CIS
RESEARCH GROUP

Heuristics & Metaheuristics for Optimization & Learning

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Useful Information

CONTATTI DOCENTE

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- Come contattarmi:
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- Pagina del corso: (Under construction)

  http://www.dmi.unict.it/mpavone/hemol.html
- Avvisi DMI:
  - http://web.dmi.unict.it/corsi/lm-18/avvisi-docente
- canale Telegram del DMI
- Pagina del corso

Canale Microsoft Teams: qxxshmh

Canale Telegram del Corso:
- https://t.me/joinchat/ahhcCKsjgEMzZjFk
- HEMOL

What to be careful for solving problems

The Complexity of a problem gives an indication on the hardness of the problem

It is important to know the size of input instances

The structure of the instances plays an important role

For some very large polynomial problems, or some specific structure, we may need the use of metaheuristics

Required search time to solve the problem is an important parameter: even if the problem is polynomial the need of using metaheuristics may be justified for real-time search constraints.

Success Key: Concepts

- Codifica del problema
- Rappresentazione della soluzione
- Definizione della funzione obiettivo
- Progettazione metodo/processo di ricerca della soluzione

Success Key: Exploration

Quando un Problema è Complesso

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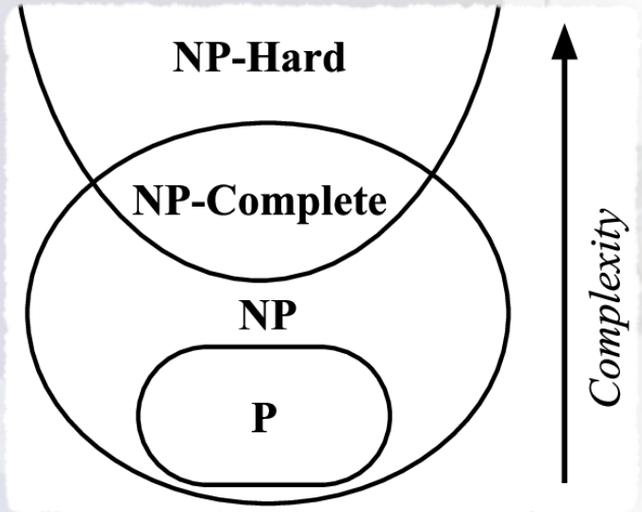
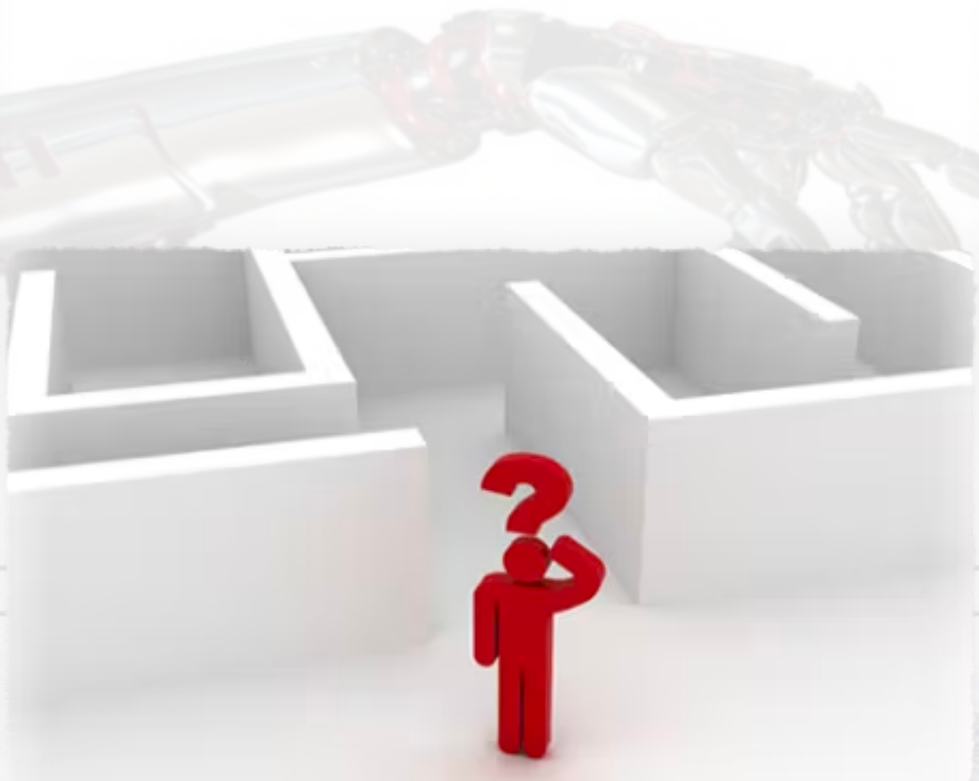
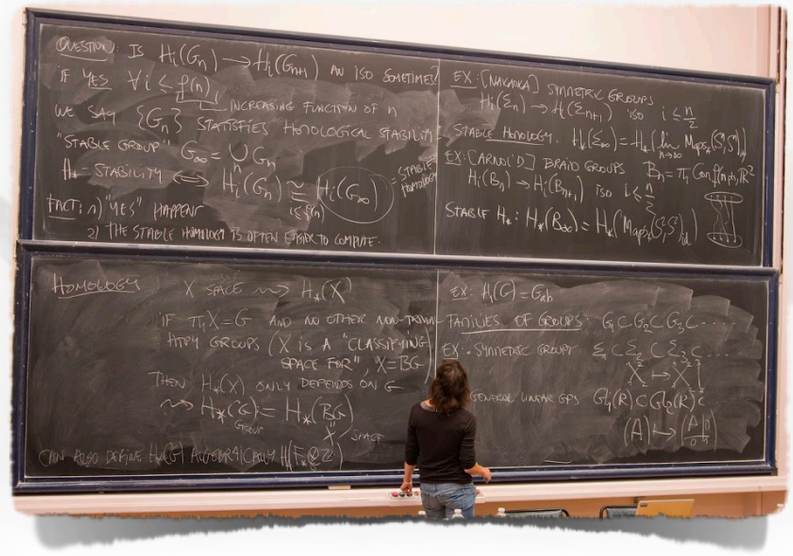
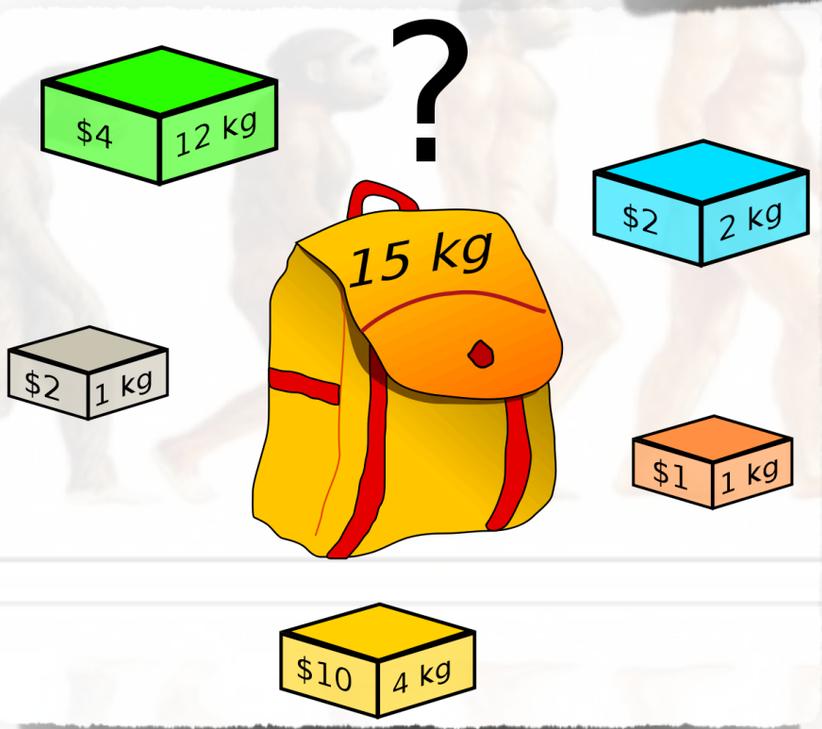
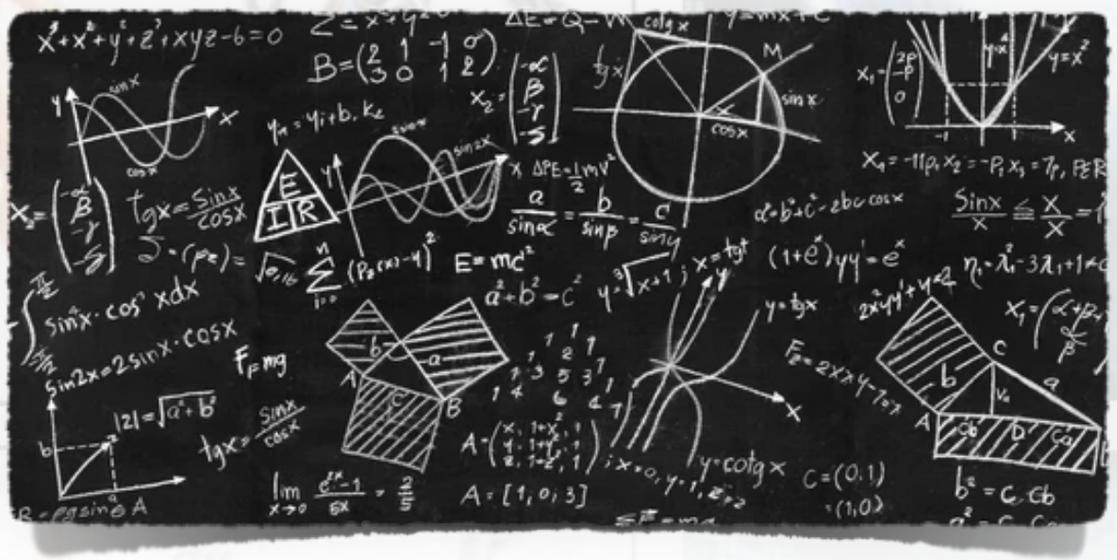










Search Space

- Given a combinatorial problem **P**, a **search space** associated to a mathematical formulation of **P** is defined by a couple **(S,*f*)**
  - where **S** is a finite set of configurations (or nodes or points) and
  - ***f*** a **cost function** which associates a real number to each configurations of **S**.
- For this structure two most common measures are **the minimum and the maximum costs**. In this case we have the **combinatorial optimization problems**.

An Example of Searching Complex

Complexity of the Landscape PSP

Energy level	No. of Conformations
0	36.098.079
-1	31.656.934
-2	12.473.446
-3	2.934.974
-4	517.984
-5	77.080
-6	10.364
-7	1194
-8	96
-9	**4**
Total	**83.779.155**

Combinatorial Landscape

Components of fitness landscape:

- Set S of admissible solutions
- Fitness function that assigns a real value to each solution
- Distance measure that defines distance between any two solutions in S

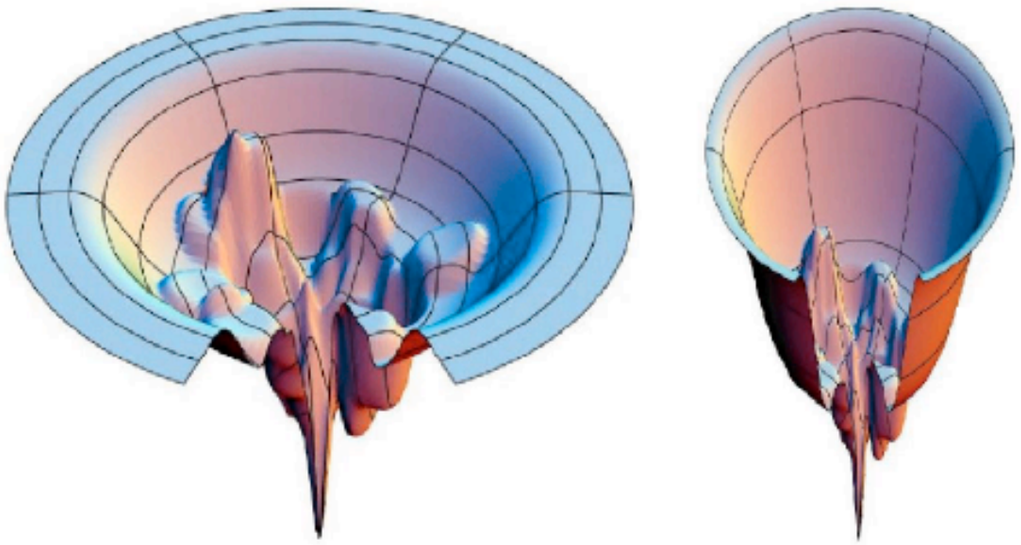
Example distance measures:

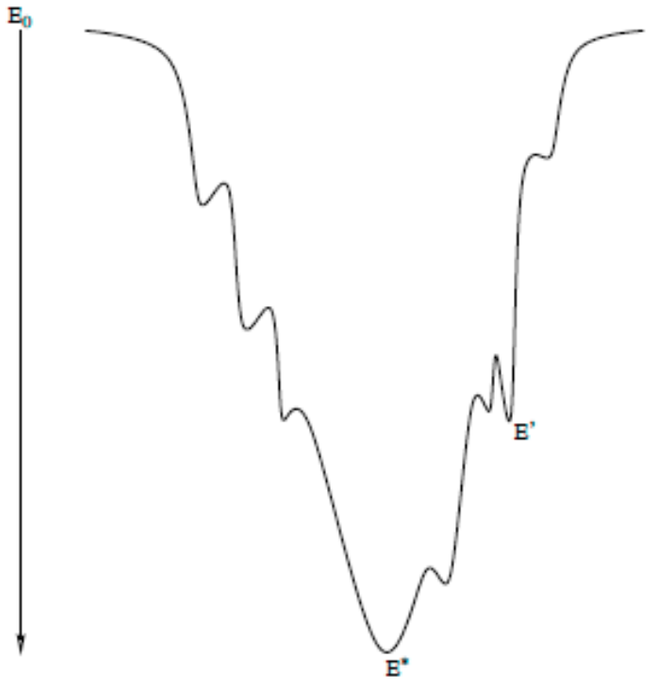
- Hamming distance for binary strings (num. mismatched bits).
- Euclidean distance metric for continuous vectors

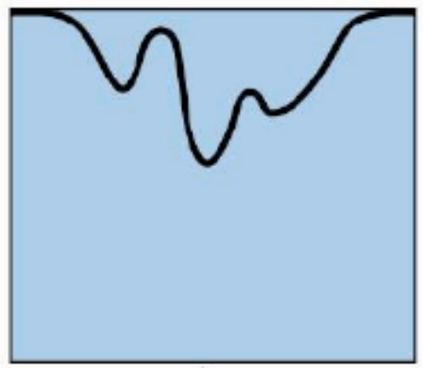
Easy Problems, and Hard Problems:

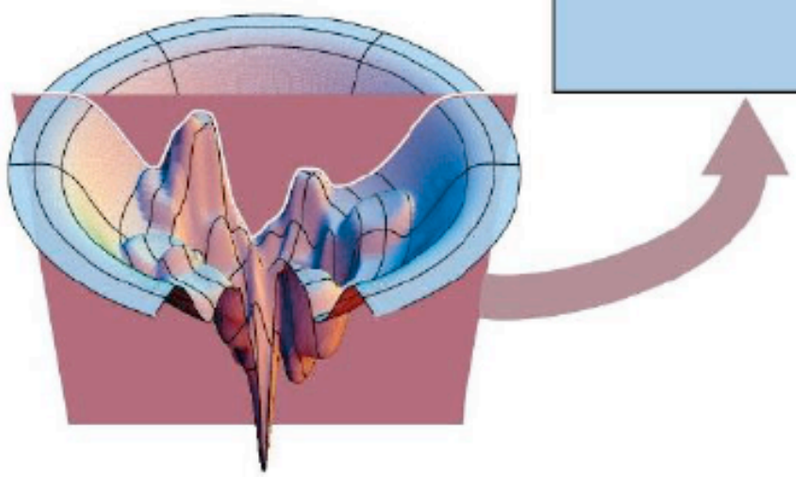
- Easy: few peaks; smooth surfaces, no ridges/plateaus
- Hard: many peaks; jagged or discontinuous surfaces, plateaus

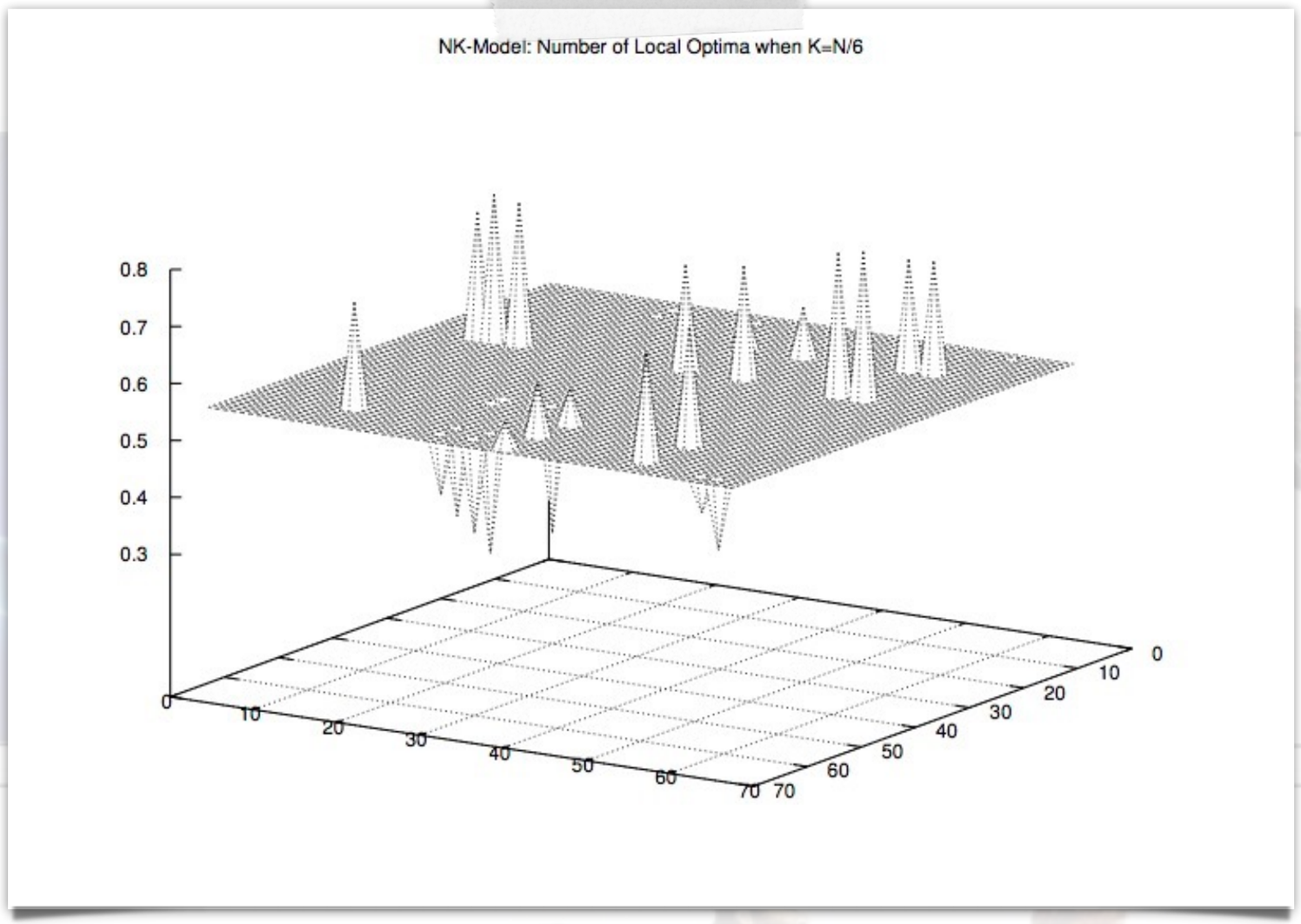
Complexity of the Landscape PSP



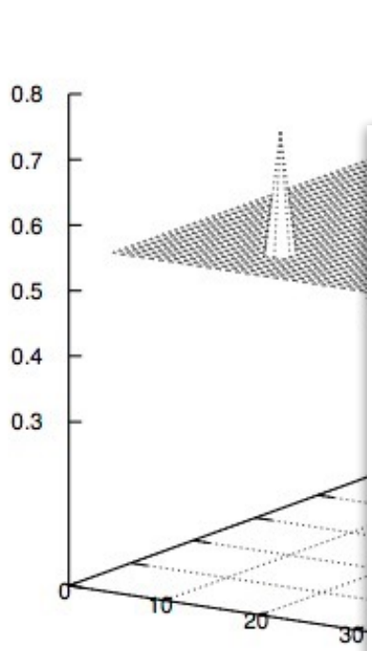




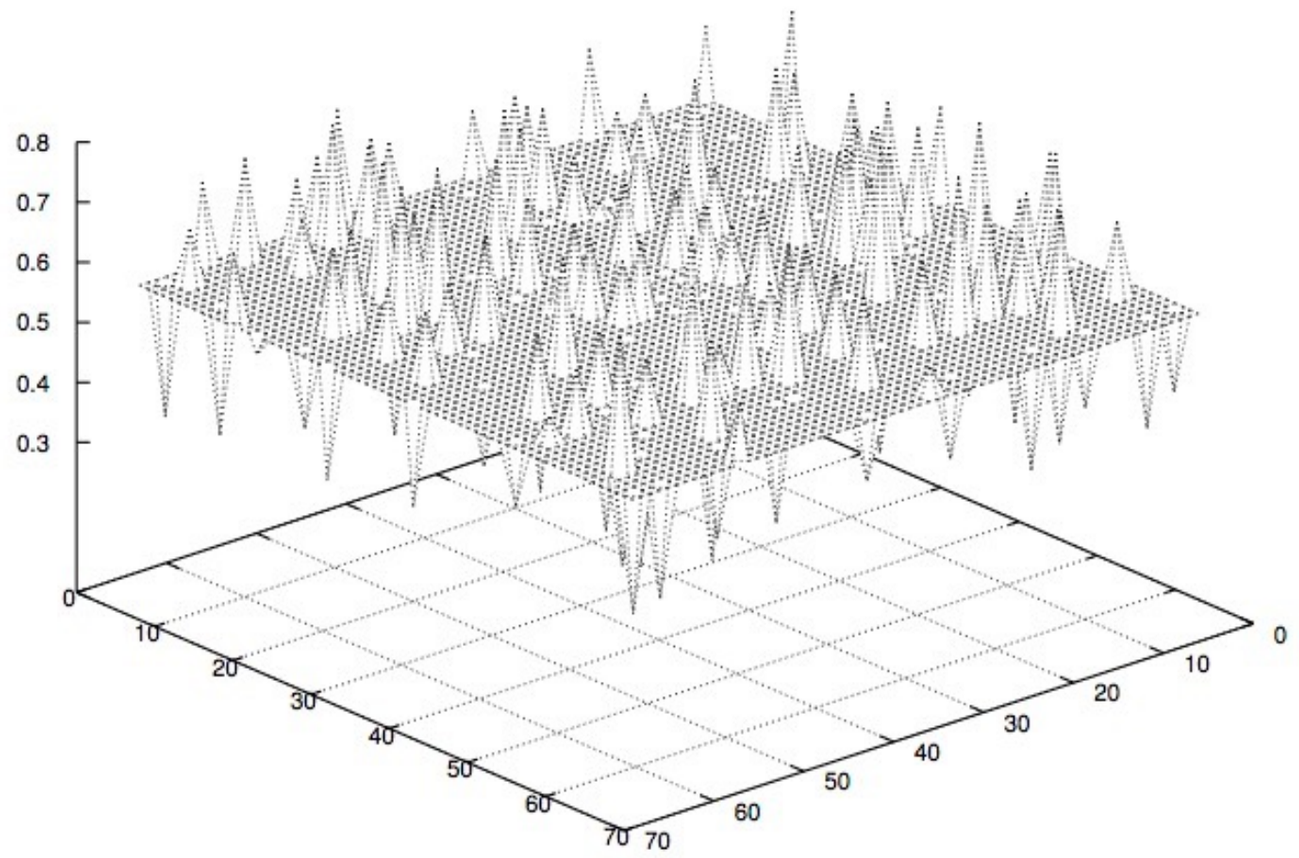



NK-Model: Number of Local Optima when K=N/6
0.8
0.7
0.6
0.5
0.4
0.3
0
10
20
30
40
50
60
70
0
10
20
30
40
50
60
70

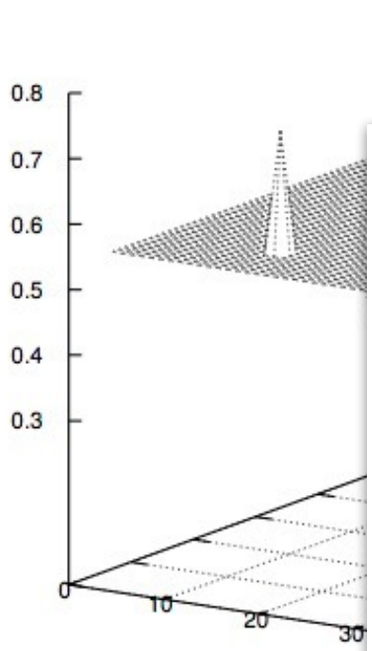
NK-Model: Number of Local Optima when K=N/6



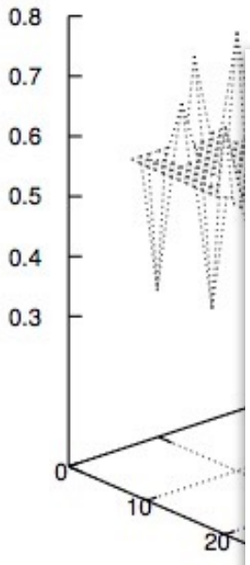
NK-Model: Number of Local Optima when K=N/2



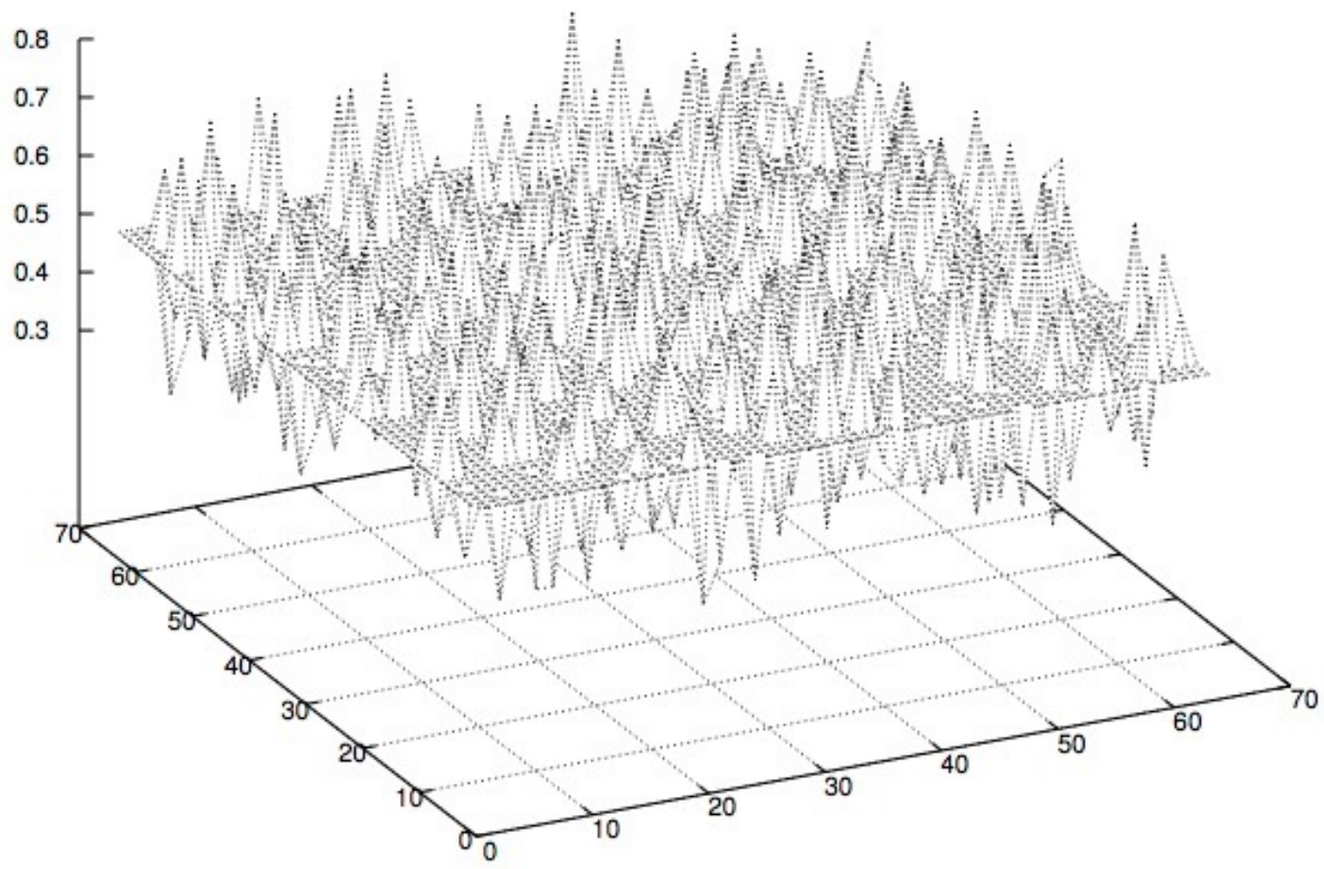
NK-Model: Number of Local Optima when K=N/6

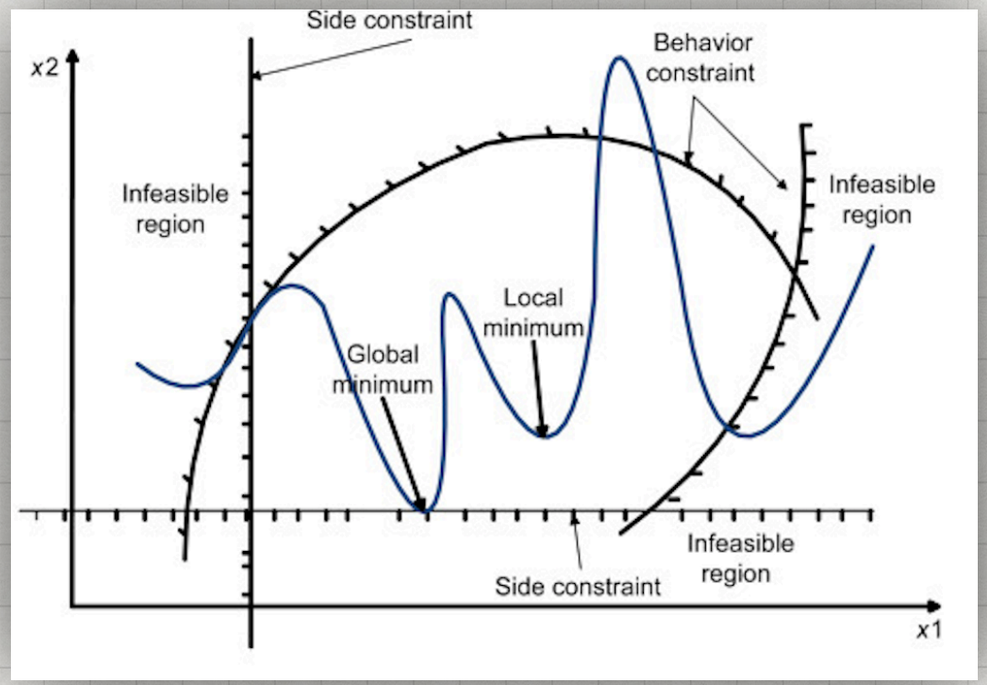


NK-Model: Number of Local Optima when K=N/2



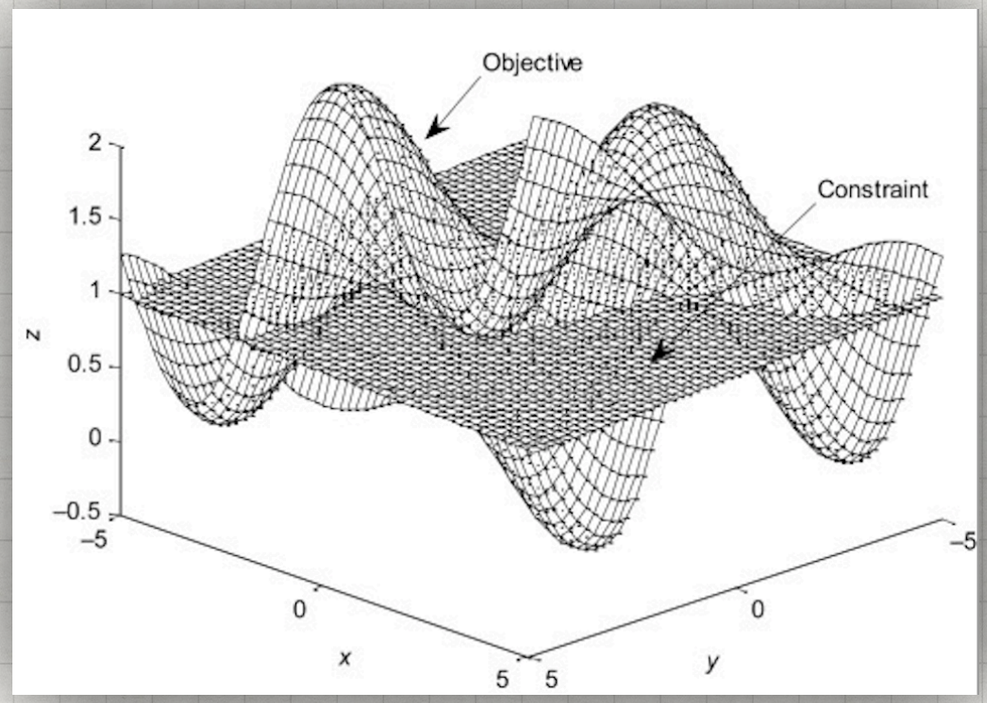
NK-Model: Number of Local Optima when K=N-1

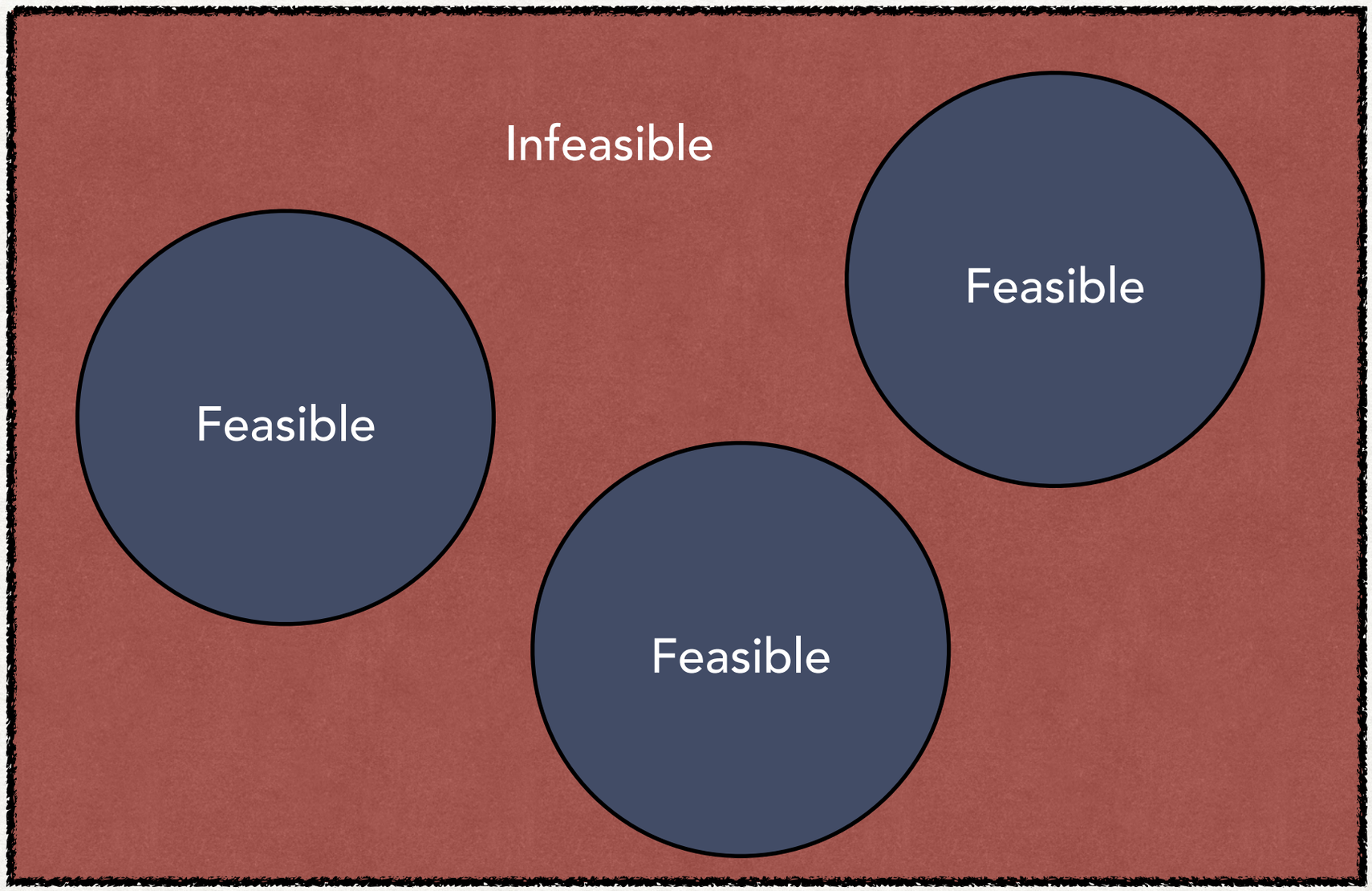




Constraint Optimization

Problems





S=Search Space