基因演算法與管理科學應用
Genetic Algorithm & Applications in Management Science

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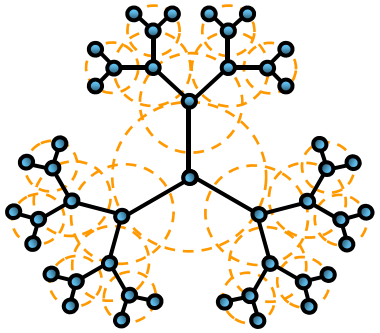
林春成

- 教育背景
  - 台大電機系　博士　(2009)
  - 台大商研所　碩士　(2007)
  - 台大電機系　碩士學程　(2000-2002，後直升)
  - 台大數學系　學士　(2000)
- 經歷
  - 陽明交大工工系　特聘教授　(2020 – 迄今)
  - 陽明交大管理學院　副院長　(2017 – 迄今)
  - 陽明交大EMBA學程　教授　(2019 – 迄今)
  - 亞洲大學　講座教授 (兼任)　(2020 – 迄今)
  - 中醫大附設醫院　顧問　(2020 – 迄今)
  - 作業研究學會　常務理事　(2020 – 迄今)
  - 演算法與計算理論學會　理事　(2020 – 迄今)
  - IEEE Senior Member　(2017 – 迄今)
  - IEEE台北分會　財務長　(2017 – 2019)
  - 交大工工系　教授(2016-迄今)、副教授(2013–16)、助理教授(2011–13)
  - 日本東京大學　客座副教授　(2012/8/1–31)
  - 北市大資科系　助理教授　(2010 – 2011)
  - 高科大資工系　助理教授　(2009 – 2010)

林春成

- 研究興趣
  - 演算法(Algorithm)、機器學習(Machine Learning)
  - 無線網路(Wireless Networks)、物聯網(Internet of Things)
  - 資訊視覺化(Information Visualization)
  - 計算管理科學(Computational Management Science)

- 主要獎項
  - 科技部傑出研究獎 (2019)
  - 系統學會「傑出青年獎」(2020)
  - 電腦學會「傑出青年獎」(2018)
  - 工工學會「優秀青年工業工程師獎」(2017)
  - 電機學會「優秀青年電機工程師獎」(2017)
  - 管科學會「呂鳳章先生紀念獎章」 (2017)
  - 4次交大優良教學獎 (2019、2018、2017、2015)



Contact Information

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- Phone: 校外(03)5731758; 校內31758
- Office hour: E-mail contact in advance

Motivations

- Practical problems are generally NP-Complete or NP-hard Problems

  → Generally, they are solved by Metaheuristic Algorithms

- The most basic metaheuristic algorithm is genetic algorithm (a.k.a., evolutionary algorithm)

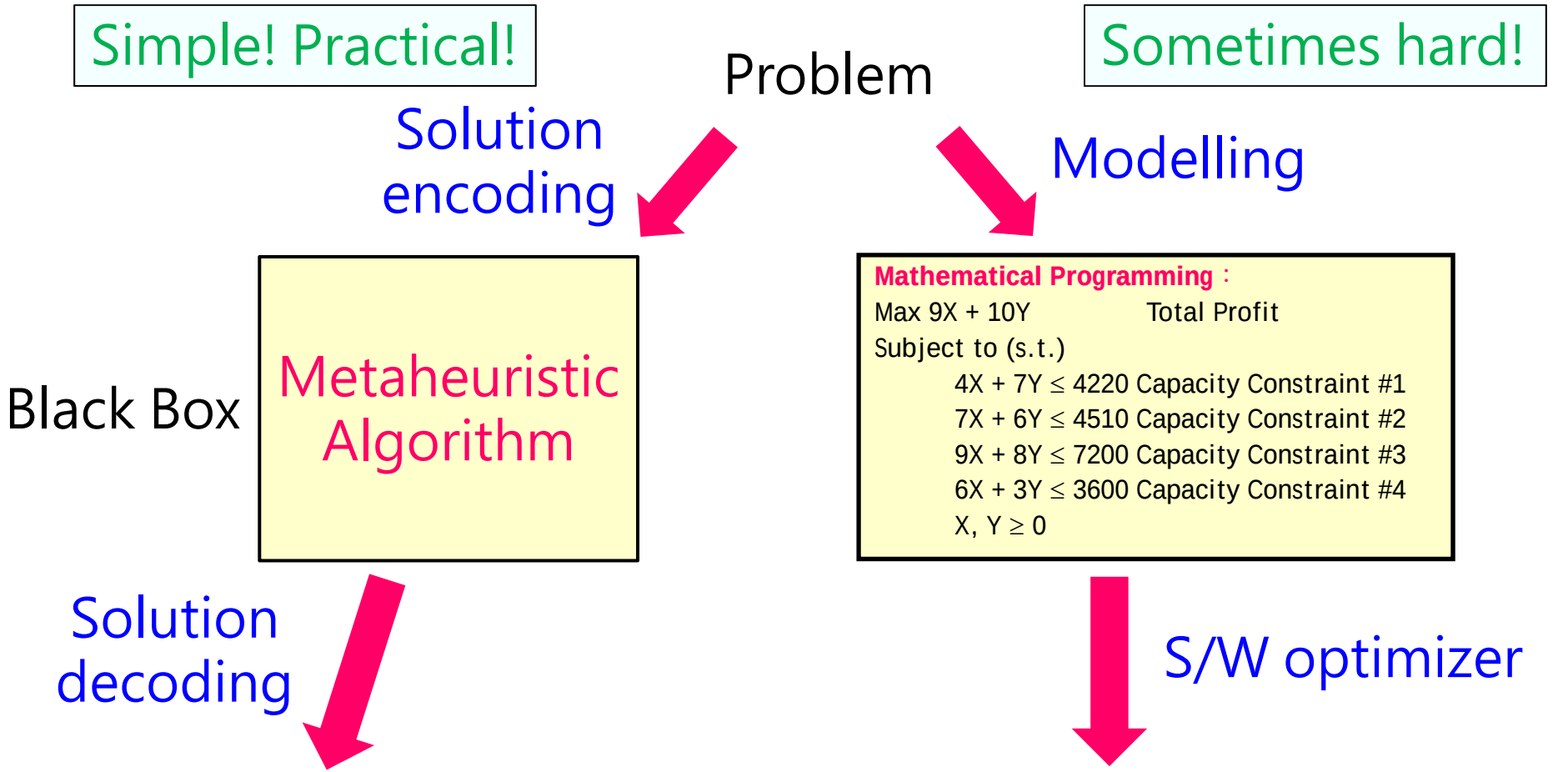
- Learn how to implement genetic algorithm to solve practical problems

Operations Research / Management Science

- Methodology
  - Mathematical Programming
  - Metaheuristic Algorithm
  - Statistics
  - Machine Learning
  - Artificial Intelligence

- Applications
  - Assignment Problem / Matching Problem
  - Facility Location Problem
  - Flow Shop Scheduling / Job Shop Scheduling
  - Traveling Salesman Problem / Vehicle Routing Problem
  - Supply Chain Management & Logistics

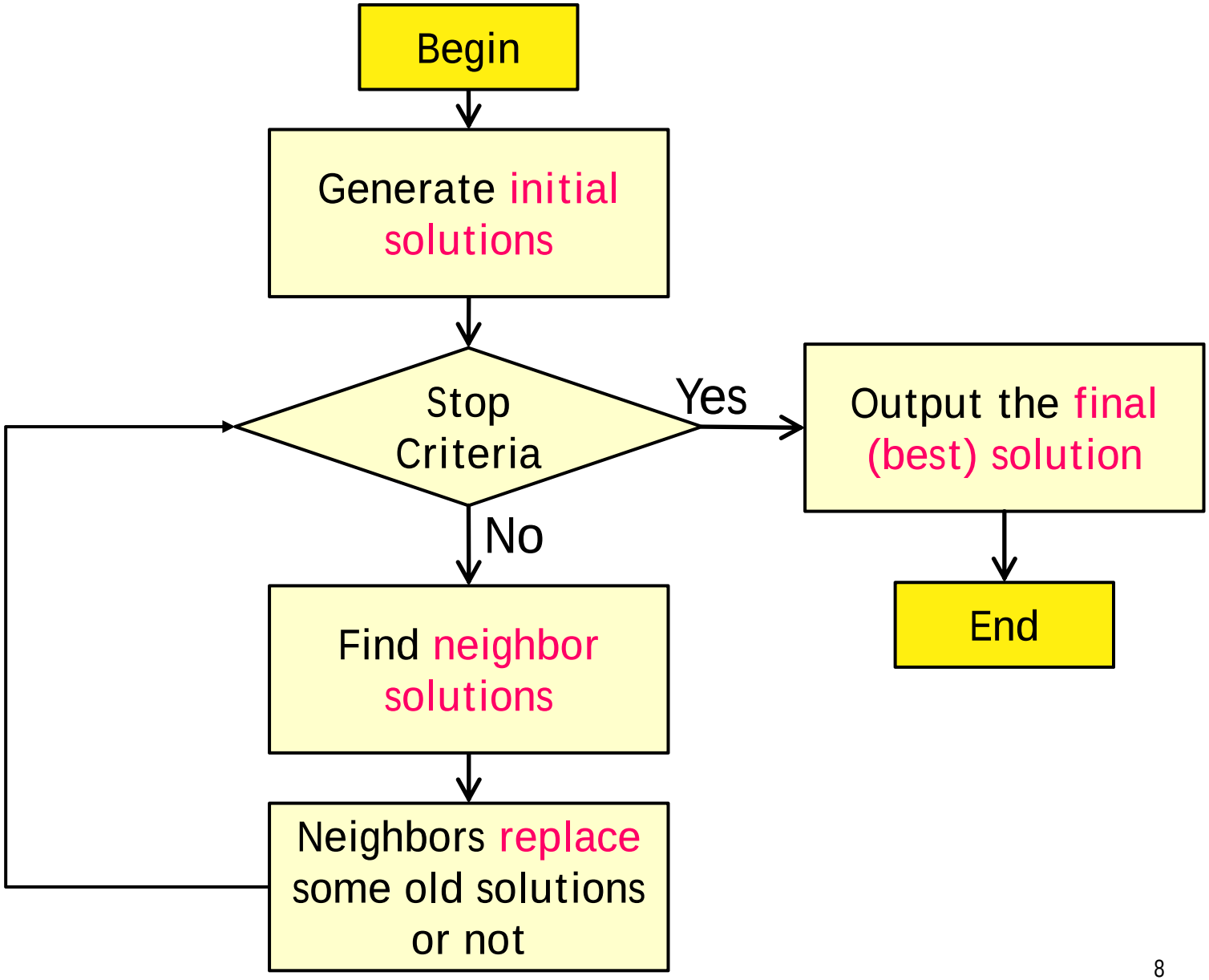
Metaheuristics vs Mathematical Programming



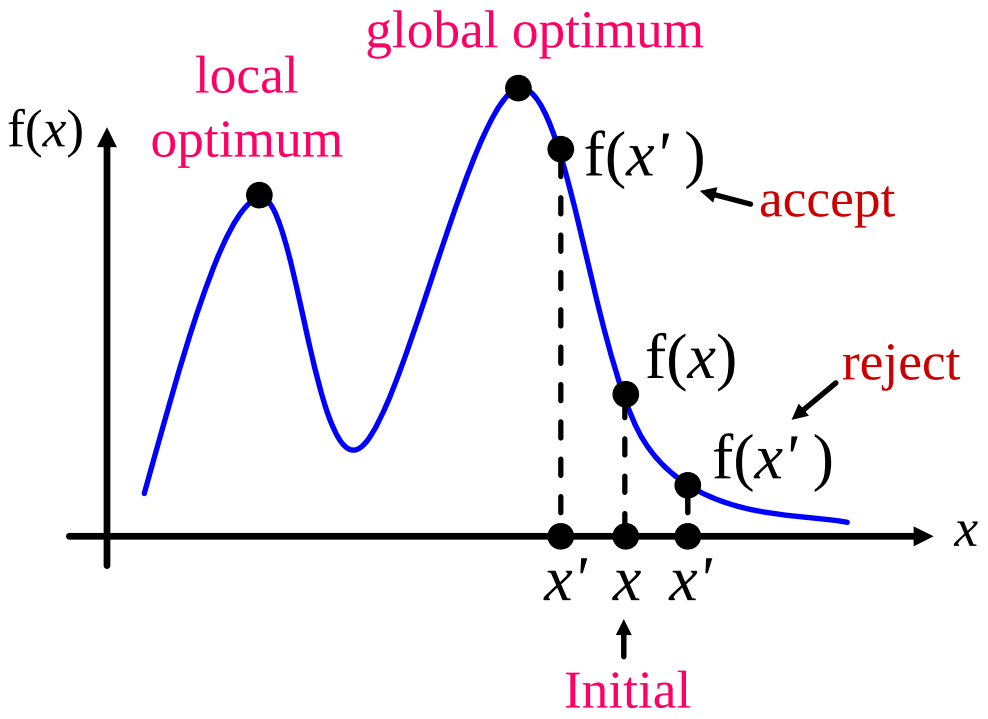
- Optimal solutions or approximation solutions
- Could solve large-scale problems

- Optimal solutions are guaranteed!
- But only suitable for small-scale problems

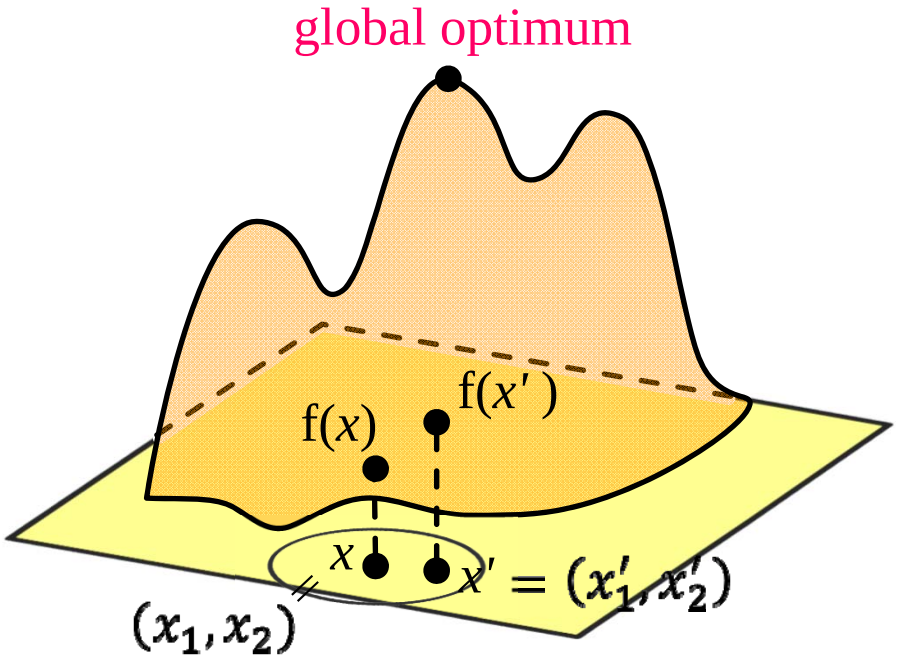
Metaheuristic Algorithm



1D



2D



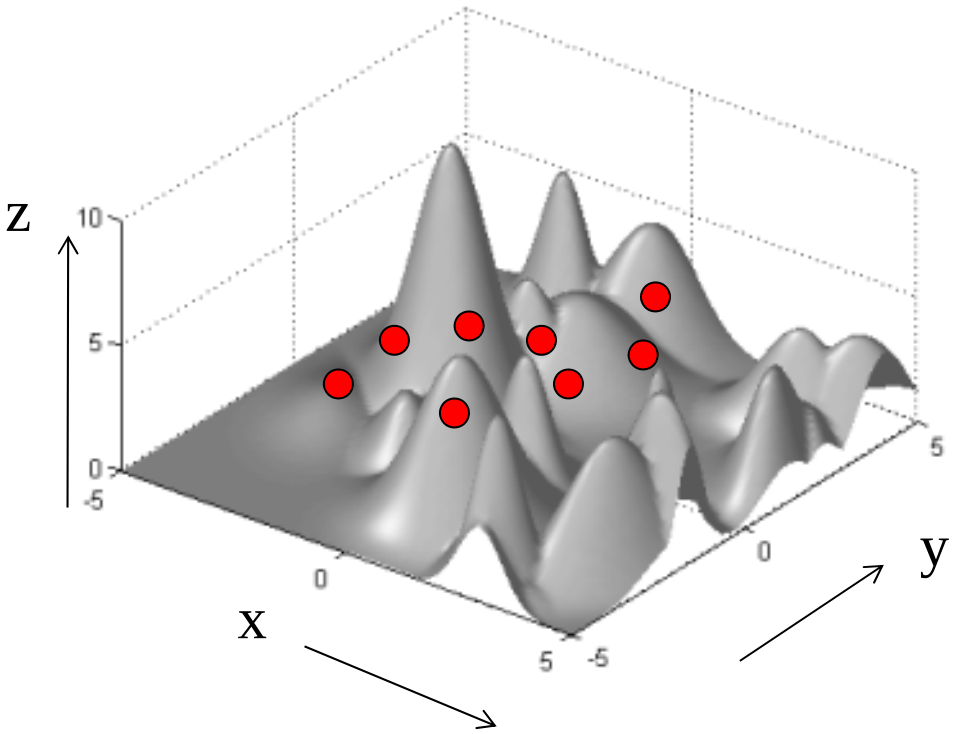
n-D space

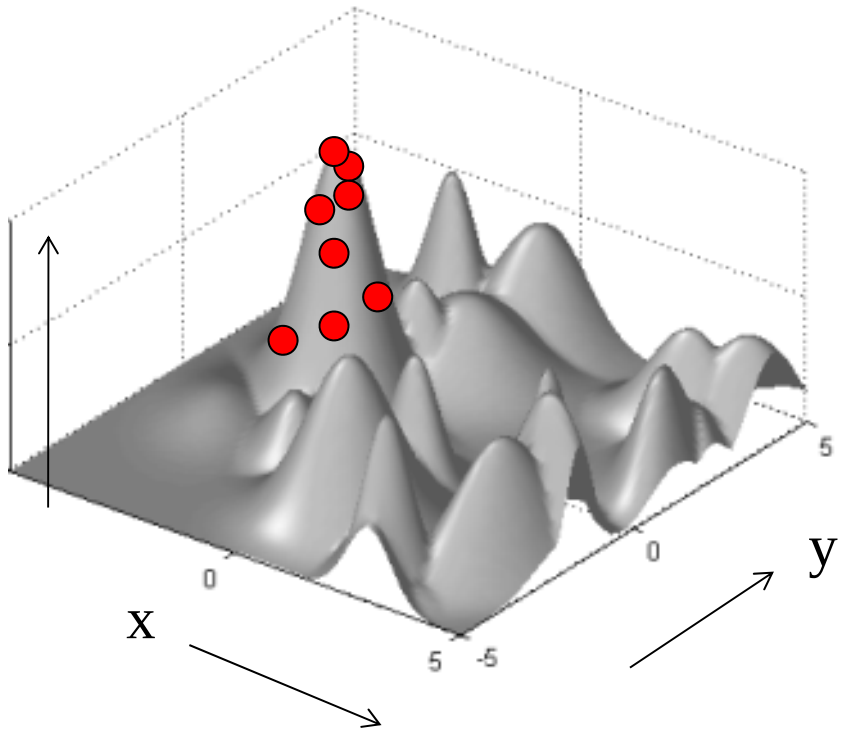
$x = (x_1, x_2, \ldots, x_n)$

↓

…

Population-based metaheuristics



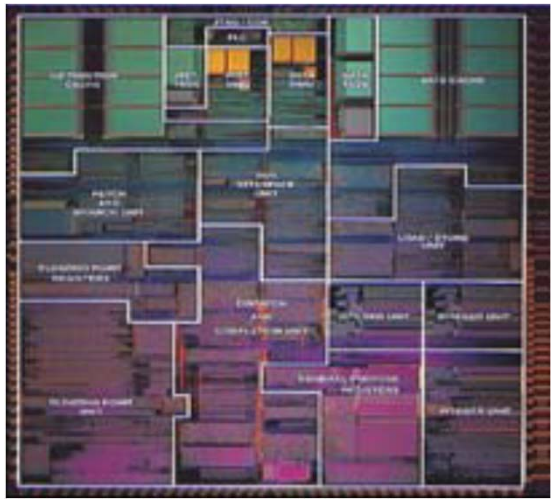


Well-known Metaheuristics

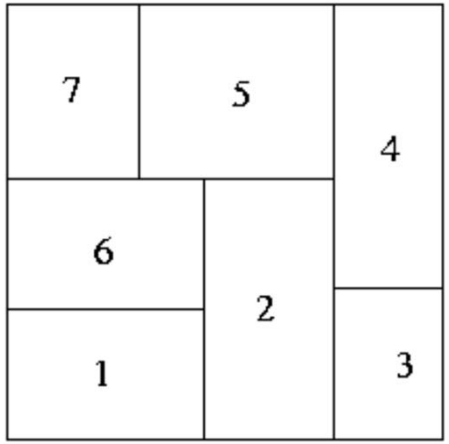
- Local-search-based metaheuristics
  - Simulated Annealing (SA)
- Population-based metaheuristics
  - Genetic Algorithm (GA)
  - Particle Swarm Optimization (PSO)
  - Ant Colony Optimization (ACO)

Example

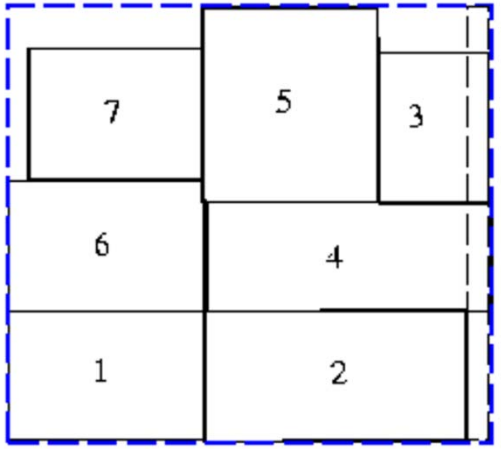
- VLSI floorplanning



CPU chip



An optimal floorplan, in terms of area



A non–optimal floorplan

- Related work
  - Wong & Liu, "A new algorithm for floorplan design," *DAC-86*.
  - Wong & Liu, "Floorplan design for rectangular and L-shaped modules," *ICCAD'87*.
  - Wong, Leong, Liu, *Simulated Annealing for VLSI Design*, pp. 31--71, Kluwer Academic Publishers, 1988.

Objectives

- Genetic algorithm (GA)
- Implementing the GA in Python language
  or using Google OR-tools
- GA applications
  in operations research/management science (OR/MS)
  - Facility location problem
  - Facility layout problem
  - Assignment problem
  - Scheduling problem
  - Container packing problem
  - Vehicle routing problem
  - Dynamic optimization, many-objective problem, uncertainty …
- Preparing presentation of an academic paper
  or implementing a practical project

Schedule (tentative)

- Week 1: Introduction + Installation
- Week 2: 228和平紀念日補假(3/1週一); 週二不上課(此1hr用於期末專題)
- Week 3: Basic Python Programming (1) / 交2人一組的名單
- Week 4: Basic Python Programming (2)
- Week 5: Genetic Algorithm (GA) – Basic (1)
- Week 6: Genetic Algorithm (GA) – Basic (2)
- Week 7: 清明節放假 (週一和週二都放假)
- Week 8: Assignment Problem Using GA / 說明專題 & 專題分組
- Week 9: Traveling Salesman Problem Using GA
- Week 10: 期中報告(分組，每組5分鐘說明期末專題要報告/實作的論文)
- Week 11: Vehicle Routing Problem Using GA
- Week 12: Flow Shop Scheduling Using GA
- Week 13: Job Shop Scheduling Using GA
- Week 14: Facility Location Problem Using GA
- Week 15: 期末專題 (週一&週二 or 週一多上一節)
- Week 16: 期末專題 (週一&週二 or 週一多上一節)
- Week 16: 06/13 (Sun. 11:59PM): 交Term project投影片、書面報告
- Week 17: 彈性補充教學
- Week 18: 彈性補充教學

Logistics

- 一般上課週 → 兩時段：
  - 週一3:30 ~ 5:20 (M78)
    - ✓ **教學約一小時，剩餘時間當場實作作業，作完可先走 (得分100%)**
  - 週二5:30 ~ 6:20 (T9)
    - ✓ **助教在MB002B實驗室，接受學生補交作業 (得分85%)**
    - ✓ **或在此時段到MB002B看完解題影片即可算補交 (得分70%)**

- 期中報告週(week 10)、期末專題週(weeks 15-16)
  - Option 1: 週一3:30 ~ 6:20 (M789)、週二不上課
  - Option 2: 週一3:30 ~ 5:20 (M78)、週二5:30~6:20 (T9)

Evaluation

- 每週實作作業 40%
  - 2人一組，每週一於課堂上有實作作業，當場做完當場交，先做完可先走
  - 週二可補交或求助，週二交作業者記為「遲交」(分數8折)
  - 請假者仍要補交，跟助教約時間

- 期中報告15% (上台報告)
  - 分?組(2~4人一組)，各組上台用5分鐘報告期末專題的規劃
  - 第11週前上傳投影片至e3new系統

- 期末專題 45% (報告週每堂均簽到 + 上台報告 + 書面報告)
  - 分組報告/實作一篇期刊論文 → 上台報告(少於50分鐘)
  - 第16週交投影片和書面報告 → 第16週上傳到 e3new系統
  - (佔5%) 專題報告的二週，每個人每堂均要簽到

課程網站與助教

- 所有的課程資訊可查e3系統：
  - https://e3.nycu.edu.tw/

- 助教(管理二館002b室)：
  - 盧科妏(工工碩班) (E-mail: aa02130032@gmail.com)
  - 黃郁晴(工工碩班) (E-mail: naruto87724@gmail.com)
  - 連倢　(工工碩班) (E-mail: jenniferlian338@gmail.com)
  - 林玟嫙(工工碩班) (E-mail: sandy580821@gmail.com)

Further courses

- Evolutionary Computation (演化計算/仿生計算)
- Metaheuristics (萬用啟發式演算法)
- Soft Computing
- Fuzzy Systems
- Computational Intelligence
- Artificial Intelligence
- Computer Vision, Image Processing, Natural Language

References

- Journals on EC methodology
  - IEEE Transactions on Evolutionary Computation
  - IEEE Transactions on Cybernetics
  - IEEE Computational Intelligence Magazine
  - Evolutionary Computation (MIT Press)
  - Applied Soft Computing (Elsevier Press)
  - Swarm and Evolutionary Computation (Elsevier Press)
  - Information Sciences (Elsevier Press)
  - Evolutionary Intelligence (Springer Press)
  - Memetic Computing (Springer Press), Soft Computing (Springer Press), Natural Computing (Springer Press)
- Journals on OR/MS applications
  - European Journal of Operational Research (Elsevier Press)
  - Computers & Industrial Engineering (Elsevier Press)
  - Computers & Operations Research (Elsevier Press)
  - International Journal of Production Economics (Elsevier Press)
  - International Journal of Production Research (Tylor & Francis Press)
  - ...

References

- Conferences
  - IEEE Congress on Evolutionary Computation (CEC)
  - IEEE World Congress on Computational Intelligence (WCCI)
  - IEEE Symposium Series on Computational Intelligence (SSCI)
  - ACM Genetic and Evolutionary Computation Conference (GECCO)
  - International Conference on Genetic Algorithms (ICGA) / GP