The 880 presentation series

“Particle swarm optimization and parallel particle swarm optimization”

presented by

Thomas Schoene

Today's topics

Artificial intelligence

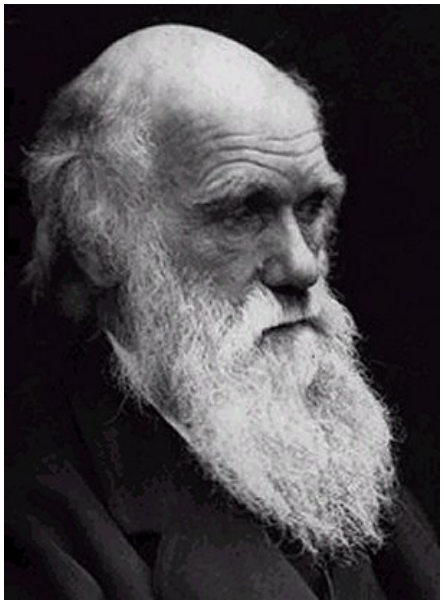
= somehow “smart” techniques

Evolutionary computation

= techniques inspired by evolution

Particle swarm optimization

= a global optimization algorithm



http://timnovate.files.wordpress.com/2009/06/charles_darwin_l1.jpg

Motivation

Find algorithms that perform good on a wide variety of problems.

Not to disproof the NFL (no free lunch) theorem.

Global optimization

Find the global optima of a function with multiple local optimums.

For example, **find the highest peak** in a mountain range.

http://www.treehugger.com/Zugspitze-mountain.jpg

http://www.stoersignale.de/blog/images/himalaya_iss1.jpg

Evolutionary computation

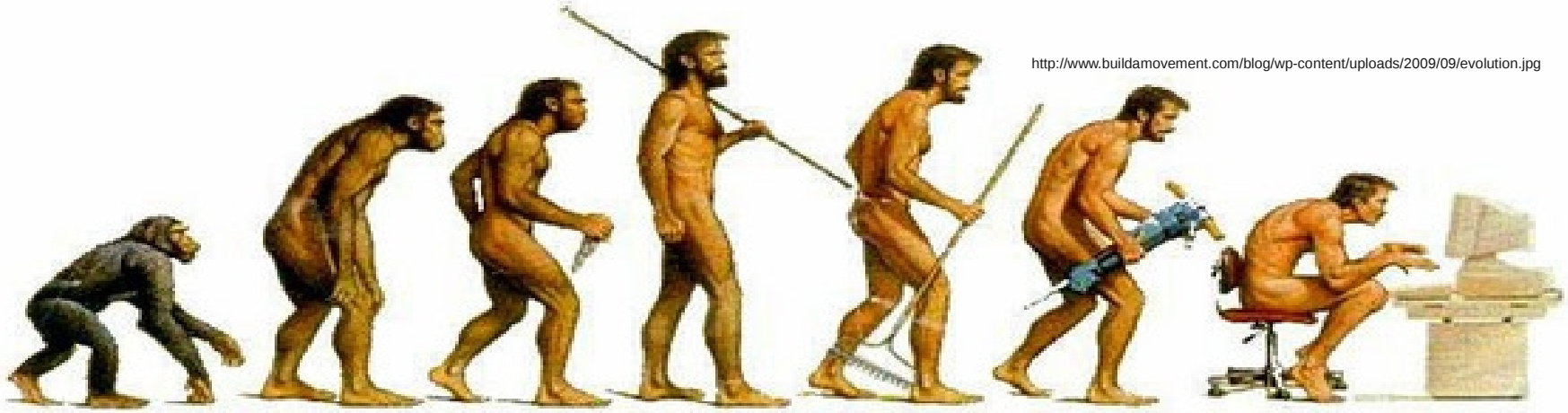
=> Evolutionary algorithms

=> Genetic algorithms, genetic programming, and so on.

=> Swarm intelligence

=> **Particle swarm optimization**, ant colony, and so on.

=> and others.



http://www.buildamovement.com/blog/wp-content/uploads/2009/09/evolution.jpg

Particle swarm optimization

A population based search algorithm.

Motions of individuals are influenced by swarms' knowledge.

Can be used in parallel.

http://photo.bassworks.com/satwiwa/fullsize/Red-Wing-Black-Bird-Swarm_fs.jpg

Particle swarm optimization

Time to watch some clips:

http://www.youtube.com/watch?v=RFRjO0vTjjM&feature=related

http://www.youtube.com/watch?v=INuCaz6fSGs&feature=related

http://www.youtube.com/watch?v=b1zkbVRaguo&feature=related

Particle swarm optimization

What do we need?

Individuals

= vector (a position in the search space)

Fitness function

= assigns a fitness value to every position

http://lims.mech.northwestern.edu/~lynch/IGERT499/swarm.jpg

Particle swarm optimization

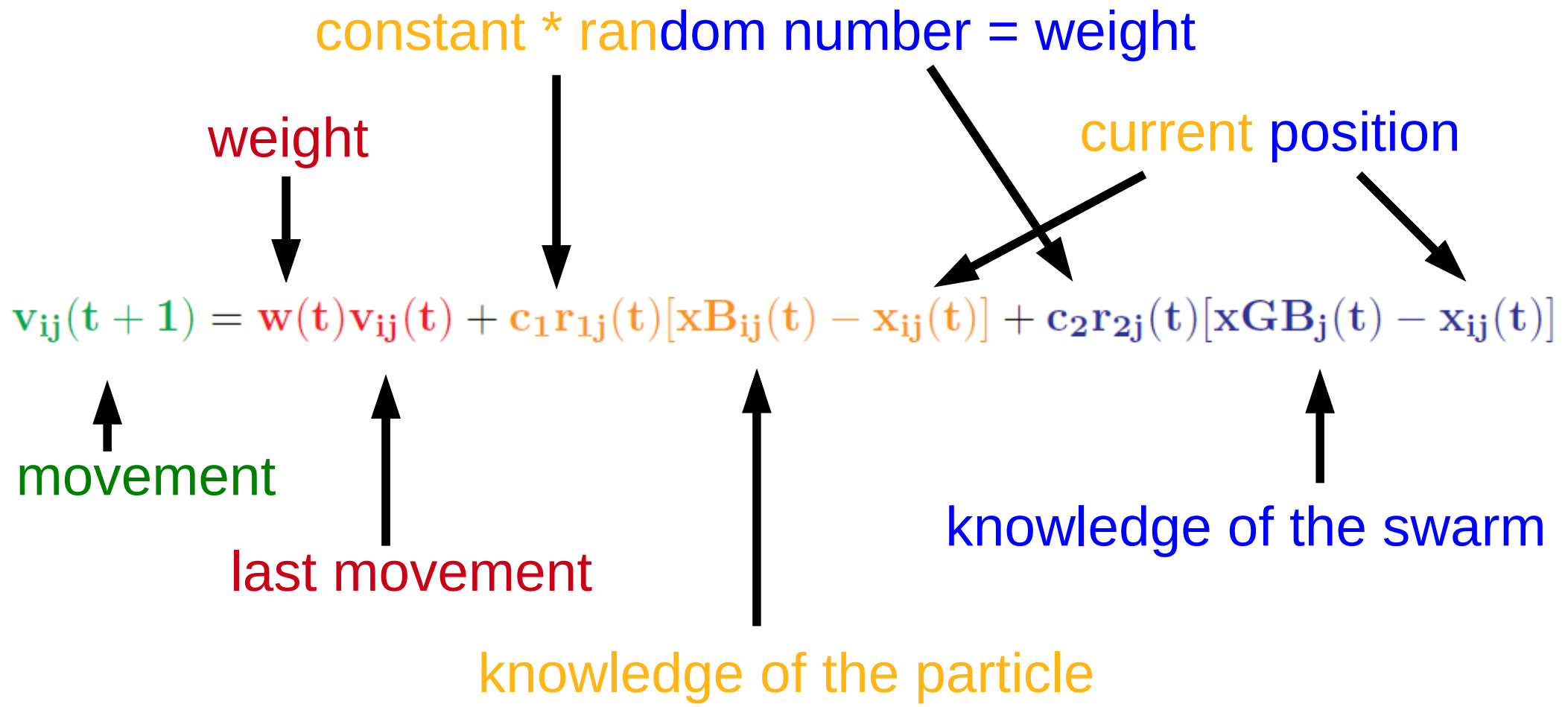
Particle's current position

$$x_{ij}(t+1) = x_{ij}(t) + v_{ij}(t+1)$$

Particle i's dimensions j's next value

velocity (movement)

Particle swarm optimization



PSO Algorithm

```
initialize particles
while goal is not reached
    for each particle
        change particle's position
        if new position better as particle's best
            particle's best = new position
        if new position better as global best
            global best = new position
```

Parallel PSO

Run the fitness evaluations in parallel.

Could also use some kind of multiple swarm approach.

http://www.comp.ua.ac.be/files/Grid-2.jpg

Particle Swarm Optimization

Balance diversity and convergence.

=> For example by changing the parameters.

There are many variations to particle swarm optimization.

http://2.bp.blogspot.com/_4s5pmFL_ZlQ/SngtjjZpZSI/AAAAAAAACCY/f77-et5F2-0/s1600/birdwatching+motivational+posters+funny+hot+babes+boobs+laughter+humorous+wallpaper+web+sites.jpg

Application fields

Optimization:

-> of engineering problems (e.g. improve a catalyst).

-> of neural networks and self-organizing maps.

-> of particle swarm optimizations parameters.

http://www.gearslutz.com/board/attachments/moan-zone/41448d1190412729-i-want-quit-become-hippy-potential.jpg

Conclusion

Evolutionary computation has good algorithms that can be used to solve a wide variety of problems.

Particle swarm optimization a versatile optimization algorithm.

Particle swarm optimization can be run in parallel.

Discussion

It is not exactly what happens in nature and evolution.

=> See also fractal geometry.

Particle swarm optimization finds a good solution, but maybe it is not the global best.

http://flywithmeproductions.com/blog/wp-content/uploads/2009/03/monkey-bird.jpg

Sources & Further Readings

[1] Computational Intelligence. An Introduction.

2nd Edition. Andries P. Engelbrecht. 2007.

[2] Parallel global optimization with the particle swarm algorithm, J. F. Schutte, J. A. Reinbolt, ... , 2004

[3] Parallel Global Optimization Tutorial , Mark Wachowiak, http://www.engr.udayton.edu/faculty/wsmari/hpc07/, 2007

[4] No Free Lunch Theorems for Optimization, David H. Wolpert and William G. Macready, 1997

Open Questions

http://api.ning.com/files/xVbOlYXthQrtJJwYCYL4ECtYfn1TzpYLKlKR-4XCNvi72lXWKSYFJFmidditmVu5*zEzscRJMthV3AkBKo6SzCQ5d5kkobAY/monkey_gun.jpg

http://www.psy.fsu.edu/history/wnk/images/DandG_holding_hands1.jpg

http://3.bp.blogspot.com/_xwE0rBDpg1Y/SPVSQt4hdFI/AAAAAAAACAQ/5cJga9QUWo0/s400/funny-animal-photos-monkey-riding-dog.jpg0

http://www.thefinancialblogger.com/wp-content/uploads/2008/08/monkey-computer.jpg