

# Concepts, Techniques, Ideas & Proofs

1. 2-SAT
2. 2-Way automata
3. 3-colorability
4. 3-SAT
5. Abstract complexity
6. Acceptance
7. Ada Lovelace
8. Algebraic numbers
9. Algorithms
10. Algorithms as strings
11. Alice in Wonderland
12. Alphabets
13. Alternation
14. Ambiguity
15. Ambiguous grammars
16. Analog computing
17. Anisohedral tilings
18. Aperiodic tilings
19. Approximate min cut
20. Approximate TSP
21. Approximate vertex cover
22. Approximations
23. Artificial intelligence
24. Asimov's laws of robotics
25. Asymptotics
26. Automatic theorem proving
27. Autonomous vehicles
28. Axiom of choice
29. Axiomatic method
30. Axiomatic system
31. Babbage's analytical engine
32. Babbage's difference engine
33. Bin packing
34. Binary vs. unary
35. Bletchley Park
36. Bloom axioms
37. Boolean algebra
38. Boolean functions
39. Bridges of Konigsberg
40. Brute force
41. Busy beaver problem
42. C programs
43. Canonical order
44. Cantor dust
45. Cantor set
46. Cantor's paradox
47. CAPCHA
48. Cardinality arguments
49. Cartesian coordinates
50. Cellular automata
51. Chaos
52. Chatterbots
53. Chess-playing programs
54. Chinese room
55. Chomsky hierarchy
56. Chomsky normal form
57. Chomskyan linguistics
58. Christofides' heuristic
59. Church-Turing thesis
60. Clay Mathematics Institute

# Concepts, Techniques, Ideas & Proofs

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| 61. | Clique problem             | 81.  | Computer viruses              | 101. | <b>Cross-product construction</b> |
| 62. | Cloaking devices           | 82.  | <b>Concatenation</b>          | 102. | Cryptography                      |
| 63. | Closure properties         | 83.  | Co-NP                         | 103. | DARPA Grand Challenge             |
| 64. | Cogito ergo sum            | 84.  | Consciousness and sentience   | 104. | DARPA Math Challenges             |
| 65. | Colorings                  | 85.  | Consistency of axioms         | 105. | <b>De Morgan's law</b>            |
| 66. | Commutativity              | 86.  | Constructions                 | 106. | <b>Decidability</b>               |
| 67. | <b>Complementation</b>     | 87.  | Context free grammars         | 107. | <b>Deciders vs. recognizers</b>   |
| 68. | <b>Completeness</b>        | 88.  | <b>Context free languages</b> | 108. | Decimal number system             |
| 69. | <b>Complexity classes</b>  | 89.  | Context sensitive grammars    | 109. | <b>Decision vs. optimization</b>  |
| 70. | Complexity gaps            | 90.  | Context sensitive languages   | 110. | Dedekind cut                      |
| 71. | Complexity Zoo             | 91.  | Continuity                    | 111. | <b>Denseness of hierarchies</b>   |
| 72. | <b>Compositions</b>        | 92.  | Continuum hypothesis          | 112. | Derivations                       |
| 73. | Compound pendulums         | 93.  | <b>Contradiction</b>          | 113. | Descriptive complexity            |
| 74. | Compressibility            | 94.  | Contrapositive                | 114. | <b>Diagonalization</b>            |
| 75. | Computable functions       | 95.  | <b>Cook's theorem</b>         | 115. | Digital circuits                  |
| 76. | Computable numbers         | 96.  | <b>Countability</b>           | 116. | Diophantine equations             |
| 77. | Computation and physics    | 97.  | Counter automata              | 117. | Disorder                          |
| 78. | Computation models         | 98.  | <b>Counter example</b>        | 118. | DNA computing                     |
| 79. | Computational complexity   | 99.  | Cross- product                | 119. | Domains and ranges                |
| 80. | Computational universality | 100. | Crossing sequences            | 120. | <b>Dovetailing</b>                |

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|------|--------------------------|------|-----------------------------------|------|------------------------------------|
| 121. | <b>DSPACE</b>            | 141. | EXPSPACE                          | 161. | <b>Game of life</b>                |
| 122. | <b>DTIME</b>             | 142. | EXPSPACE complete                 | 162. | Game theory                        |
| 123. | EDVAC                    | 143. | EXPTIME                           | 163. | Game trees                         |
| 124. | <b>Elegance in proof</b> | 144. | EXPTIME complete                  | 164. | Gap theorems                       |
| 125. | <b>Encodings</b>         | 145. | <b>Extended Chomsky hierarchy</b> | 165. | Garey & Johnson                    |
| 126. | Enigma cipher            | 146. | <b>Fermat's last theorem</b>      | 166. | General grammars                   |
| 127. | Entropy                  | 147. | Fibonacci numbers                 | 167. | Generalized colorability           |
| 128. | <b>Enumeration</b>       | 148. | Final states                      | 168. | <b>Generalized finite automata</b> |
| 129. | Epsilon transitions      | 149. | <b>Finite automata</b>            | 169. | Generalized numbers                |
| 130. | Equivalence relation     | 150. | Finite automata minimization      | 170. | Generalized venn diagrams          |
| 131. | Euclid's "Elements"      | 151. | Fixed-point theorem               | 171. | Generative grammars                |
| 132. | Euclid's axioms          | 152. | <b>Formal languages</b>           | 172. | Genetic algorithms                 |
| 133. | Euclidean geometry       | 153. | <b>Formalizations</b>             | 173. | <b>Geometric / picture proofs</b>  |
| 134. | Euler's formula          | 154. | Four color problem                | 174. | Godel numbering                    |
| 135. | Euler's identity         | 155. | Fractal art                       | 175. | <b>Godel's theorem</b>             |
| 136. | Eulerian tour            | 156. | Fractals                          | 176. | Goldbach's conjecture              |
| 137. | <b>Existence proofs</b>  | 157. | Functional programming            | 177. | Golden ratio                       |
| 138. | Exoskeletons             | 158. | Fundamental thm of Algebra        | 178. | Grammar equivalence                |
| 139. | Exponential growth       | 159. | Fundamental thm of Arithmetic     | 179. | <b>Grammars</b>                    |
| 140. | Exponentiation           | 160. | Gadget-based proofs               | 180. | Grammars as computers              |

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|------|-------------------------|------|--------------------------------|------|-----------------------------|
| 181. | Graph cliques           | 201. | Household robots               | 221. | Intelligence and mind       |
| 182. | Graph colorability      | 202. | Hung state                     | 222. | Interactive proofs          |
| 183. | Graph isomorphism       | 203. | Hydraulic computers            | 223. | Intractability              |
| 184. | Graph theory            | 204. | Hyper computation              | 224. | Irrational numbers          |
| 185. | Graphs                  | 205. | Hyperbolic geometry            | 225. | JFLAP                       |
| 186. | Graphs as relations     | 206. | Hypernumbers                   | 226. | Karp's paper                |
| 187. | Gravitational systems   | 207. | Identities                     | 227. | Kissing number              |
| 188. | Greibach normal form    | 208. | Immerman's Theorem             | 228. | Kleene closure              |
| 189. | "Grey goo"              | 209. | Incompleteness                 | 229. | Knapsack problem            |
| 190. | Guess-and-verify        | 210. | Incompressibility              | 230. | Lambda calculus             |
| 191. | Halting problem         | 211. | Independence of axioms         | 231. | Language equivalence        |
| 192. | Hamiltonian cycle       | 212. | Independent set problem        | 232. | Law of accelerating returns |
| 193. | Hardness                | 213. | Induction & its drawbacks      | 233. | Law of the excluded middle  |
| 194. | Heuristics              | 214. | Infinite hotels & applications | 234. | Lego computers              |
| 195. | Hierarchy theorems      | 215. | Infinite automata              | 235. | Lexicographic order         |
| 196. | Hilbert's 23 problems   | 216. | Infinite loops                 | 236. | Linear-bounded automata     |
| 197. | Hilbert's program       | 217. | Infinity hierarchy             | 237. | Local minima                |
| 198. | Hilbert's tenth problem | 218. | Information theory             | 238. | LOGSPACE                    |
| 199. | Historical perspectives | 219. | Inherent ambiguity             | 239. | Low-deg graph colorability  |
| 200. | Historical computers    | 220. | Initial state                  | 240. | Machine enhancements        |

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|------|---------------------------|------|----------------------------------|------|----------------------------------|
| 241. | Machine equivalence       | 261. | Navier-Stokes equations          | 281. | <b>P vs. NP</b>                  |
| 242. | Mandelbrot set            | 262. | Neural networks                  | 282. | Parallel postulate               |
| 243. | Manhattan project         | 263. | Newtonian mechanics              | 283. | Parallel simulation              |
| 244. | <b>Many-one reduction</b> | 264. | NLOGSPACE                        | 284. | <b>Dovetailing simulation</b>    |
| 245. | Matiyasevich's theorem    | 265. | Non-approximability              | 285. | Parallelism                      |
| 246. | Mechanical calculator     | 266. | Non-closures                     | 286. | Parity                           |
| 247. | Mechanical computers      | 267. | <b>Non-determinism</b>           | 287. | Parsing                          |
| 248. | Memes                     | 268. | Non-Euclidean geometry           | 288. | Partition problem                |
| 249. | <b>Mental poker</b>       | 269. | <b>Non-existence proofs</b>      | 289. | Paths in graphs                  |
| 250. | Meta-mathematics          | 270. | NP                               | 290. | Peano arithmetic                 |
| 251. | Millennium Prize          | 271. | <b>NP completeness</b>           | 291. | Penrose tilings                  |
| 252. | Minimal grammars          | 272. | NP-hard                          | 292. | Physics analogies                |
| 253. | Minimum cut               | 273. | NSPACE                           | 293. | Pi formulas                      |
| 254. | Modeling                  | 274. | NTIME                            | 294. | <b>Pigeon-hole principle</b>     |
| 255. | Multiple heads            | 275. | <b>Occam's razor</b>             | 295. | Pilotless planes                 |
| 256. | Multiple tapes            | 276. | Octonions                        | 296. | Pinwheel tilings                 |
| 257. | Mu-recursive functions    | 277. | <b>One-to-one correspondence</b> | 297. | Planar graph colorability        |
| 258. | MAD policy                | 278. | <b>Open problems</b>             | 298. | Planarity testing                |
| 259. | Nanotechnology            | 279. | <b>Oracles</b>                   | 299. | <b>Polya's "How to Solve It"</b> |
| 260. | Natural languages         | 280. | P completeness                   | 300. | Polyhedral dissections           |

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|------|-------------------------|------|-----------------------------|------|-----------------------------|
| 301. | Polynomial hierarchy    | 321. | Quantifiers                 | 341. | Rejection                   |
| 302. | Polynomial-time         | 322. | Quantum computing           | 342. | Relations                   |
| 303. | P-time reductions       | 323. | Quantum mechanics           | 343. | Relativity theory           |
| 304. | Positional # system     | 324. | Quaternions                 | 344. | Relativization              |
| 305. | Power sets              | 325. | Queue automata              | 345. | Resource-bounded comput.    |
| 306. | Powerset construction   | 326. | Quine                       | 346. | Respect for the definitions |
| 307. | Predicate calculus      | 327. | Ramanujan identities        | 347. | Reusability of space        |
| 308. | Predicate logic         | 328. | Ramsey theory               | 348. | Reversal                    |
| 309. | Prime numbers           | 329. | Randomness                  | 349. | Reverse Turing test         |
| 310. | Principia Mathematica   | 330. | Rational numbers            | 350. | Rice's Theorem              |
| 311. | Probabilistic TMs       | 331. | Real numbers                | 351. | Riemann hypothesis          |
| 312. | Proof theory            | 332. | Reality surpassing Sci-Fi   | 352. | Riemann's zeta function     |
| 313. | Propositional logic     | 333. | Recognition and enumeration | 353. | Robots in fiction           |
| 314. | PSPACE                  | 334. | Recursion theorem           | 354. | Robustness of P and NP      |
| 315. | PSPACE completeness     | 335. | Recursive function theory   | 355. | Russell's paradox           |
| 316. | Public-key cryptography | 336. | Recursive functions         | 356. | Satisfiability              |
| 317. | Pumping theorems        | 337. | Reducibilities              | 357. | Savitch's theorem           |
| 318. | Pushdown automata       | 338. | Reductions                  | 358. | Schmitt-Conway biprism      |
| 319. | Puzzle solvers          | 339. | Regular expressions         | 359. | Scientific method           |
| 320. | Pythagorean theorem     | 340. | Regular languages           | 360. | Sedenions                   |

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- 361. Self compilation
- 362. Self reproduction**
- 363. Set cover problem
- 364. Set difference
- 365. Set identities
- 366. Set theory
- 367. Shannon limit
- 368. Sieve of Eratosthenes
- 369. Simulated annealing
- 370. Simulation**
- 371. Skepticism
- 372. Soundness
- 373. Space filling polyhedra
- 374. Space hierarchy**
- 375. Spanning trees**
- 376. Speedup theorems
- 377. Sphere packing
- 378. Spherical geometry
- 379. Standard model
- 380. State minimization**
- 381. Steiner tree
- 382. Stirling's formula
- 383. Stored program
- 384. String theory
- 385. Strings**
- 386. Strong AI hypothesis
- 387. Superposition
- 388. Super-states**
- 389. Surcomplex numbers
- 390. Surreal numbers
- 391. Symbolic logic
- 392. Symmetric closure
- 393. Symmetric venn diagrams
- 394. Technological singularity
- 395. Theory-reality chasms
- 396. Thermodynamics
- 397. Time hierarchy**
- 398. Time/space tradeoff**
- 399. Tinker Toy computers
- 400. Tractability**
- 401. Tradeoffs
- 402. Transcendental numbers
- 403. Transfinite arithmetic**
- 404. Transformations**
- 405. Transition function**
- 406. Transitive closure
- 407. Transitivity
- 408. Traveling salesperson
- 409. Triangle inequality**
- 410. Turbulence
- 411. Turing complete**
- 412. Turing degrees**
- 413. Turing jump
- 414. Turing machines**
- 415. Turing recognizable**
- 416. Turing reduction
- 417. Turing test**
- 418. Two-way automata
- 419. Type errors
- 420. Uncomputability**



# Concepts, Techniques, Ideas & Proofs

## INFLUENCES

- 421. Uncomputable functions
- 422. Uncomputable numbers
- 423. Uncountability
- 424. Undecidability
- 425. Universal Turing machine
- 426. Venn diagrams
- 427. Vertex cover
- 428. Von Neumann architecture
- 429. Von Neumann bottleneck
- 430. Wang tiles & cubes
- 431. Zero-knowledge protocols



## EINSTEIN SIMPLIFIED

“Make everything as simple as possible, but not simpler.”  
- Albert Einstein (1879-1955)

**Occam's razor!**

