CSE/ECE 848 Introduction to Evolutionary Computation

Module 4 - Lecture 20 - Part 4

Dynamic Problems in EC: Performance Measures and Benchmark Problems

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Performance Measures for DO

- Performance measures for stationary problems
  - Best so far
  - Average best so far (offline)
  - Average of all evaluations (online)
- Performance measures for dynamic problems
  - Adaptation performance I
  - Average distance to the optimum
  - Best of generation average
  - Accuracy Acc

$I = 1/T \sum f_{best}(t)/f_{opt}(t)$

T:	number of generation
$f_{best}(t)$:	best fitness in the population at time t
$f_{opt}(t)$:	global optimum at time t

$Acc = 1/K \sum err_i$

err_i :	difference between the current best in the population just before change and the optimum value averaged over the entire run
K:	Number of changes of the fitness landscape

Knowledge for Performance Measures

- Knowledge on the position of the optimum is available
  - Distance to optimum can be calculated
- Knowledge on the best fitness value is available
  - Accuracy can be calculated
- No global knowledge is available
  - Only the current best can be known

Benchmark Problems

- Change a constant problem into a time-dependent problem
- Real space
  - Switch between different functions
  - Move/reshape peaks in fitness landscape
- Binary space
  - Switch between states of a problem (eg knapsack)
  - Use binary masks (eg XOR DOP generator)
- Permutation space
  - Change decision variables (eg item weights/profits in knapsack)
  - Add/delete decision variables (new jobs/nodes etc)

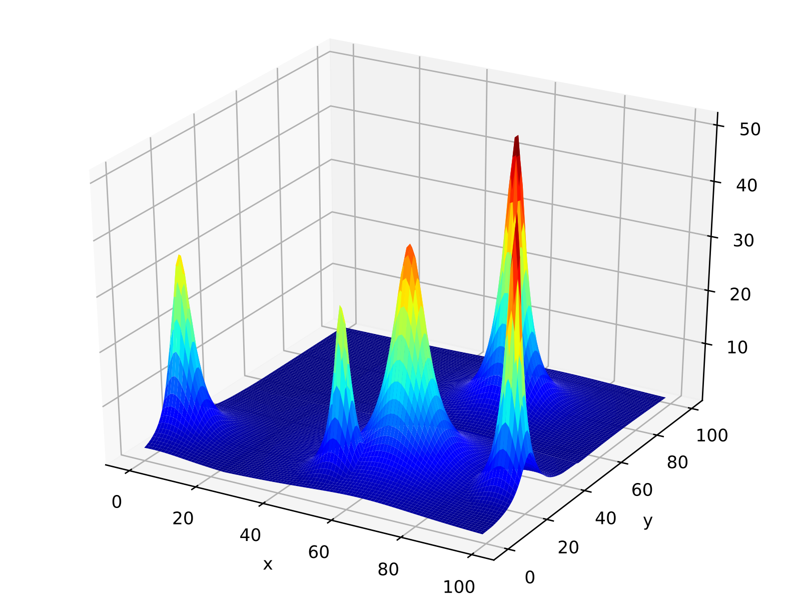
Benchmark Problems - Real Space

- Moving Peaks Benchmark (MBP) (Branke 1999)

$$f(\mathbf{x}) = \frac{h}{1+w\sqrt{\sum_{i=1}^{N}(x_i-p_i)^2}}$$

h(t): Height; w(t) width;
p_i (t) location of peak

with appropriate dynamics



DEAP Benchmarks

Benchmark Problems - Binary Space

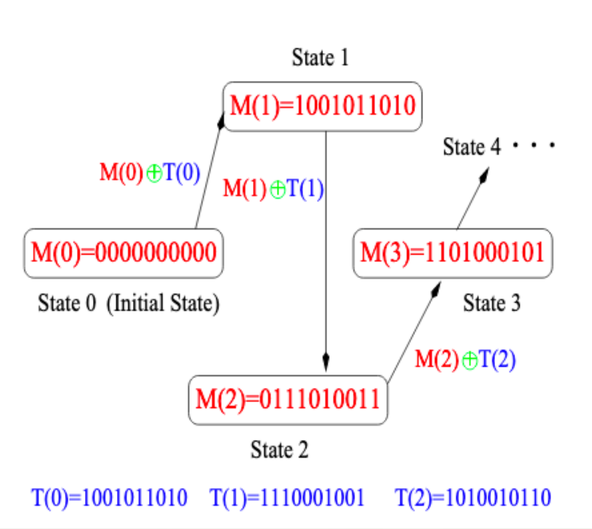
- XOR DOP generator (Yang 2003)
- Can create DOPs from any binary fitness function f(x)
- Create a mask M(k) where k is the period k=t/τ with τ being the number of generations things are constant

$$\vec{M}(0) = \vec{0} \quad \text{(the initial state)}$$
$$\vec{M}(k+1) = \vec{M}(k) \oplus \vec{T}(k)$$

- with T(k) a template with ρ randomly distributed ones
- Then

$$f(\vec{x}, t) = f(\vec{x} \oplus \vec{M}(k))$$

- τ, ρ control the speed/severity of change



Yang, GECCO 2013

Benchmark Problems - Combinatorial Space

- Dynamic Traveling Salesperson (DTSP)
- Minimize tour length or cost D(t)
- Given a set of cities i, visit each city once and return to your starting place
- Distance/cost between cities d_{ij} (t) is time dependent

$$f(x,t) = Min(\sum_{i=1}^{n} d_{x_i, x_{i+1}}(t))$$

where i = $\{1, \ldots, n\}$; $x_{n+1} = x_1$