UNIVERSITÉ CÔTE D'AZUR

Algorithmes Évolutionnaires (M2 MIAGE IA²)

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Séance 5
Gestion des contraintes

Handling Constraints

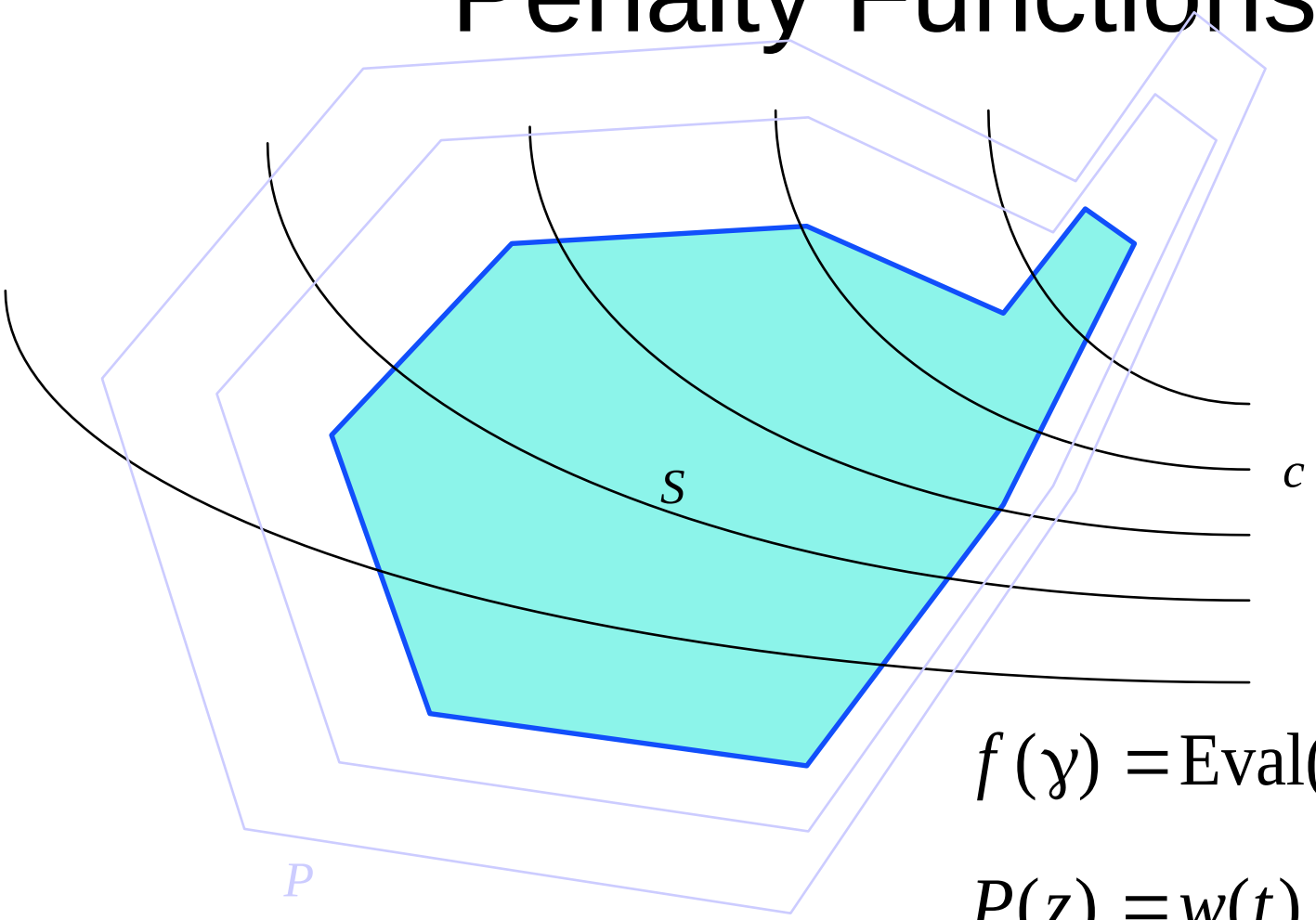
Three commonly used techniques:

- Penalty functions
- Decoders/repair algorithms
- Appropriate data structures and specialized genetic operators

Penalty Functions

- Basic idea: turn constraints into optimization criteria

Penalty Functions



$$f(y) = \text{Eval}(c(z)) + P(z)$$

$$P(z) = w(t) \sum_i w_i \Delta_i(z)$$

Penalty Functions

- Basic idea: turn constraints into optimization criteria

- Caution:

  Risk of spending most of the time evaluating unfeasible solutions, sticking with the first feasible solution found, or finding an unfeasible solution that scores better than feasible solutions

Example: Transport Problem

- Given:
  - Set of *n* “factories”
  - Set of *m* “customers”
  - Cost of transporting one unit from each factory to each customer
- Minimize the cost of transport
- Constraints:
  - every customer should receive the amount ordered

Killer Solution for Transport Problem

- Do not deliver anything to any customer
- Total transport cost: 0
- Excellent performance at the cost of some constraint violations

Discussion of Penalty Functions

- Very general
- Easy to apply
- Requires a grain of salt
- Not always efficient

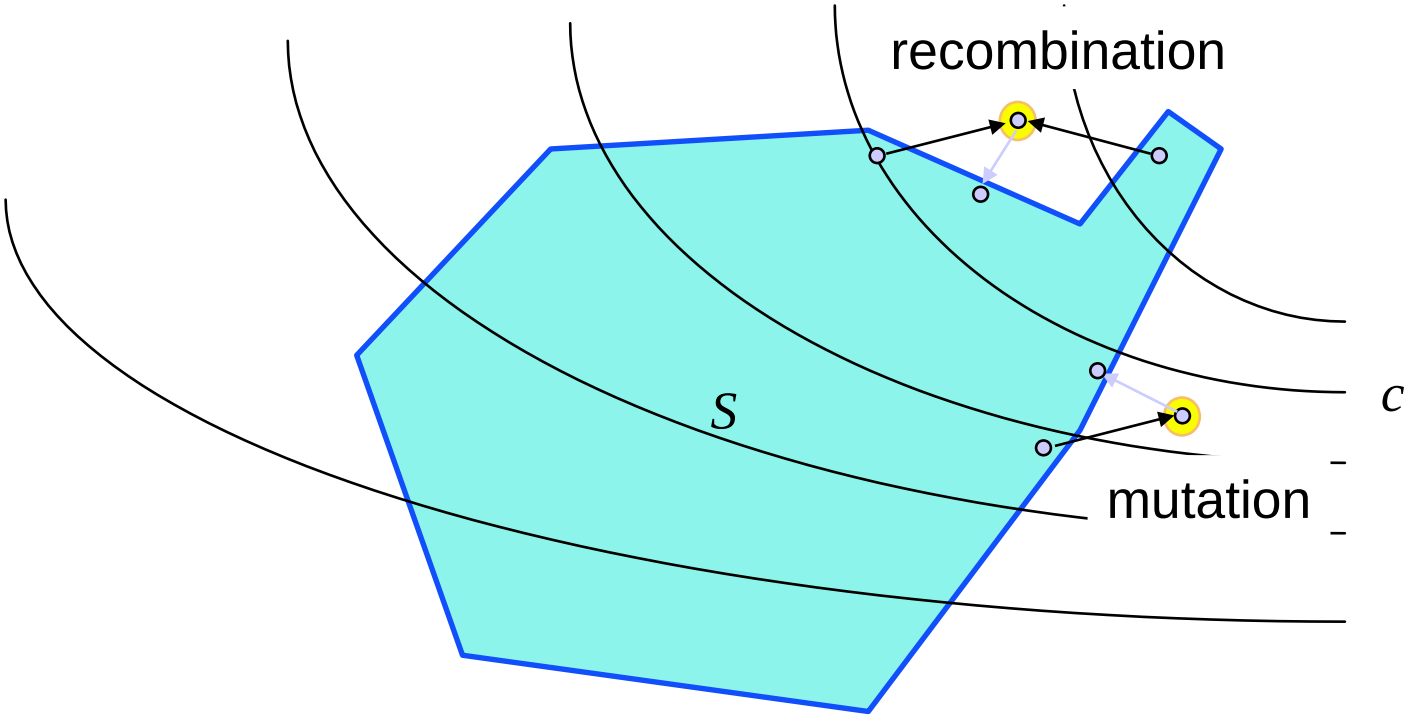
Decoders or Repair Algorithms

- Computationally intensive
- Tailored to the particular problem/application

Decoders or Repair Algorithms

- Basic idea:
  - genetic operators can produce infeasible solution
  - infeasible solutions are “repaired”
- Two general approaches:
  - decoders
  - repair algorithms

Decoders / Repair Algorithms



Common Assumption

- Algorithm available which is capable of transforming an infeasible solution into a feasible one
- Complexity of the algorithm is lower-order

Decoders

- Infeasible solutions are kept in the population
- They are regarded as genotypes
- Genetic operators do not care about constraints
- Genotypes are “decoded” into feasible solutions

Repair Algorithms

- Feasible solutions only can be part of the population
- After a genetic operator is applied, algorithm “repairs” the offspring
- Infeasible traits never get inherited

Discussion of Decoders, Repair Algorithms

- Very interesting in principle
- Not much used in practice
- Main issue: for many hard problems, repairing an infeasible solution is almost as hard as solving the problem

Specialized Data Structures and Operators

- All possible genotypes encode for feasible solutions
- No time at all is spent processing infeasible solutions
- Ideal state of affairs
- Not always possible

Requirements

- All feasible solutions can be represented
- No infeasible solution can be represented, or…
- Genetic operators preserve feasibility
- Population is seeded with feasible solutions