Last lectures:

- Heuristic algorithms: dispatching rules
- Heuristic algorithms: local search

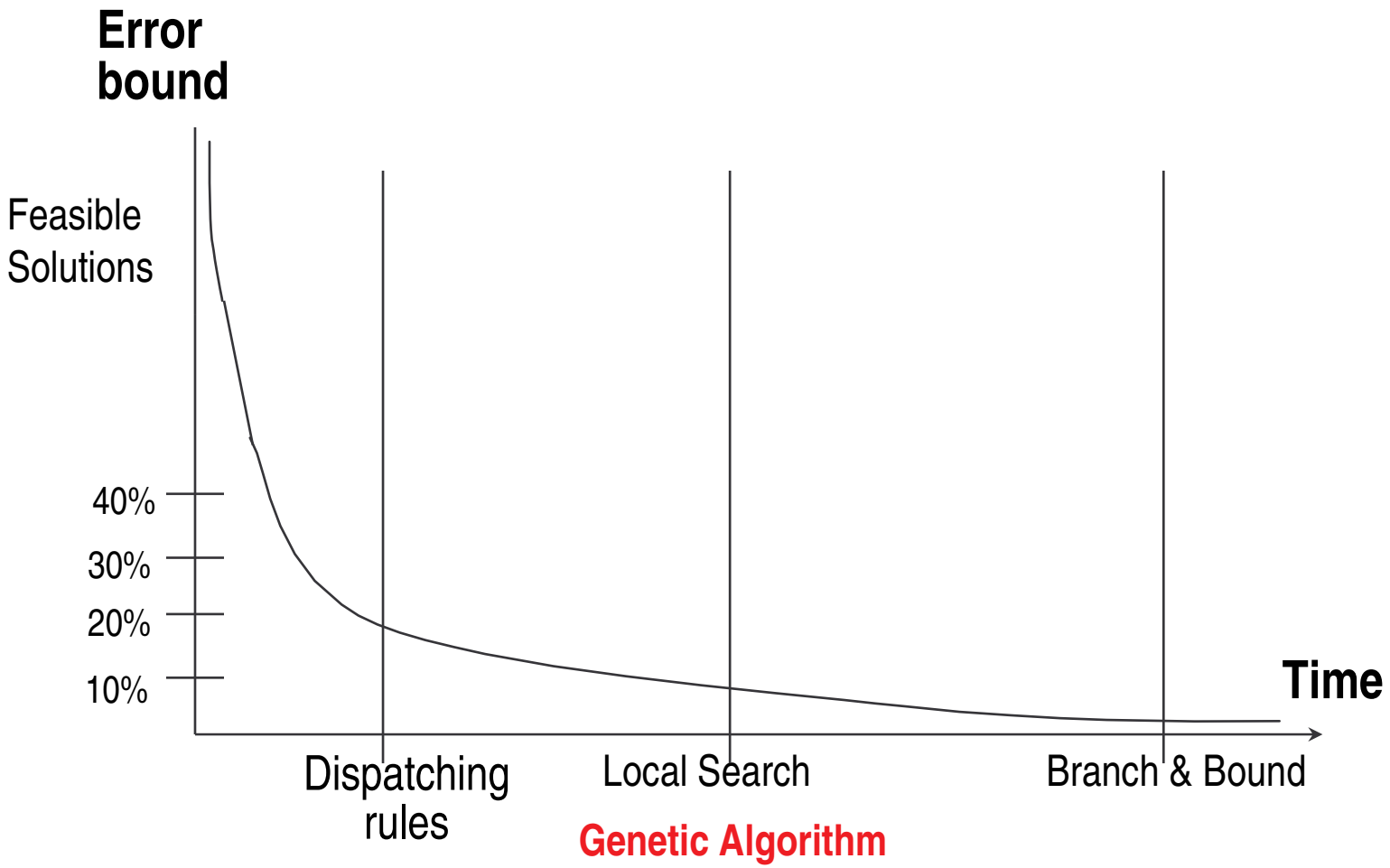
This lecture:

- Heuristic algorithms: genetic algorithms

Final Lecture:

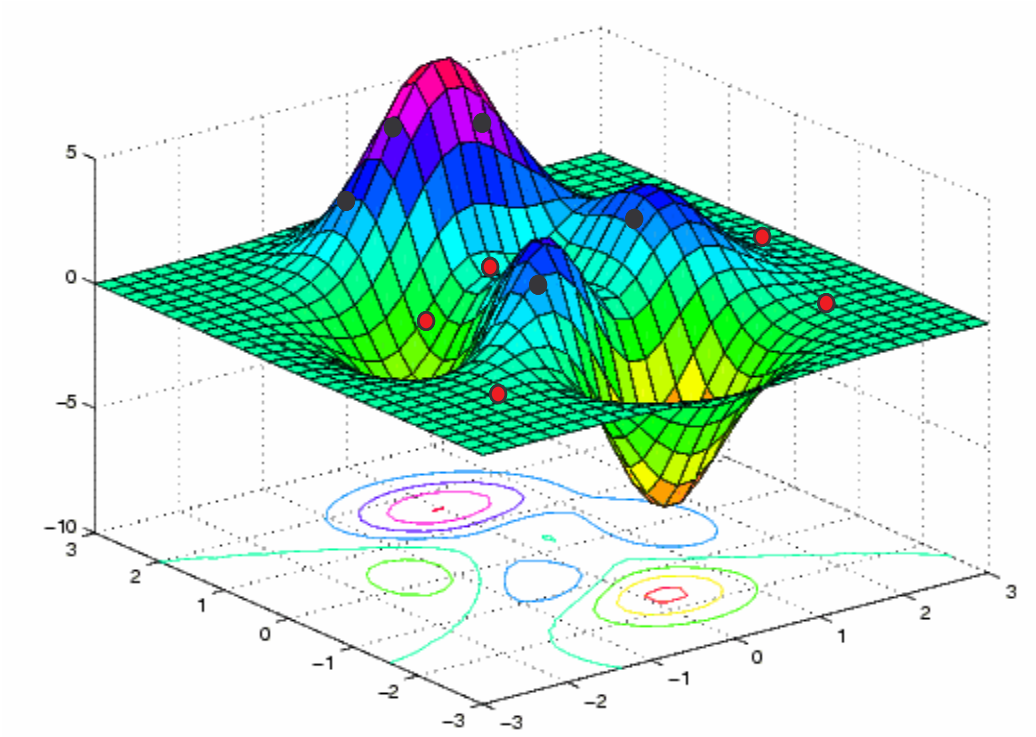
- job shop

Choosing an Algorithm

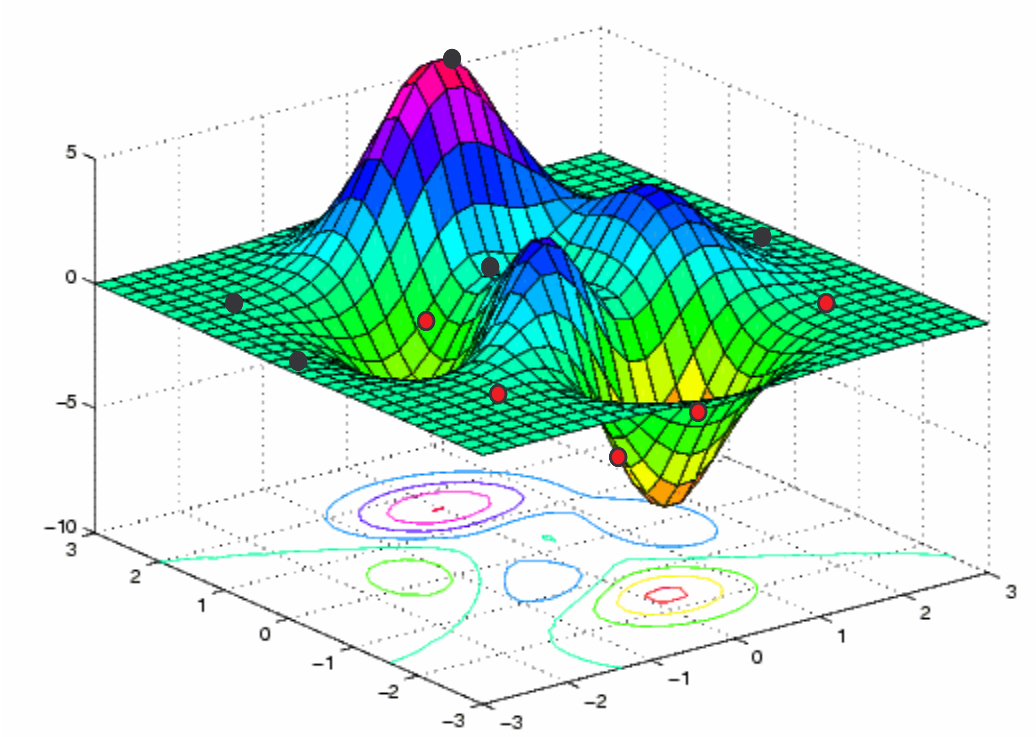


Local Search	Genetic Algorithms
Solution $\rightarrow$ Solution'	Population $\rightarrow$ Population'
	(parents $\rightarrow$ offspring)
Acceptance test	**"Survival of the fittest"** principle

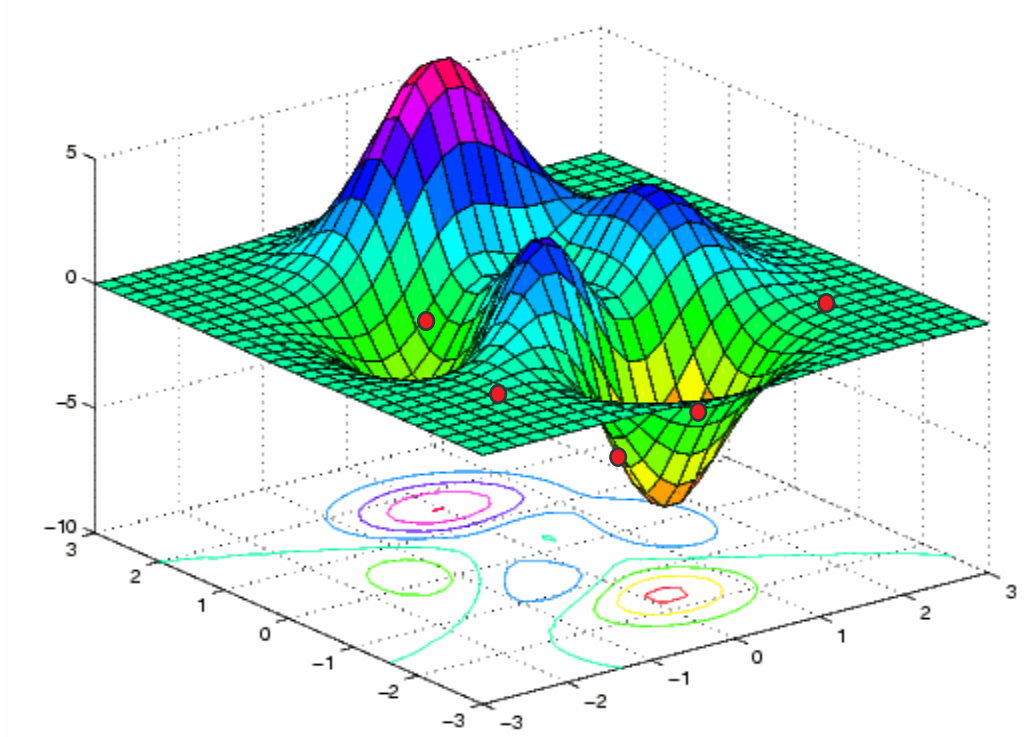
Genetic Algorithm (GA)



Genetic Algorithm (GA)



Genetic Algorithm (GA)



Genetic Algorithm (GA)

With probability p_{cross}, each pair undergoes a **crossover**; otherwise, the pair is unchanged (no children born)

Under a **crossover** operation, the two solutions, which we refer to as parents, combine to produce two offspring, each containing some characteristics of each parent.

Reorder crossover. Select two positions at random as crossover points and then reorder the sub-sequences between these positions to match the order of the elements in the other sequence.

1	2	3	4	5	6	7	8	9	10
3	8	7	1	9	4	2	10	6	5

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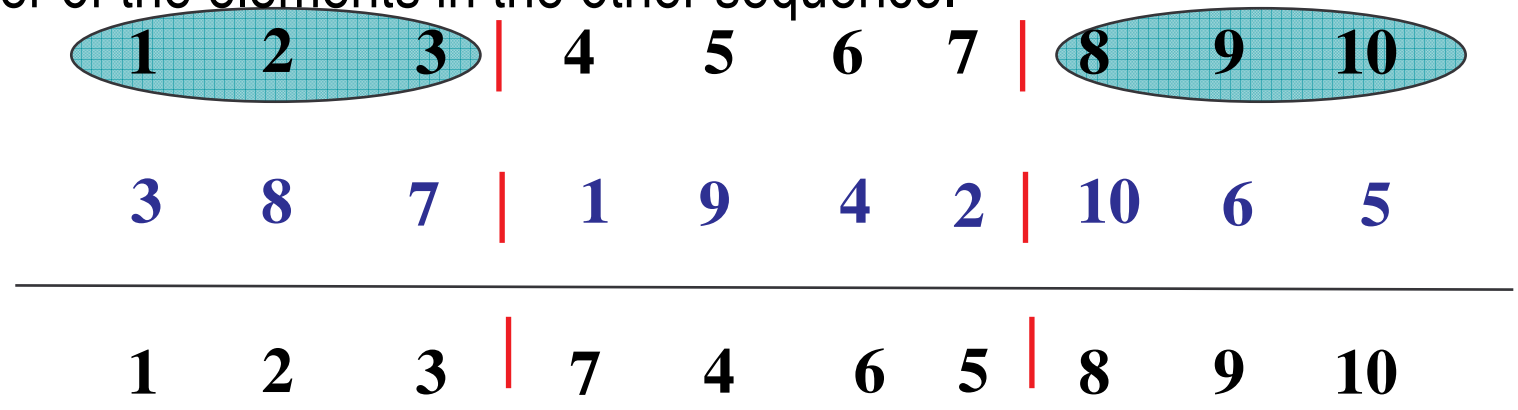

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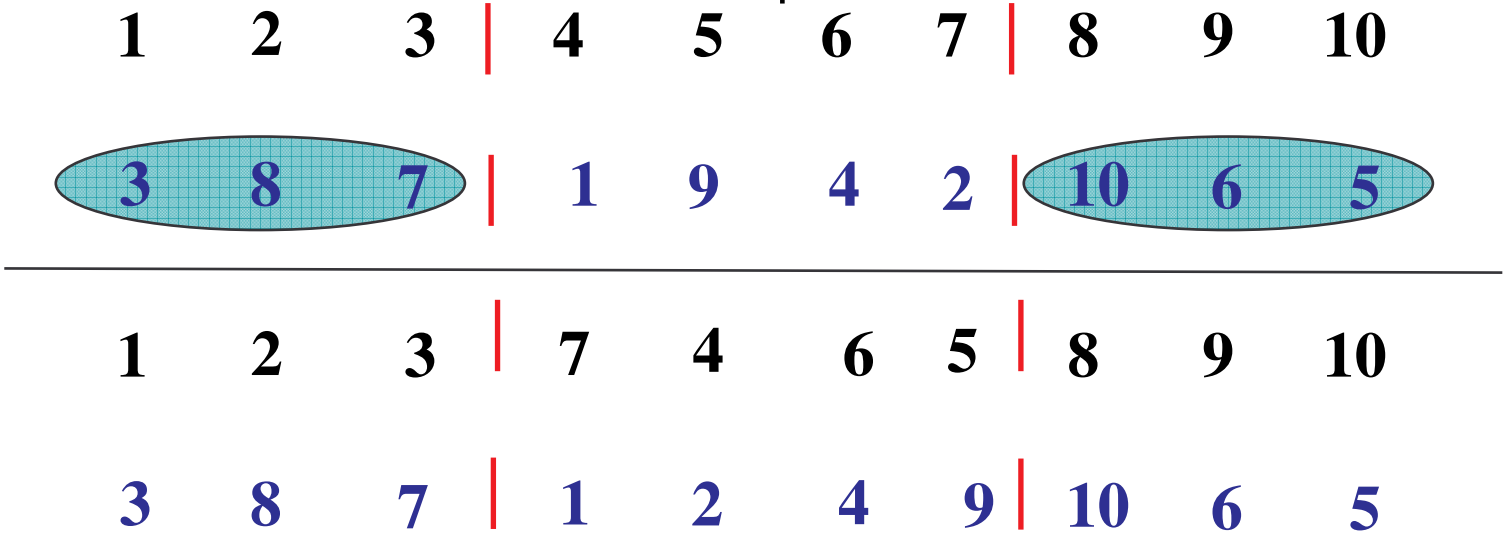


Genetic Algorithm (GA)

A **mutation** operation is applied to solutions before placing them into the new population, each element of each string (each jobs in the permutation) is selected with probability p_{mut} to be perturbed.

If a job of a string is selected for **mutation**, then it is swapped with another randomly selected job in the same string (**a neighbour in the swap neighbourhood**).

Genetic Algorithm (GA)

We illustrate this approach using the following instance of problem $F2|\ |\Sigma w_j C_j$:

Select $p_{cross} = 0.6$ and $p_{mut} = 0.05$

j	a_j	b_j	w_j
1	3	5	7
2	1	4	2
3	6	2	4
4	2	6	1

Genetic Algorithm (GA)

The original population:

Selected for mating

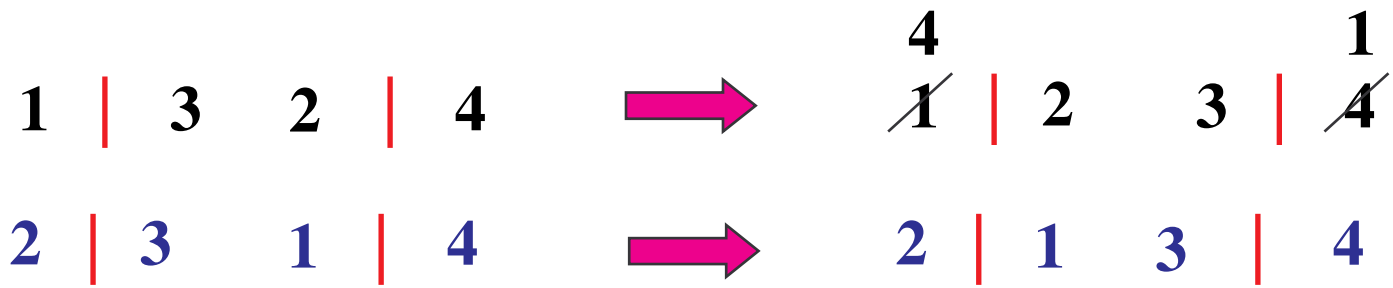
S	$F(S)$	Rank
(1,2,3,4)	156	2
(1,3,2,4)	151	1
(1,3,4,2)	159	3
(2,3,1,4)	172	4
(4,1,3,2)	197	6
(3,1,2,4)	190	5
(4,1,2,3)	209	8
(2,4,1,3)	205	7

Genetic Algorithm (GA)

Suppose that the pairs are formed **(1, 4)** and **(2,3)**

Take the first pair and apply **Reorder crossover** with positions **2** and **3**.

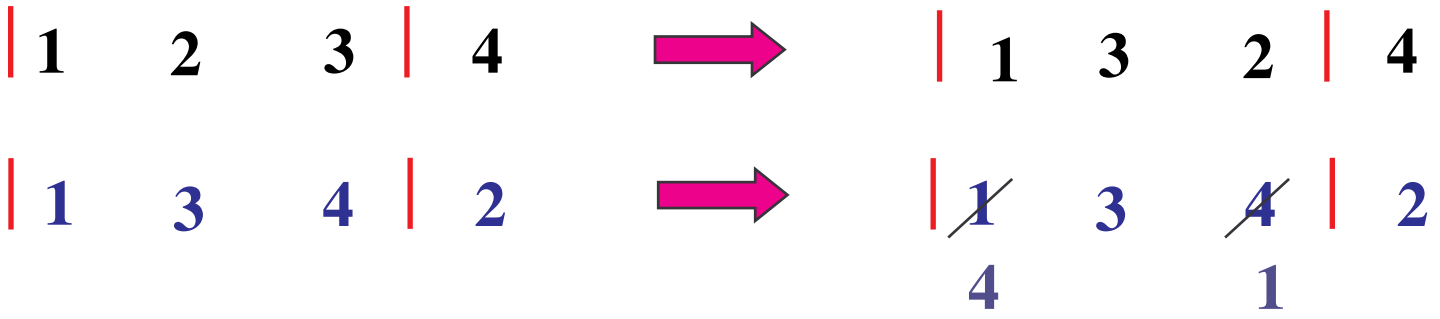
Suppose the **first** child is subject to **mutation** for job **4**, and that job is swapped with **1**



Genetic Algorithm (GA)

Take the second pair and apply **Reorder crossover** with positions **1** and **3**.

Suppose the **second** child is subject to **mutation** for job **4**, and that job is swapped with **1**



Genetic Algorithm (GA)

The next population:

Select best four strings for mating, etc.

S	$F(S)$	Rank
(1, 2, 3, 4)	156	4
(1, 3, 2, 4)	151	2 – 3
(1, 3, 4, 2)	159	5
(2, 3, 1, 4)	172	6
(4, 2, 3, 1)	221	8
(2, 1, 3, 4)	146	1
(1, 3, 2, 4)	151	2 – 3
(4, 3, 1, 2)	200	7

Conclusions

Advantages:

- Implementation does not require much knowledge about the structural properties of the problem;
- Can be easily coded
- Often give fairly good solutions

Disadvantages:

- May be less efficient (in terms of the running time and the accuracy of the solution) than problem-specific approaches

Conclusions

Combining several techniques

Step 1. Apply a “promising” dispatching rule or a composite dispatching rule

Step 2. Use the schedule found as an initial solution for a local search method.