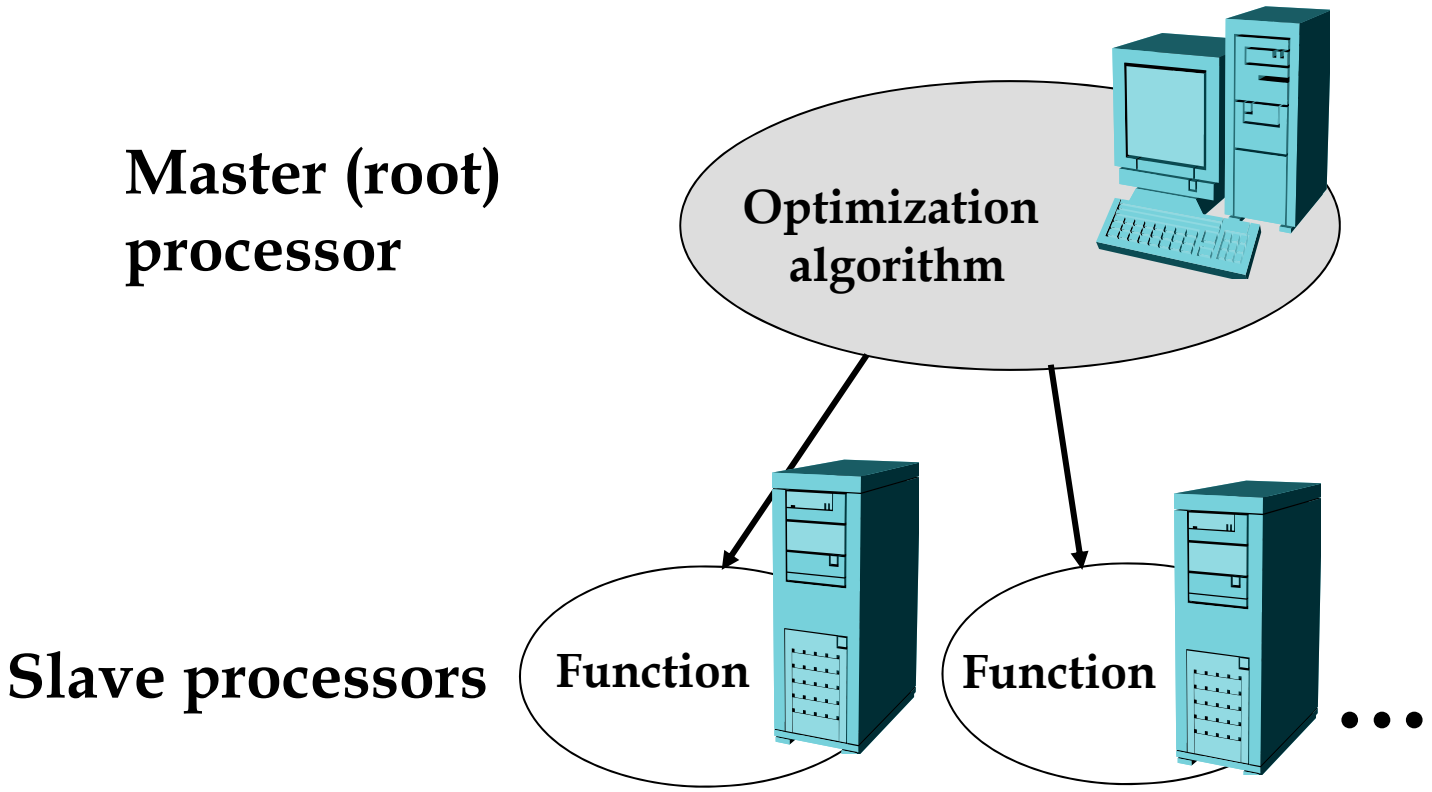
Parallel Evolutionary Algorithms

- **Goal**
  - **Minimize computational demands of EAs**
  - **Improve search abilities of EAs**
- **Parallelization**
  - **Between objective function and optimization algorithm – „Master-Slave model“**
  - **Parallelization of algorithm – „Grained EA“**

Master-Slave model



Master-Slave model

- **Division between objective function and optimization algorithm**
- **Does not change behavior of EA**
- **Optimal number of processors**

$$P^* = \sqrt{\frac{nT_f}{T_c}}$$

T_f **… time for one evaluation**

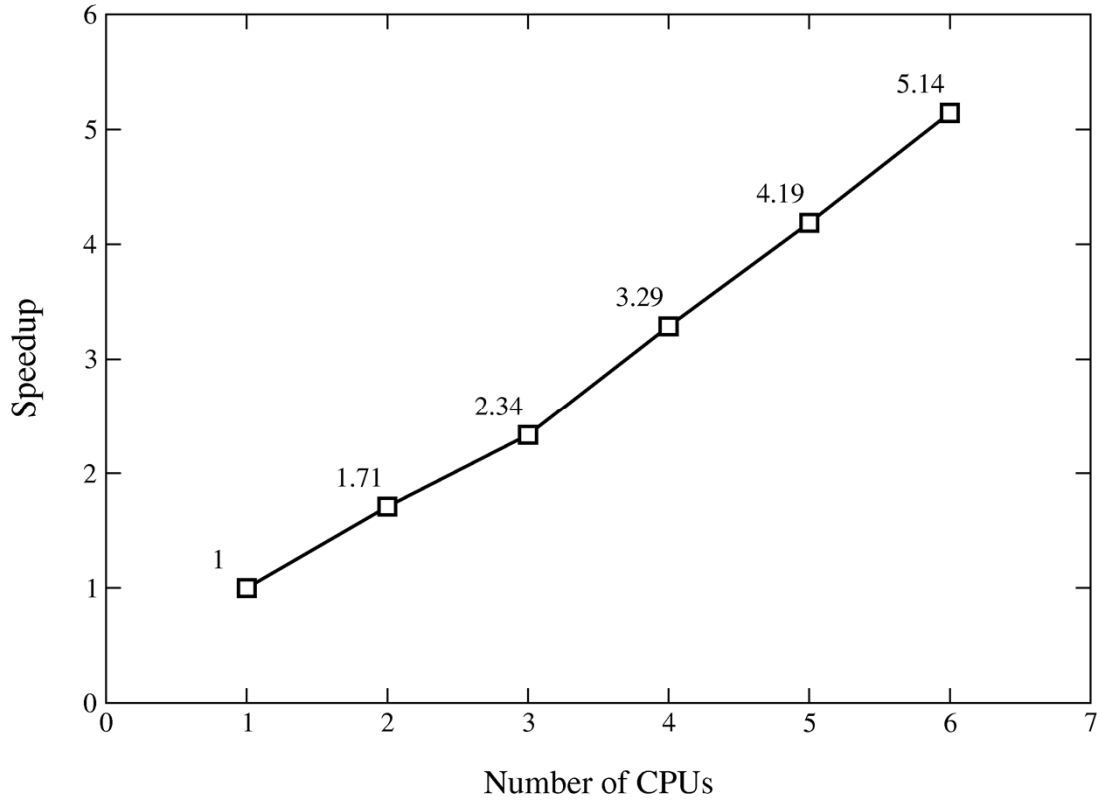
T_c **…** ***„latency time“*****, delay cased by processors' communication**

n **… population size**

Speed-up (acceleration)

- **Time on n processors / time on one processor**
- **Goal:**

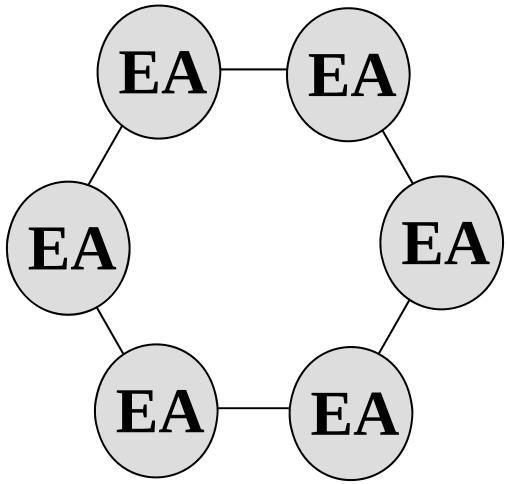
  Linear speed-up

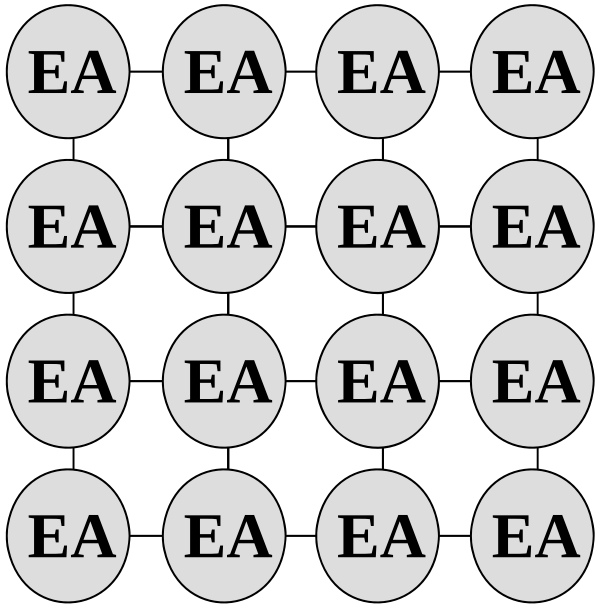


Grained EAs

Coarse grained EAs & Fine grained EAs

(Island model)





Coarse grained & Fine grained EAs

- **Create several EAs and send data in between**
- **Change behavior and 3 new parameters**
- **Better search abilities (do not suffer as much with premature convergence)**

References

[1] Cantú-Paz, E. (1997). A survey of parallel genetic algorithms (Illi-GAL ReportNo. 97003). Technical report, Urbana, IL: University of Illinois at Urbana-Champaign.

[2] Cantú-Paz, E. (2001). *Efficient and Accurate Parallel Genetic Algorithms*. Kluwer Academic Publishers.

No free lunch theorem

$$\sum_f P(d_m^Y \mid f, m, a_1) = \sum_f P(d_m^Y \mid f, m, a_2)$$

a_1,a_2	two different algorithms
m	iterations' counter
f	any function
$d_m{}^Y$	desired solution

"There is no best algorithm".

Valid for all *f !!!*

[Schumacher et al., 2001]

$$\sum_{f \in S} P(d_m^Y \mid f, m, a_1) = \sum_{f \in S} P(d_m^Y \mid f, m, a_2)$$

$$S \subseteq F$$

iff S is closed under permutation (c.u.p.)

$$\pi : \quad X \to X$$

$$\pi f : \quad X \to Y : \quad \pi f(x) = f(\pi^{-1}(x))$$

then

S is c.u.p. if $\forall f \in S$ every $\pi f \in S$

"There can be best algorithm for set of functions which is not c.u.p.".

References

[1] Wolpert, D. H. and Macready, W. G. (1997). No free lunch theorems for optimization. IEEE Transactions on Evolutionary Computations, 1:67–82.

[2] Corne, D. and Knowles, J. (2003). No free lunch and free leftovers theorems for multiobjective optimization. In Proceedings of the Second International Conference on Evolutionary Multi-Criterion Optimization (EMO 2003), Faro, Portugal, pages 327–341.

A humble plea. Please feel free to e-mail any suggestions, errors and typos to **matej.leps@fsv.cvut.cz**.

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