Evolutionary Algorithms for Multi-Objective Path Planning

Ceng 713 Project, 2011

Tugcem Oral

Outline

- Introduction
- Related Papers
- What To Do
- Discussion

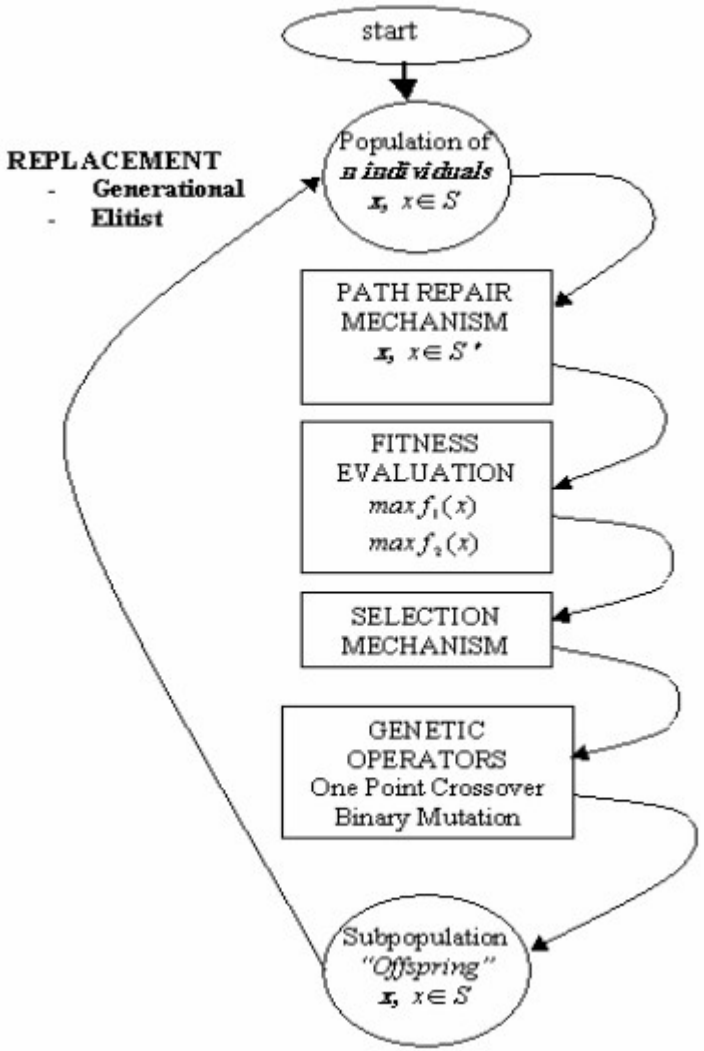
Introduction

- Multi-Objective Optimization
- MSPP
- Moving Targets & Obstacles
- PSO
- Evolutionary Approaches

GA For MOOPP

- Point-to-point offline planning
- 2D Static Environment
- MOGA
- Input
  - nxn grid with obstacles and wd
- Output
  - Valid paths
  - Minimize path length and difficulty

GA For MOOPP cont'd



- Random initialization
- Path repair mechanism
- Fitness Evaluation
- Roulette Wheel Selection
- Genetic Operators
  - One point xover
  - One bit binary mutation
- Generational and Elitist Replacement

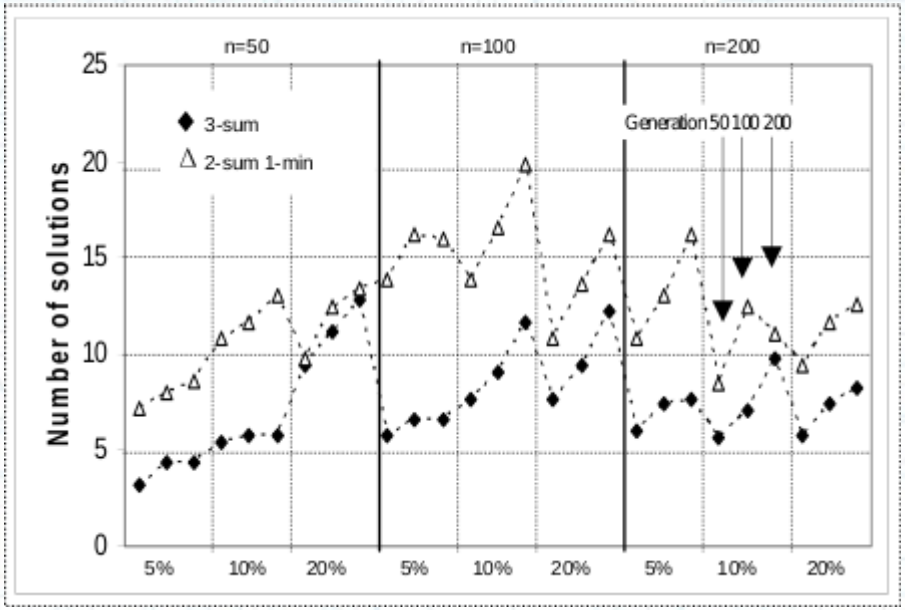
EA For MSPP

- Introduce MSPP
- Concentrate on multiobjectivity
- Complexity of algorithm
- Graph representation
- Static environment
- SPEA2

EA For MSPP cont'd

- Initial Population : Random
- Fitness Function : SPEA2
  - Use “density function” to avoid genetic drift
- Selection
  - Survival Selection : “best” (non-dominated) individuals
  - Mating Selection : binary tournament selection
- Recombination
  - One point xover
- Mutation

EA For MSPP cont'd –
Experimental Results



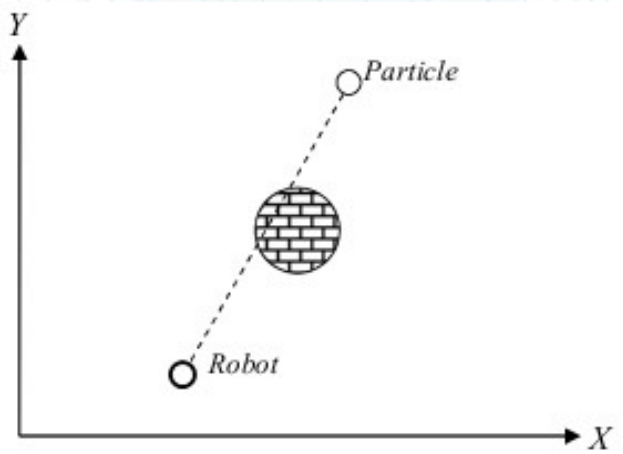
Generates more efficient paths as # of generations increase.

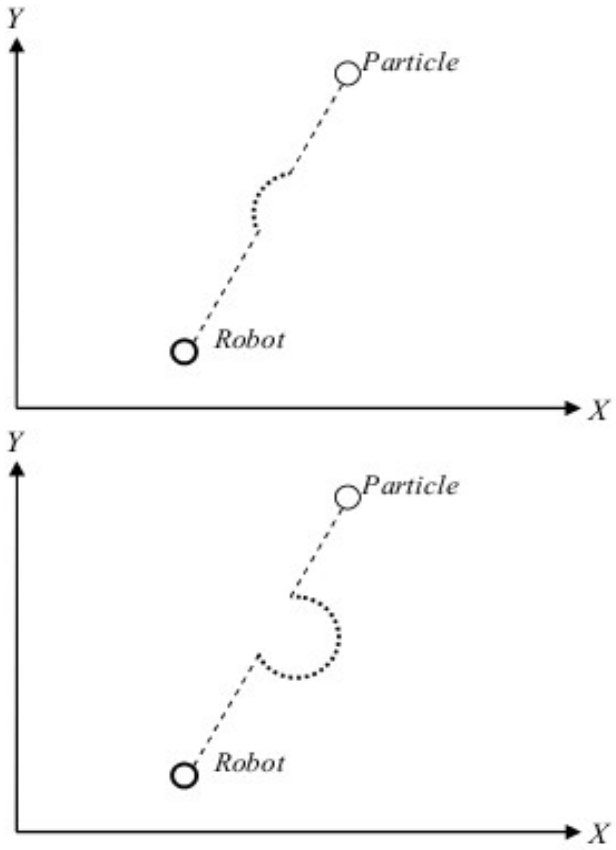
Using PSO For Moving Targets

- Uses PSO in dynamic environment.
- Assumptions
  - Maximum footstep for agent and target
  - P_{goal} is the probability of target movement
  - Obstacles are circular, no collision
- Principles
  - Always select shortest path
  - Agent rotates not to collide with obstacles

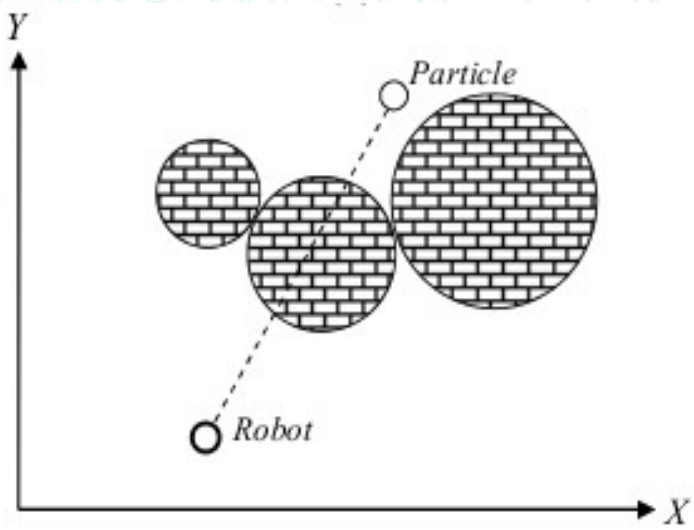
Using PSO For Moving Targets cont'd

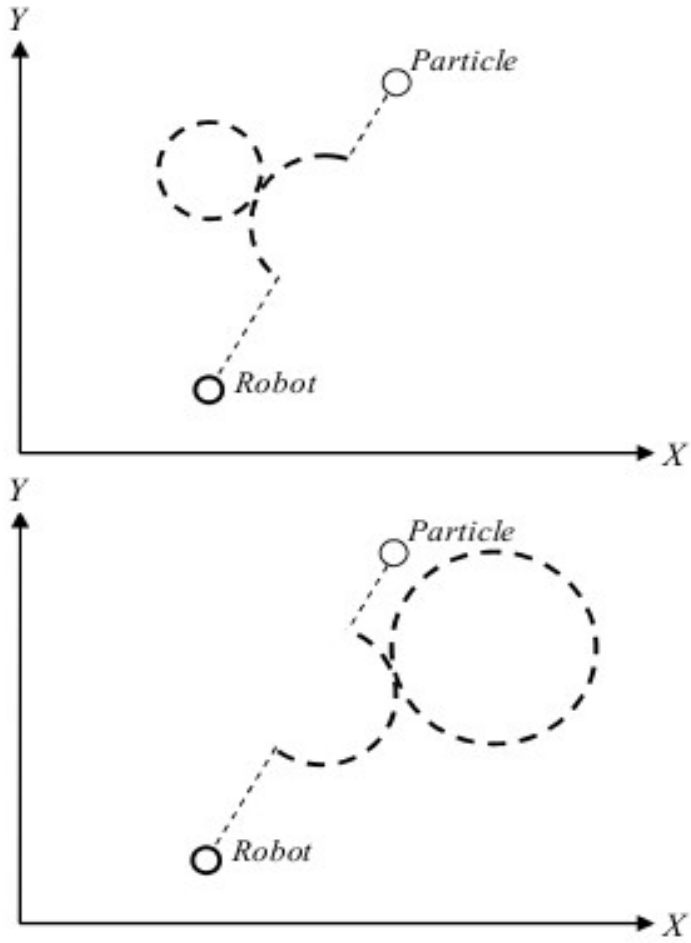
- Euclidean distance between points
- Penalty function





Using PSO For Moving Targets cont'd

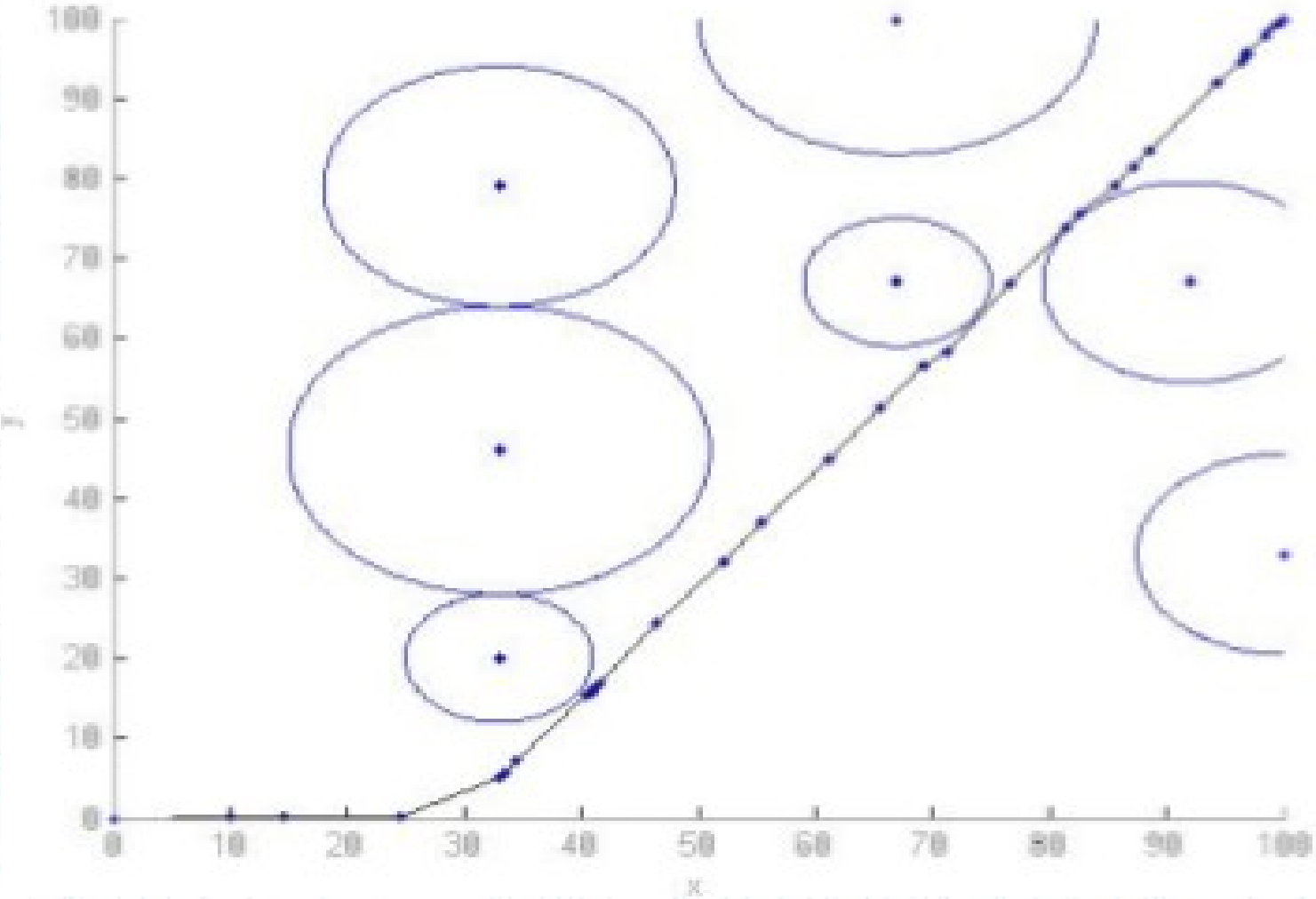




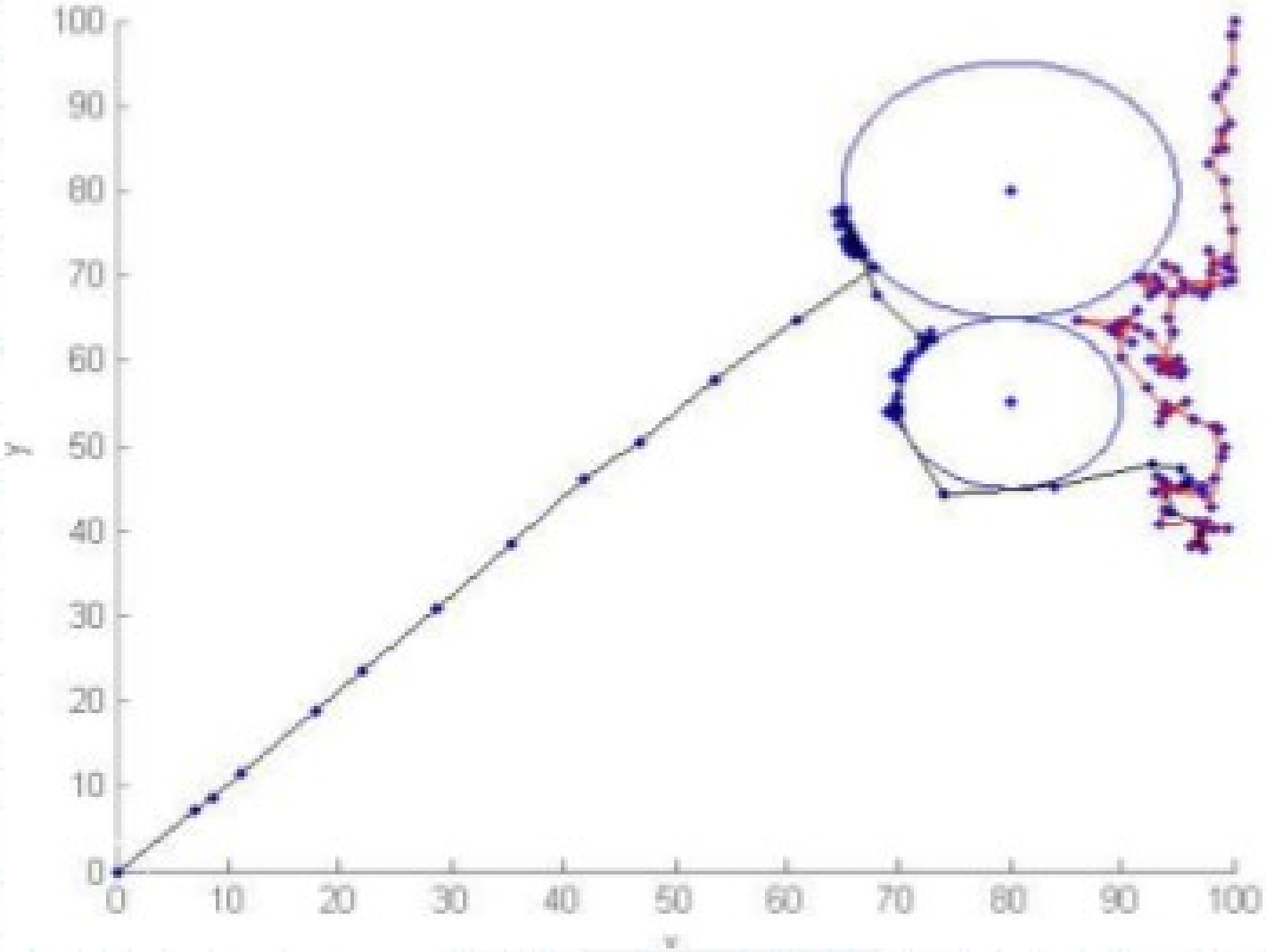
Using PSO For Moving Targets cont'd

- Step 1: Add current position of robot to the path.
- Step 2: If the distance between the current position of the agent and the goal is less than or equal to a predefined threshold, go to step 6.
- Step 3: Move the obstacles and the goal according to their corresponding relocation probability and velocity.
- Step 4: Initialize PSO swarm around current position of the agent. Evolve PSO swarm.
- Step 5: Choose global best position of the swarm to be the current position of the agent and go back to step 1.
- Step 6: Add the goal position to the path and stop.

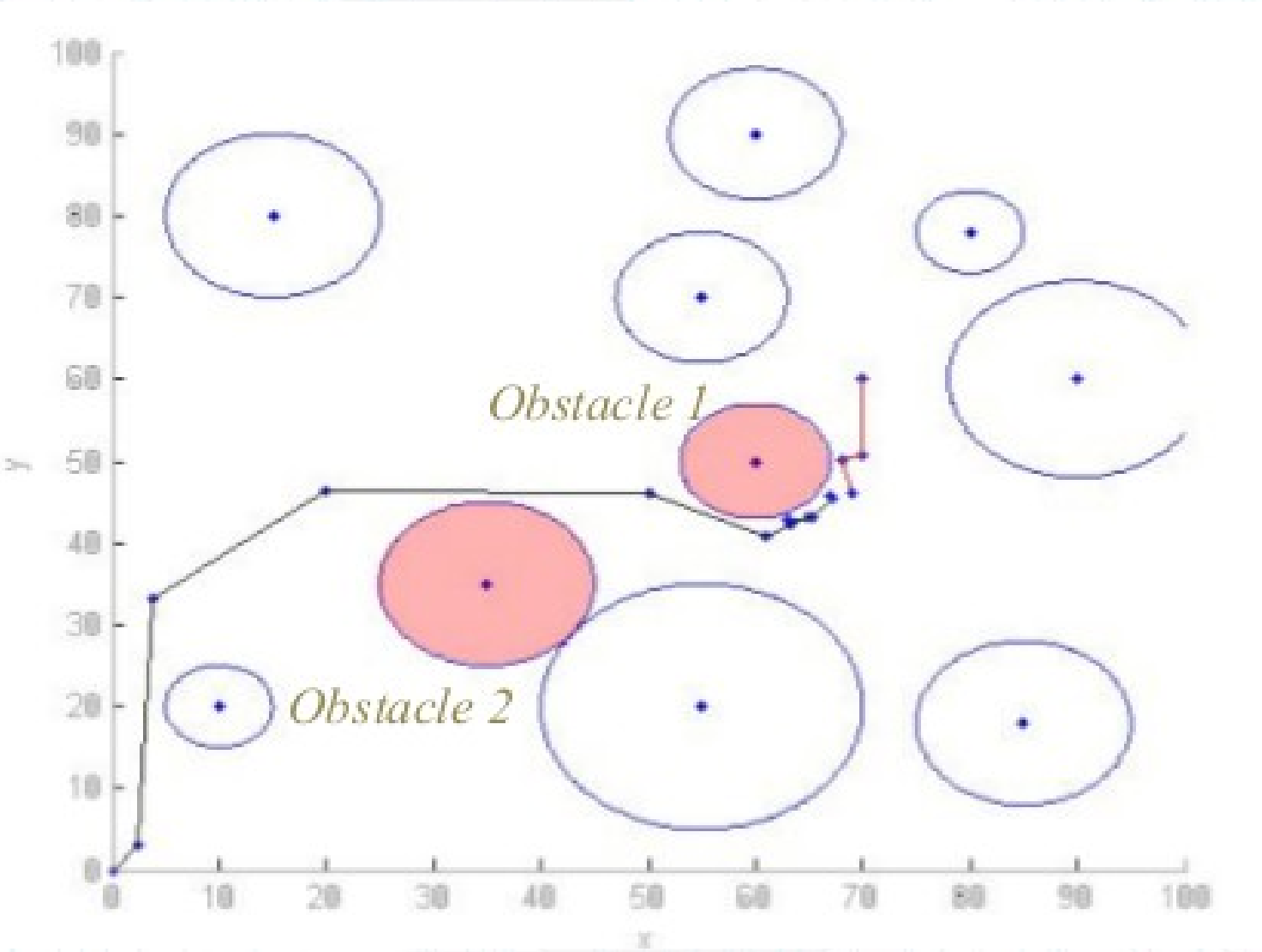
Using PSO For Moving Targets cont'd – Experimental Results



Using PSO For Moving Targets cont'd – Experimental Results



Using PSO For Moving Targets cont'd – Experimental Results



What To Do

- Try to give the idea about evolutionary based multi-objective path planning
- Combine strategies
- Concentrate on *moving targets* - other components of environment are static

References

- Oscar Castillo, Leonardo Trujillo, and Patricia Melin. 2006. Multiple Objective Genetic Algorithms for Path-planning Optimization in Autonomous Mobile Robots. Soft Comput. 11, 3 (October 2006), 269-279. DOI=10.1007/s00500-006-0068-4 http://dx.doi.org/10.1007/s00500-006-0068-4
- Pangilinan, J.M.A. and Janssens, G.K., Evolutionary algorithms for the multiobjective shortest path problem. In: Proceedings of the World Academy of Science, Engineering and Technology, vol. 21 (PWASET), pp. 205-210.
- Amin Zargar Nasrollahy, Hamid Haj Seyyed Javadi, "Using Particle Swarm Optimization for Robot Path Planning in Dynamic Environments with Moving Obstacles and Target," ems, pp.60-65, 2009 Third UKSim European Symposium on Computer Modeling and Simulation, 2009
- Xiaoxun Sun, William Yeoh, and Sven Koenig. 2010. Moving target D* Lite. In Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems: volume 1 - Volume 1 (AAMAS '10), Vol. 1. International Foundation for Autonomous Agents and Multiagent Systems, Richland, SC, 67-74.

Thank You

Any Question?