國立臺北大學自然資源與環境管理研究所
113 學年度第二學期『資源管理與環境系統分析』

課程講義(12)：非線性規劃與演算法
Nonlinear Programming and Algorithms

- NONLINEAR PROGRAMMING -- INTRODUCTION
  - □ Local Optima vs. Global Optima
  - □ Convexity and Convex Programming
    - ⇨ Convexity of a Function: Convex, Concave and Un-determinant
    - ⇨ Convex Region vs. Non-convex Region
  - □ Analytical Solutions vs. Numerical Solutions
    - ⇨ Linearization of Nonlinear Objective Function => May not be necessary nowadays!
    - ⇨ Software Packages => Lingo, Euler Math Toolbox, Excel Solver Add-in, etc.
  - □ Nonlinear Programming (Chapter 13) in Applied Mathematical Programming (http://web.mit.edu/15.053/www/AMP-Chapter-13.pdf)

- UNCONSTRAINED OPTIMIZATION
  - □ Minima, Maxima and Saddle Points
    - ⇨ Necessary Conditions and Sufficient Conditions
  - □ Gradient of a Function (First Derivatives)
  - □ Hessian Matrix (Second Derivatives)
    - ⇨ Positively Definite: All the Eigenvalues are Positive

- LAGRANGE MULTIPLIERS AND OTHER METHODS
  - □ Lagrange Multiplier Method
    - ⇨ Constraints with All Equalities
    - ⇨ Properties of the Lagrange Multipliers
  - □ Kuhn-Tucker Conditions: Constraints with Inequalities
  - □ Gradient Search Procedure (Greedy) => Danger of Being Trapped at Local Optima
  - □ Applying Maximum Entropy Principle to Solving the Unfair Dice Problem

- ALGORITHMS FOR NONLINEAR PROGRAMS
  - □ Optimization Algorithms in Mathematical Optimization (Wikipedia)
    - ⇨ Simplex Algorithm of George Dantzig, designed for linear programming
    - ⇨ Interactive Methods: Newton's method, Sequential quadratic programming…
    - ⇨ Heuristics
      - Differential evolution
      - Dynamic relaxation
      - Evolutionary algorithms
      - Genetic algorithms
      - Hill climbing with random restart
      - Memetic algorithm
      - Nelder–Mead simplicial heuristic
      - Particle swarm optimization
      - Simulated annealing
      - Stochastic tunneling
      - Tabu search

□ Heuristic (Metaheuristic) Algorithms (https://en.wikipedia.org/wiki/Metaheuristic)

https://zh.wikipedia.org/zh-tw/元启发算法

演算法

模擬退火法 (Simulated annealing algorithm, SA)
社會認知算法 (Social cognitive optimization, SCO)
簡化群體演算法 (Simplified swarm optimization, SSO)
調和搜尋演算法 (Harmony search, HS)
水循環算法 (Water cycle algorithm, WCA)
汽車跟蹤最佳化演算法 (Car tracking optimization algorithm)
細菌覓食法 (bacterial foraging algorithm)

仿生元啟發式演算法

基因演算法 (Genetic algorithm, GA)
粒子群演算法 (Particle swarm optimization, PSO)
蟻群演算法 (Ant colony optimization, ACO)
布穀鳥搜索算法 (Cuckoo Search, CS)
蝙蝠算法 (Bat algorithm, BA)
螢火蟲算法 (Firefly algorithm, FA)
猴群演算法 (Monkey algorithm)
獅子演算法 (Lion optimization algorithm, LOA)
人工蜂群演算法 (Artificial bee colony, ABC)
病毒最佳化演算法 (Virus Optimization Algorithm, VOA)
飛蛾搜尋演算法 (Moth search algorithm)
鯊魚氣味演算法 (Shark smell optimization, SSO)
蚯蚓最佳化演算法 (Earthworm optimization algorithm, EWA)
帝王企鵝演算法 (Emperor Penguins Colony, EPC)
抹香鯨算法 (Sperm whale algorithm, SWA)
人類精神搜索 (Human mental search, HMS)
海洋掠食者算法 (Marine Predators Algorithm, MPA)
狩獵搜索 (Hunting search, HuS)
遷徙鳥類最佳化 (Migrating birds optimization, MBO)
靴子進階演算法（Boots Advanced Algorithm, BAA)

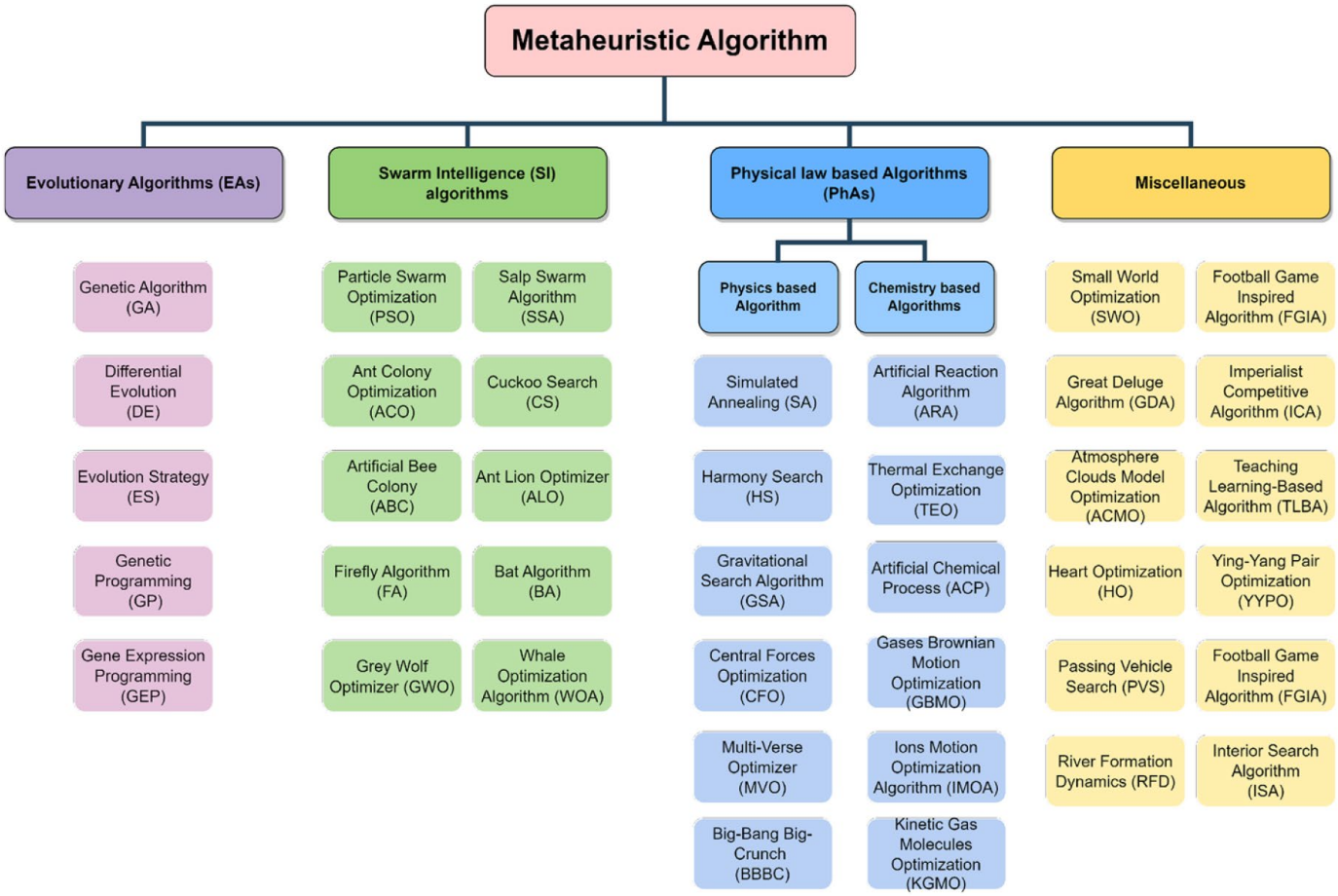

Fig. 5 Classification of MAs based on the source of inspiration

https://zeus.inf.ucv.cl/~bcrawford/UAH_CHARLA-MAYO-22-2023/1-An exhaustive review of the metaheuristic algorithms.pdf