LAST CLASS:

- HILL CLIMBING
- FITNESS LANDSCAPE

TODAY:

REAL-WORD-LIKE PROBLEMS

(WELL-KNOWN OPT. PROBLEMS)

EXAMPLE #1

KNAPSACK PROBLEM

HIGH LEVEL SPECIFICATION

GIVEN N OBJECTS OF WHICH WE KNOW THE VALUE AND THE WEIGHT. GIVEN A KNAPSACK WITH A KNOWN CAPACITY.

WHAT IS THE SUBSET OF OBJECTS THAT WE CAN TRANSPORT SO THAT

- THE TOTAL VALUE IS MAX
- THE TOTAL WEIGHT IS ≤ CAPACITY

NUMERIC EXAMPLE

0 0 0 1 1 0 1 0 0 0

WEIGHTS : 23, 31, 29, 44, 53, 38, 63, 85, 89, 82

VALUES : 92, 57, 49, 68, 60, 43, 67, 84, 87, 72

CAPACITY : 165

- WHAT ARE SOLUTIONS (CONCEPT) ?
- WHAT REPRESENTATION FOR SOLUTIONS
- WHAT FITNESS ? ←
- WHAT NEIGHBORHOOD ? ←

- WHAT ARE SOLUTION ?

  DON'T TRY TO SOLVE THE PROBLEM !

  A PARTITIONING OF OBJECTS INTO OBJECTS CARRIED IN THE KNAPSACK AND NOT CARRIED

- HOW TO REPRESENT ? (IF POSSIBLE, STRINGS OR VECTORS, ...)

  BINARY STRINGS OF LENGTH N (# OF OBJECTS)
  WHERE 1 ⟶ OBJECT IN THE KNAPSACK, 0 ⟶ NOT IN THE KNAPSACK

- FITNESS :

  if (TOTAL WEIGHT ≤ CAPACITY)
  then fitness = TOTAL VALUE (ADMISSIBLE SOLUTION)
  else − TOTAL WEIGHT (NOT ADMISSIBLE)

- NEIGHBORHOOD

NEIGHBORHOOD OF A SOLUTION x CAN USUALLY BE DEFINED AS:

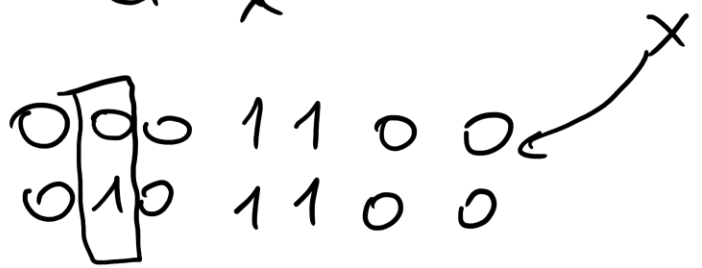
- $N(x) = \{ y \mid d(x,y) \leq k \}$ FOR SOME d AND k
- $N(x) = \{ y \mid y = \varphi(x) \}$ φ IS AN OPERATOR THAT TRASFORMS SOLUTIONS

TYPICAL NEIGHBORHOOD FOR BINARY STRINGS: BIT FLIP

φ = CHANGES ONE BIT IN THE STRING REPR. OF x

d = HAMMING DISTANCE

$k = 1$



EXAMPLE #2

TRAVELLING SALESPERSON PROBLEM (TSP)

GIVEN : A SET OF CITIES AND THEIR PAIRWISE DISTANCES
ONE CITY = HOME

OBJECTIVE : FIND THE CYCLIC PATH STARTING FROM HOME AND RETURNING HOME THAT VISITS ALL OTHER CITIES ONCE WITH THE MINIMUM TOTAL DISTANCE.

- SOLUTIONS ?
- REPRESENTATION
- FITNESS
- NEIGHBORHOOD

NUMERIC EXAMPLE

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

SOLUTIONS ARE STRINGS OF N+1 VALUES (N = # CITIES) WHERE HOME IS IN POSITION 1 AND N+1 AND ALL OTHER POSITIONS CONTAIN ALL VALUES ONCE

EXAMPLE (HOME = 1)

$x = 1\ 3\ 5\ 4\ 2\ 1$

$y = 1\ 4\ 5\ 3\ 2\ 1$

FITNESS:

$f(x) = d(1,3) + d(3,5) + d(5,4) + d(4,2) + d(2,1) =$

$= 7 + 1 + 6 + 8 + 9 = 31$

NEIGHBORHOOD

SWAP OF TWO CITIES

$f(y) = d(1,4) + d(4,5) + d(5,3) + d(3,2) + d(2,1) =$

$= 1 + 6 + 1 + 3 + 9 = 20$