [C++ implementation](#).
- **DDA line algorithm.** Uses floating-point math to plots a straight line between 2 specified points.
- **Flood fill.** Fills a connected region with a color.
- **HDR.** There are many algorithms for contrasting photos. [Here is a list](#).
- **Image Restoring.** Restore photo, improve images.
- **Xiaolin Wu's line algorithm.** Line antialiasing.
- **Painter's algorithm.** Detects visible parts of a 3-dimensional scenery.
- **Ray tracing.** Realistic image rendering.
- **Phong shading.** An illumination model and an interpolation method in 3D computer graphics.
- **Gouraud shading.** Simulate the differing effects of light and colour across the surface of a 3D object.
- **Scanline rendering.** Constructs an image by moving an imaginary line.
- **Global illumination.** Considers direct illumination and reflection from other objects.
- **Interpolation.** Constructing new data points such as in digital zoom.
- **Resynthesizer.** Remove an object on a photo and rebuild the background Used by Photoshop and The Gimp. [Resynthesizer tutorial](#) .
- **Slope-intercept algorithm.** It is an implementation of the slope-intercept formula for drawing a line.
- **Spline interpolation.** Reduces error with Runge's phenomenon.
- **3D Surface Tracker Technology.** Adding images or vidéo on walls in a vidéo, hidden surfaces being taken into account.

## Lists, arrays and trees

### Searching

- **Binary search algorithm.** Locates an item in a sorted list.
- **Breadth-first search.** Traverses a graph level by level.
- **Best-first search.** Traverses a graph in the order of likely importance using a priority queue.
- **Depth-first search.** Traverses a graph branch by branch.
- **Dictionary search.** See predictive search.
- **Disjoint-set** data structure and algorithm. With for application, [building a maze](#).
- **Hash table.** Associate keys to items in an unsorted collection, to retrieve them in a linear time.
- **Interpolated search.** See predictive search.
- **Median search.** In an unordered list of numbers. [Torben's](#) algo is slower but does not modify the input array.
- **Predictive search.** Binary like search which factors in magnitude of search term versus the high and low values in the search.
- **Selection algorithm.** Finds the  $k$ th largest item in a list.
- **Skip list.** Structure composed of linked lists for a quicker access, and algorithm or search/insertion.
- **Splay tree.** Binary tree with a function to place a node at the root and reorganize other accordingly.
- **Uniform-cost search.** A tree search that finds the lowest cost route where costs vary.

### Sorting

- **Binary tree sort.** Sort of a binary tree, incremental, similar to insertion sort.
- **Bogosort.** Inefficient random sort of a desk card.
- **Bubble sort.** For each pair of indices, swap the items if out of order.
- **Bucket sort.** Split a list in buckets and sort them individually. Generalizes pigeonhole sort.
- **Cocktail sort** (or bidirectional bubble, shaker, ripple, shuttle, happy hour sort). Variation of bubble sort that sorts in both directions each pass through the list.
- **Comb sort.** Efficient variation of bubble sort that eliminates "turtles", the small values near the end of the list and makes use of gaps between values.
- **Counting sort.** It uses the range of numbers in the list A to create an array B of this length. Indexes in B are

used to count how many elements in A have a value less than i.

- **Gnome sort.** Similar to insertion sort except that moving an element to its proper place is accomplished by a series of swaps, as in bubble sort.
- **Heapsort.** Convert the list into a heap, keep removing the largest element from the heap and adding it to the end of the list.
- **Insertion sort.** Determine where the current item belongs in the list of sorted ones, and insert it there.
- **Introsort.** Or introspective sort. It begins in quicksort and switches to heapsort at certain recursion level.
- **Merge sort.** Sort the first and second half of the list separately, then merge the sorted lists.
- **Pancake sort.** Reverse elements of some prefix of a sequence.
- **Pigeonhole sort.** Fill an empty array with all elements of an array to be sorted, in order.
- **Postman sort.** Hierarchical variant of bucket sort, used by post offices.
- **Quicksort.** Divide list into two, with all items on the first list coming before all items on the second list.; then sort the two lists. Often the method of choice.
- **Radix sort.** Sorts keys associated to items, or integer by processing digits.
- **Selection sort.** Pick the smallest of the remaining elements, add it to the end of the sorted list.
- **Shell sort.** Improves insertion sort with use of gaps between values.
- **Smoothsort.** See heapsort.
- **Stochastic sort.** See bogosort.

### Merging

- **Simple Merge.** Merge n sorted streams into one output stream. All the stream heads are compared, and the head with the least key is removed and written to the output.
- **k-way Merge sort (or p-way).** A merge sort that sorts a data stream using repeated merges.

## Logic programming

- **Davis–Putnam algorithm.** Checks the validity of a first-order formula.

## Mathematics

### Algebra

- **Buchberger's algorithm.** Finds a Gröbner basis.
- **Extended Euclidean algorithm.** Solves the equation  $ax+by=c$ .
- **Fourier transform multiplication.** For very big numbers, computing the fast Fourier transforms for two numbers, and multiplying the two results entry by entry.
- **Gram-Schmidt process.** Orthogonalizes a set of vectors.
- **Gauss-Jordan elimination.** Solves systems of linear equations.
- **Karatsuba multiplication.** Recursive algorithm efficient for big numbers. Derived from the Toom-Cook method.
- **Knuth-Bendix completion.** For rewriting rule systems.
- **Multivariate division.** For polynomials in several indeterminates.
- **Risch algorithm.** Translates indefinite integral to algebraic problem.
- **Toom-Cook (Toom3).** Splits each number to be multiplied into multiple parts.

### Eigenvalue algorithm

Algorithms to find the Eigenvalue and/or Eigenvector of a matrix.

- **QR algorithm.** A popular method based on the QR decomposition.
- **Inverse iteration.** Iterative eigenvalue algorithm.
- **Rayleigh quotient iteration.** Extends the principle of the inverse iteration by using the Rayleigh quotient to obtain increasingly accurate eigenvalue estimates.
- **Arnoldi iteration.** Compute the eigenvalues of the orthogonal projection of A onto the Krylov subspace.
- **Lanczos iteration.** Method to find a zero vector in the process of the quadratic sieve.
- **Jacobi method.** Numerical procedure for the calculation of all eigenvalues and eigenvectors of a real symmetric matrix
- **Bisection.**
- **Divide-and-conquer.** Apply to real symmetric matrices.

Eigenvector algorithms

- **Richardson eigenvector algorithm.**
- **Max-Plus.** Eigenvector algorithm for nonlinear H<sub>1</sub> control.
- **Abrams and Lloyd eigenvector algorithm.**

### Arithmetic

- **Binary GCD algorithm.** Efficient way of calculating greatest common divisor.
- **Booth's multiplication.** Multiply two signed numbers in two's complement notation.
- **Euclidean algorithm.** Computes the greatest common divisor.
- **Binary multiplication (Peasant or Egyptian multiplication).** Decomposes the larger multiplicand into a sum of powers of two and creates a table of doublings of the second multiplicand.

### *Discrete logarithm in group theory*

- **Baby-step giant-step.** This is a series of well defined steps to compute the discrete logarithm.
- **Pollard's rho algorithm for logarithms.** Analogous to Pollard's rho algorithm for integer factorization but solves the discrete logarithm problem.
- **Pohlig-Hellman algorithm.** Solves the problem for a multiplicative group whose order is a smooth integer. Based on the Chinese remainder theorem and runs in polynomial time.
- **Index calculus algorithm.** Best known algorithm for certain groups, as the multiplicative group modulo  $m$ .

### *Integer factorization*

Breaking an integer into its prime factors . Also named prime factorization.

- **Fermat's factorization method.** A representation of an odd integer as the difference of two squares.
- **Trial division.** The simplest of the integer factorization algorithms. Try to divide the integer  $n$  by every prime number.
- **Lenstra elliptic curve factorization** or elliptic curve factorization method (ECM). Fast, sub-exponential running time, employs elliptic curves.
- **Pollard's rho** . Variation of Pollard's  $p-1$  that is effective at splitting composite numbers with small factors.
- **Pollard's  $p-1$ .** A special-purpose algorithm, that is only suitable for integers with specific types of factors.
- **Congruence of squares.** Finding a congruence of squares modulo  $n$  is a mean to factor the integer  $n$ .
- **Quadratic sieve.** Uses the idea of Dixon's method. It is a general-purpose algorithm that is simpler than the number field sieve and the fastest for integers under 100 decimal digits.
- **Dixon's factorization method.** General-purpose integer factorization algorithm.
- **Special number field sieve.** Special-purpose algorithm ideal for Fermat numbers.
- **General number field sieve (GNS).** Derived from special number field sieve. Efficient algorithm known for factoring big integers. Uses steps to factor the integer.

### *Prime test*

Determining whether a given number is prime.

- **AKS primality test (Agrawal-Kayal-Saxena).** The first published algorithm to be simultaneously polynomial, deterministic, and unconditional. Generalization of Fermat's theorem, extended to polynomials.
- **Fermat primality test.** Rely on an equality or set of equalities that hold true for prime values, and then see whether or not they hold for the number to test.
- **Miller-Rabin primality test.** Similar to the Fermat primality test. Unconditional probabilistic algorithm.
- **Sieve of Eratosthenes.** Ancient algorithm for finding all prime numbers up to a specified integer.
- **Sieve of Atkin.** Optimized version of the sieve of Eratosthenes.
- **Solovay-Strassen primality test.** Same principle as the Fermat test.

### *Numerical*

- **Fibonacci.** Calculating the sequence of Fibonacci.
- **Biconjugate gradient method.** Solves systems of linear equations.
- **Dancing Links.** Finds all solutions to the exact cover problem.
- **De Boor algorithm.** Computes splines.
- **De Casteljau's algorithm.** Computes Bezier curves.
- **False position method.** Approximates roots of a function.
- **Gauss-Legendre.** Computes the digits of  $\pi$ .
- **Kahan summation.** A more accurate method of summing floating-point numbers.
- **MISER.** Monte Carlo simulation, numerical integration.
- **Newton's method.** Finds zeros of functions with calculus.
- **Rounding functions.** The classic ways to round numbers.
- **Secant method.** Approximates roots of a function.
- **Shifting nth-root.** Digit by digit root extraction.
- **Square root.** Approximates the square root of a number.
- **Borwein's algorithm.** Calculates the value of  $1/e$ .
- **Metropolis-Hastings.** Generate a sequence of samples from the probability distribution of one or more variables.

### *Matrix processing*

- **Exponentiating by squaring.** Quickly computes powers of numbers and matrices.



- **Rutishauser.** Algorithm for tridiagonalizing banded matrices. Uses the standard chasing step.
- **Strassen algorithm.** Faster matrix multiplication.
- **Symbolic Cholesky decomposition.** Efficient way of storing sparse matrix.
- **Zha's algorithm.** For tridiagonalizing arrowhead matrices, improves Rutishauser.
- **Matrix chain multiplication.** Given a sequence of matrices, we want to find the most efficient way to multiply these matrices together using dynamic programming (not to perform the multiplication).

## Optic

- **Gerchberg Saxton.** algorithm for the determination of the phase from image and diffraction plane pictures.

## Optimization

See also [Graphs](#).

- **Almost Linear Max Flow.** An algorithm by Kelner, Tat Lee, Orecchia, Sidford for maximum flow considering all paths simultaneously.
- **Ant colony optimization.** Probabilistic technique for solving problems which can be reduced to finding good paths through graphs.
- **BFGS** (Broyden-Fletcher-Goldfarb-Shanno method). Solves a unconstrained nonlinear optimization problem.
- **Branch and bound.** Method to find optimal solutions of discrete and combinatorial optimization problems.
- **Conjugate gradient method.** Iterative algorithm for the numerical solution of systems of linear equations, whose matrix is symmetric and positive definite.
- **Evolution strategy.** Technique based on ideas of adaptation and evolution. Operators are. mating selection, recombination, mutation, fitness function evaluation, and environmental selection.
- **Gauss-Newton.** An algorithm for solving nonlinear least squares problems.
- **Gradient descent.** Approaches a local minimum of a function by taking steps proportional to the negative of the gradient (or the approximate gradient) of the function at the current point.
- **Gradient ascent.** Approaches a local maximum of a function, as gradient descent but one takes steps proportional to the gradient.
- **Levenberg-Marquardt.** Numerical solution to the problem of minimizing a sum of squares of several, generally nonlinear functions that depend on a common set of parameters.
- **Line search.** Iterative approaches to find a local minimum of an objective function in unconstrained optimization.
- **Local search.** Metaheuristic for solving hard optimization problems as maximizing a criterion among a number of candidate solutions.
- **Nelder-Mead method** (downhill simplex method). A nonlinear optimization algorithm.
- **Newton's method in optimization.** The same algorithm to find roots of equations in one or more dimensions can also be used to find local maxima and local minima of functions.
- **Paxos.** Set of distributed algorithms to achieve consensus among several proposals and many factors.
- **PSO, Particle swarm optimization.** Swarm intelligence modeled by particles in multidimensional space that have a position and a velocity.
- **Random-restart hill climbing.** Meta-algorithm built on top of the hill climbing optimization algorithm.
- **Simplex algorithm.** An algorithm for solving the linear programming problem
- **Simulated annealing.** Generic probabilistic meta-algorithm for the global optimization problem, inspired by annealing in metallurgy.
- **Steepest descent.** see gradient descent.
- **Stochastic tunneling.** Approach to minimize a function based on the Monte Carlo method-sampling.
- **Tabu search.** optimization method of search algorithm by using memory structures.
- **Trust search.** Another iterative approaches to find a local minimum of an objective function in unconstrained optimization.

## Parsing

- **CYK (Cocke-Younger-Kasami).** An efficient  $O(n^3)$  algorithm for parsing any CNF context-free grammar.
- **Earley's algorithm.** A chart parser,  $O(n^3)$  algorithm for parsing any context-free grammar.
- **Inside-outside.** An  $O(n^3)$  algorithm for re-estimating production probabilities in probabilistic context-free grammars.

### LL Parsers

Parse a LL context-free grammar top-down from left to right.

Such as [ANTLR](#) that is LL(\*).

### LR Parsers

Bottom-up parsers for context-free grammars.



- **Dijkstra's shunting yard algorithm** is commonly used to implement operator precedence parsers which convert from infix notation to Reverse Polish notation (RPN).
- **LALR (Look-ahead LR)**. With a one-token look-ahead. Yacc/Bison use LALR(1)
- **SLR (Simple LR) parser**. An LR(0) modified to prevent shift-reduce and reduce-reduce conflicts. Remains inferior to LR(1).
- **Canonical LR parser** or LR(1) parser. Has a look-ahead of one token.
- **GLR**. (Generalized LR parser) by Masaru Tomita. An extension of an LR to handle nondeterministic or ambiguous grammars. It is efficient to parse natural language.

### Recursive Descent Parsers

Top-down parsers built from a set of mutually-recursive procedures that represent the production rules of the grammar.

- **Packrat parser**. A linear time parsing algorithm supporting context-free LL(k) grammars. Use backup and memoization (remembering its choices) to avoid non-termination.

### Prediction (statistics)

- **Baum-Welch**. Finds the unknown parameters of a Hidden Markov Model (HMM). It makes use of the forward-backward algorithm.
- **Viterbi**. Calculates the *Viterbi path*, a sequence of states that is most likely to appear in a sequence of event.

### Quantum

*Application of quantum computation to various categories of problems*

- **Grover's algorithm**. Provides quadratic speedup for many search problems.
- **Shor's algorithm**. Provides exponential speedup for factorizing a number.
- **Deutsch-Jozsa**. Criterion of balance for Boolean function.

### (Pseudo) Random number generators

- **Blum Blum Shub**. Based on a formula on prime numbers.
- **Mersenne twister**. By Matsumoto Nishimura, fast and with high period.
- **Lagged Fibonacci generator**. Improvement of Linear congruential generator, uses the Fibonacci sequence.
- **Linear congruential generator**. One of oldest, not the best, use three numbers to generate a sequence.
- **Yarrow algorithm**. By Bruce Schneier, John Kelsey, and Niels Ferguson. Cryptographically secure pseudorandom numbers generator, can also be used as a real random number generator, accepting random inputs from analog random sources.
- **Fortuna**. Allegedly an improvement on Yarrow algorithm.
- **Linear feedback shift register**. A shift register whose input bit is a linear function of its previous state. The first state is the seed.

### Sciences

#### Astronomy

- **Ephemerides**.
- **Positions of Moon** or other celestial objects.
- **Julian day**. Number of days that have elapsed since Monday, January 1, 4713 BC in the proleptic Julian calendar. The algorithm is a formula. Variations are: heliocentric, chronological, modified, reduced, truncated, Dublin Lillian julian day.
- **Julian date**. The Julian day, not rounded, decimal fraction.

#### Medical

- Computation useful in healthcare.
- Help to diagnosis.

### Signal processing

- **CORDIC**. Fast trigonometric function computation technique.
- **Rainflow-counting algorithm**. Reduces a complex stress history to a count of elementary stress-reversals for use in fatigue analysis.
- **Osem**. Algorithm for processing of medical images.

- **Goertzel algorithm.** Can be used for DTMF digit decoding.
- **Discrete Fourier transform.** Determines the frequencies contained in a (segment of a) signal.
  - **Fast Fourier transform**
  - **Cooley-Tukey FFT**
  - **Rader's FFT**
  - **Bluestein's FFT**
  - **Bruun's FFT**
  - **Prime-factor FFT**
- **Richardson-Lucy deconvolution.** Image de-blurring algorithm.
- **Elser Difference-Map.** X-Ray diffraction microscopy.
- **Shazam.** Recognition of a song by comparing signals and detecting what is unique.

## Software engineering

- **Algorithms for Recovery and Isolation Exploiting Semantics.** Recovery.
- **Unicode Collation.** Provides a standard way to put names, words or strings of text in sequence.
- **CHS conversion.** Converting between disk addressing systems.
- **Cyclic redundancy check.** Calculation of a check word.
- **Parity control.** Simple/fast error detection technique. Is a number even or odd?

## Memory allocation

- **Boehm garbage collector.** Conservative garbage collector.
- **Buddy memory allocation.** Algorithm to allocate memory such that fragmentation is less.
- **Generational garbage collector.** Fast garbage collectors that segregate memory by age.
- **Mark and sweep.**
- **Reference counting.** Simple memory manager that counts links to data and reclaims the space when the count is zero.

## Distributed systems

- **Lamport ordering.** A partial ordering of events based on the *happened-before* relation.
- **Snapshot.** A snapshot is the process of recording the global state of a system.
- **Vector clocks.** A total ordering of events.
- **Marzullo.** Distributed clock synchronization.
- **Intersection.** Another clock agreement algorithm.

## Operating systems algorithms

- **Banker.** Algorithm used for deadlock avoidance.
- **Page replacement.** Selecting the victim page under low memory conditions.
- **Bully.** Selecting new leader among many computers.

## Disk scheduling algorithms.

- **Elevator.** Disk scheduling algorithm that works like an elevator.
- **Shortest seek first.** Disk scheduling algorithm to reduce seek time.

## Process synchronisation algorithms.

- **Peterson.** Allows two processes to share a single-use resource without conflict, using shared memory for communication. Can be generalized.
- **Lamport's Bakery algorithm.** Improve the robustness of multiple thread-handling processes by means of mutual exclusion.
- **Dekker.** Another concurrent programming algorithm, as the Peterson's one.

## Scheduling algorithms

- **Earliest deadline first scheduling.** When an event occurs (end of task, new task released, etc.) the queue will be searched for the process closest to its deadline.
- **Fair-share scheduling.** Sharing cpu time between groups and users in groups. Another algorithm is called recursively to manage sharing of processes.
- **Least slack time scheduling or Least Laxity First.** Assigns priority based on the slack time (difference between the deadline, ready and run time) of a process.
- **List scheduling.** From an ordered list of processes with priorities, assign first to highest priority the available resources. Possible strategies: critical path, longest path, highest level first, longest processing time.
- **Multi level feedback queue.**
- **Rate-monotonic scheduling.** Optimal, preemptive, static-priority scheduling algorithm. Priority given in rate monotonic principle (first deadline is first processed).

- **Round-Robin scheduling.** Simplest algorithm, assigns time slices to each process without priority.
- **Shortest job next (or first).** Executes next the waiting process with the smallest execution time, is non-preemptive.
- **Shortest remaining time.** A version of shortest job next scheduling that terminates the running process before to choose another task.

## Texts

### Searching

- **Aho-Corasick.** Search in a text by building a table from words.
- **Bitap (or shift-or, shift-and, Baeza-Yates-Gonnet).** Fuzzy string searching algorithm developed by Udi Manber and Sun Wu.
- **Boyer-Moore string search.** Search in text by skipping sub-string not containing letters in the searched input.
- **Burrows Wheeler transform.** String transformation that may be used to search words in a text faster.
- **Knuth-Morris-Pratt.** Build a table when searching to skip sub-string.
- **Rabin-Karp string search.** Use hashing for multiple searches.
- **Longest common subsequence problem.** Haskell's algorithm. Of two sequences.
- **Longest increasing subsequence problem.** Of two sequences. It also reduces to find the longest path in a directed acyclic graph.
- **Shortest common supersequence.** Of two sequences.
- **Horspool.** Simplification of the Boyer-Moore algorithm.  $O(mn)$ .

### Approximate matching

- **Levenshtein distance (or edit distance).** Minimum number of operations (insertion, deletion, replacement) needed to transform one string into the other.
- **Soundex.** Phonetic algorithm for indexing words by their sound (in English).
- **Metaphone.** Indexing words by their sound (in English).
- **NYSIIS.** (New York State Identification and Intelligence System). Phonetic algorithm that improves soundex.

### Word processing

- **Latent Dirichlet Allocation (LDA).** Analysis of documents to associate the content with a topic. Used by search engines.
- **Latent Semantic Indexing (LSI).** Automation of methods to attach a text to a topic from the words that occur commonly in this context.
- **Stemming.** A method of reducing words to their stem, or root form.

## Utilities

- **Doomsday.** Day of the week.
- **Xor swap.** Swaps the values of two variables without using a buffer by xoring the values.
- **Hamming weight.** Find the number of 1 bits in a binary word.
- **Luhn.** A checksum formula for validating identification numbers such as credit-card numbers.
- **Create bit mask.** Bit manipulation algorithms.

## Misc.

- **BrowseRank.** Alternative to PageRank based on users behavior.
- **Hypertext Induced Topic Selection (HITS, patent in 1997).** Algorithm for scoring Web pages, by Jon Kleinberg. One score depends upon backlinks, the other one is based on external links.
- **Leaf shape.** From 28 parameters, the Growth-Algorithm Model of Leaf Shape can reproduce all the shape of real leaves found in the nature.
- **PageRank.** (1998) Algorithm of scoring by Larry Page and Sergey Brin (Google), using backlinks and external links. The score of a Web page depends also to various other criteria.
- **Schreier-Sims.** For permutation groups. A method of computing a Base and Strong Generating Set (BSGS) of a permutation group. Used by algebra algorithms.
- **Robinson-Schensted.** Combinatorial algorithm.

### Links

- List of [astonishing algorithms to transform pictures](#).



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