

# Task scheduling in heterogeneous distributed computing using genetic algorithms

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# Outline

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- ♦ Introduction
- ♦ Distributed Computing
- ♦ Scheduling algorithm
- ♦ Results
- ♦ Conclusion
- ♦ Future Work



# Introduction

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- ♦ Dynamic task allocation problem
  - ♦ Heterogeneous distributed computing
  - ♦ NP-Hard problem
  - ♦ Evolutionary algorithms well suited
- ♦ Other solutions less efficient
  - ♦ Zero communication time
- ♦ Created scheduler to more realistically model distributed systems

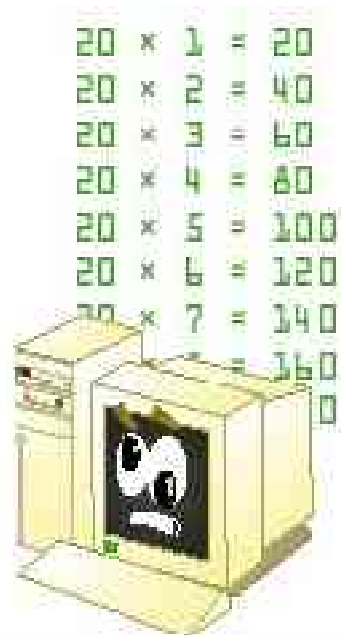
# Distributed Computing



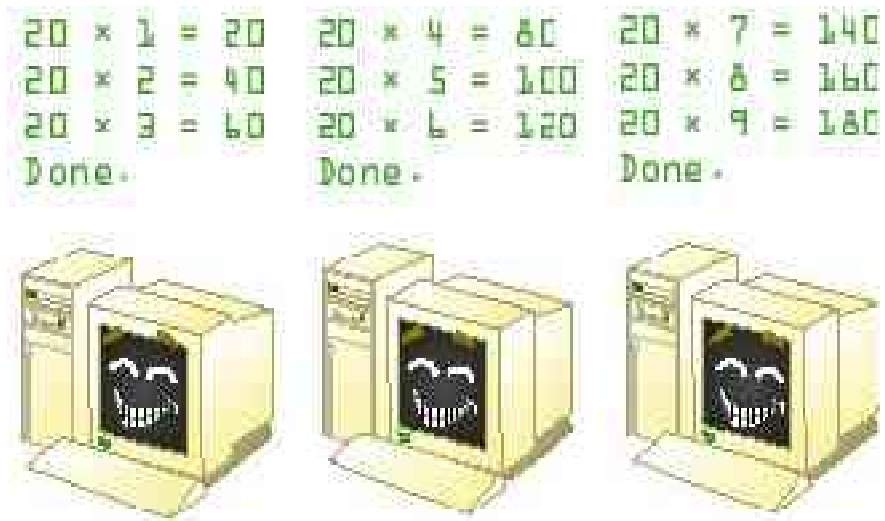
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- ◆ Client-server model



**One computer** could handle this work, but would process it slowly.



If **multiple computers** split the work up, they would get done more quickly than one computer alone. This is **distributed computing**.

# Distributed Computing



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- ♦ Variable heterogeneous computing resources
  - ♦ Non-exclusive usage
  - ♦ Processors can be added or removed
  - ♦ Network can become congested

# Distributed system



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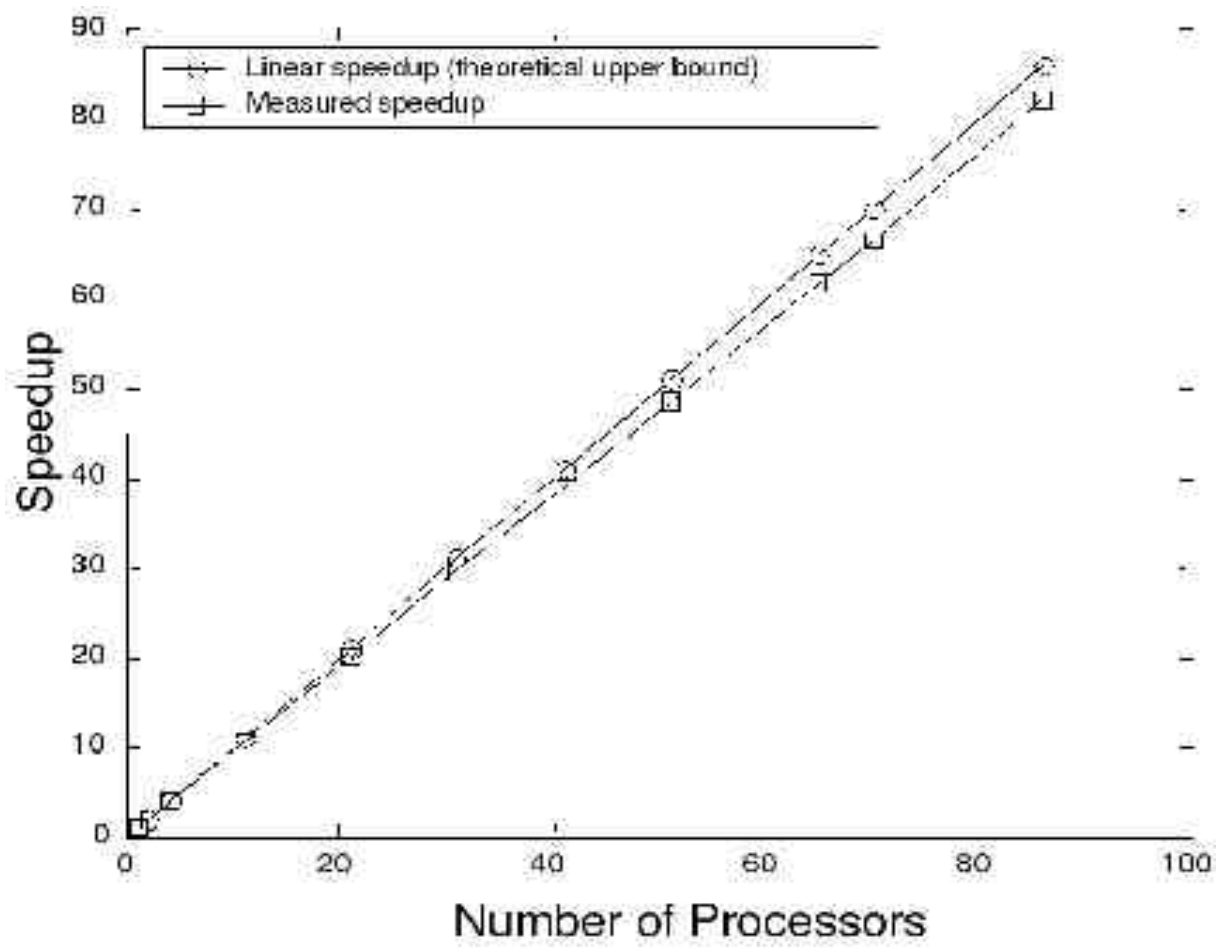
- ♦ Utilises spare clock cycles from desktop PCs
- ♦ 200+ PCs in NUI Maynooth utilised
- ♦ Multiple operating systems
  - ♦ Windows 98/NT/2000/XP, Linux Fedora/Debian/Mandrake, Apple, Solaris

# Speedup - TSP



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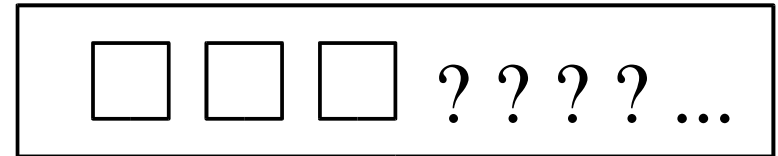
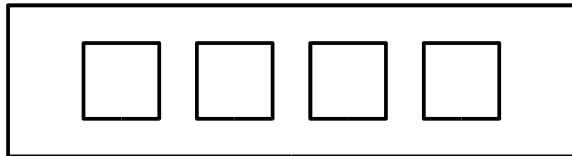


# Scheduling



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## Static

- Schedules created before runtime & cannot change
- Tasks must all be known in advance
- Cannot adapt to changing resources

## Dynamic

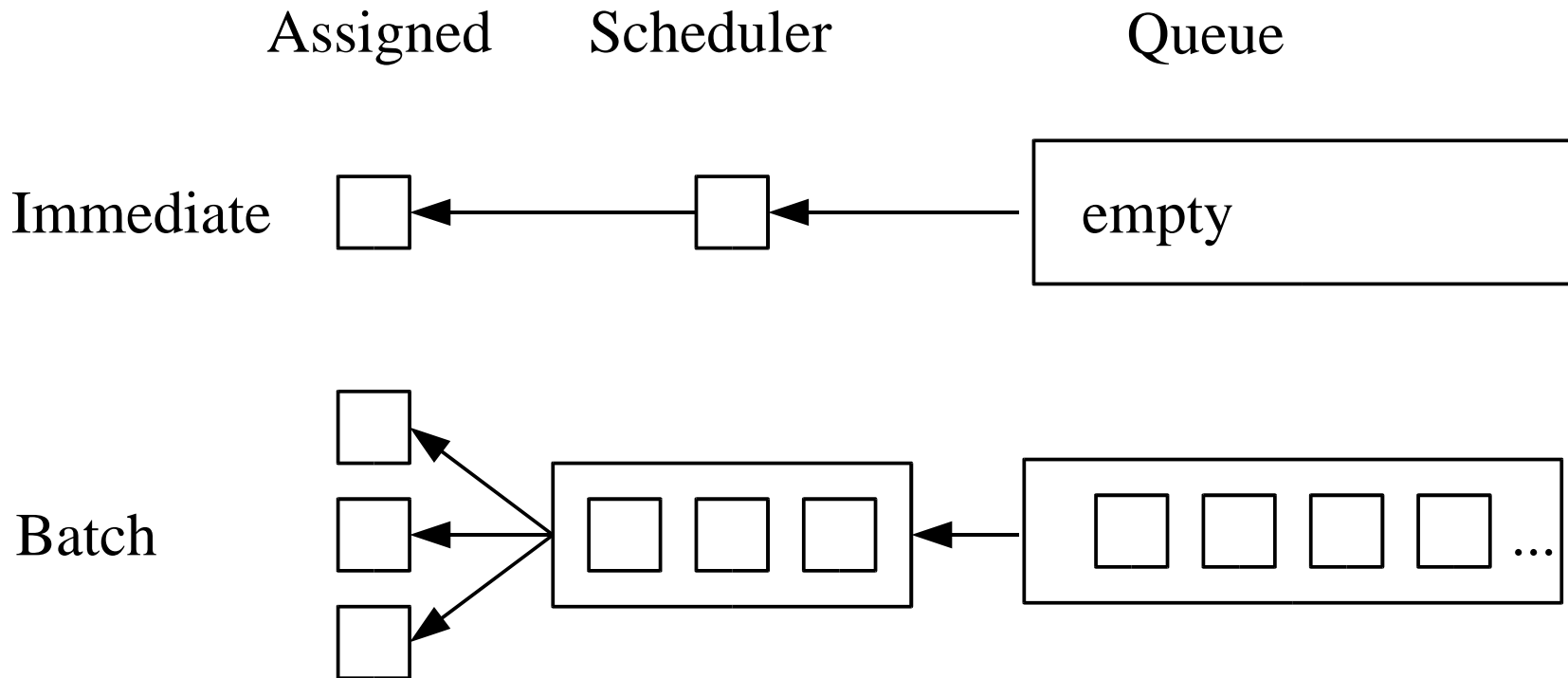
- Schedules created during runtime
- No knowledge of task until it arrives
- Can adapt to changing resources

# Scheduling



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# Scheduling Algorithm

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- ♦ Genetic Algorithm based
  - ♦ Search large spaces quickly
  - ♦ List scheduling heuristic
- ♦ Batch scheduling
- ♦ Smoothing function
- ♦ Linpack benchmark



# Scheduling Algorithm

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- ♦ Initialisation: Most-into-least list scheduling heuristic
- ♦ Fitness function: based on relative error
  - ♦ Euclidian distance from lower bound to current solution
- ♦ Roulette wheel selection
- ♦ Cycle crossover
- ♦ Elitism

# Experiments



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- ♦ Micro GA
  - ♦ Population size of 10
- ♦ Poisson randomness
  - ♦ Normal, uniform, and multimodal also tested
- ♦ Compared to 6 schedulers
  - ♦ 3 immediate mode
  - ♦ 3 batch mode

# Other schedulers



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- ♦ Immediate mode
  - ♦ Earliest first
  - ♦ Lightest Load
  - ♦ Round Robin
- ♦ Batch mode
  - ♦ Min-Min
  - ♦ Max-Min
  - ♦ Zomaya: homogeneous state-of the-art

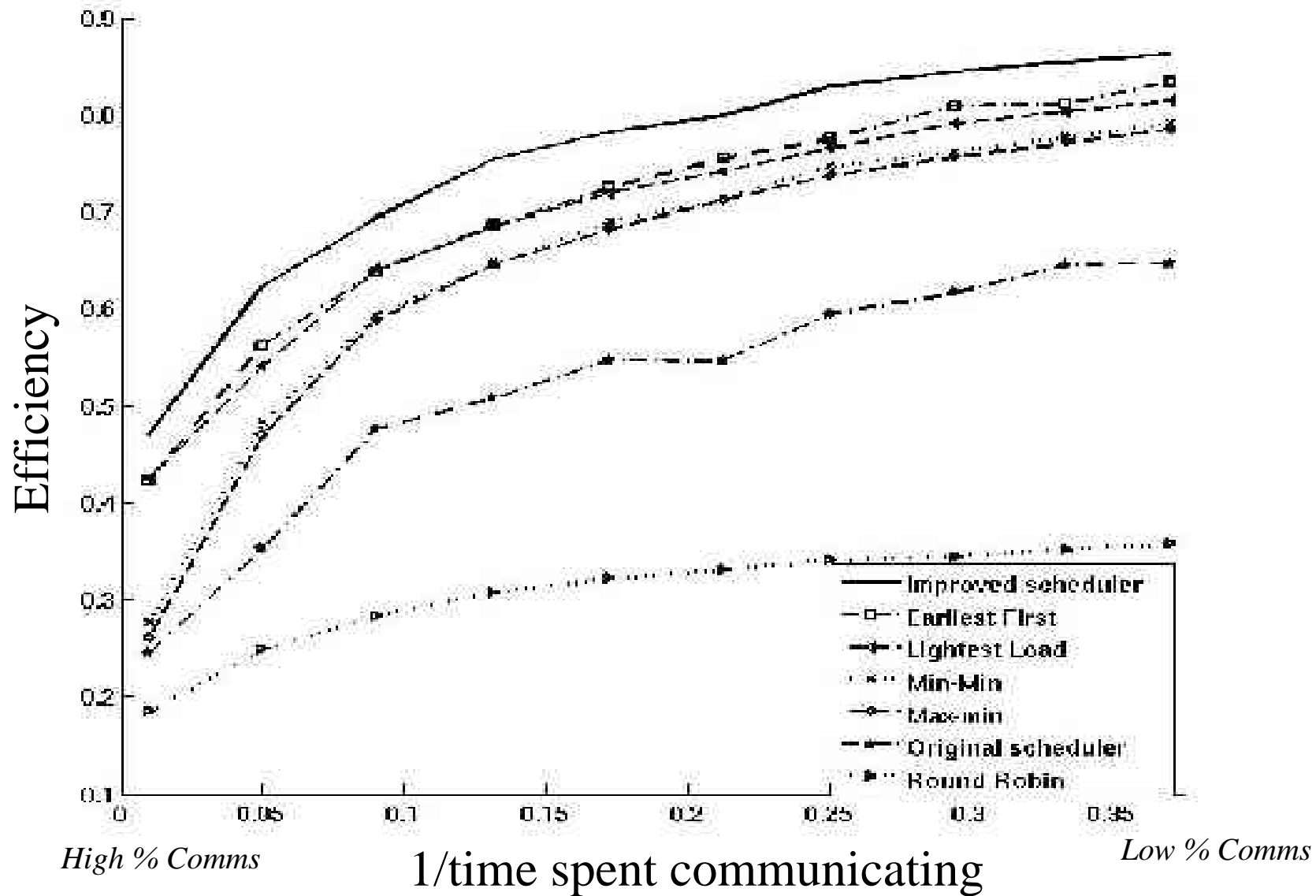
# Setup



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- ♦ Simulation
- ♦ Lookup tables in scheduler
  - ♦ Processor execution rates
  - ♦ Communications costs
- ♦ Model communications & processors
- ♦ Queue of assigned tasks





# Conclusion

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- ♦ Dynamic task scheduler for heterogeneous distributed computing
- ♦ Statistical estimation of system properties
- ♦ Better performance than existing techniques



# Future Work

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- ♦ Deploy on live distributed system
- ♦ Generalise further
- ♦ Use other evolutionary techniques
  - ♦ Tabu, Ant Colony, etc...
- ♦ Employ better pattern recognition techniques



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# Contact Us

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