Swarm Intelligence

Seminar

Ruby LV Moritz

INF
FACULTY OF
COMPUTER SCIENCE

Overview

Organisation of the seminar

Current research topics

Schedule

Today:	organisation, topics
Next week:	tutorial, topics fixed
November 17th:	3 minutes, 3 slides
December 1st:	5 minutes, 5 slides
January 12th, 19th, 26th:	final presentations

All other Tuesdays: trouble shooting if required

Todo

1) Write and submit a 8-10 (Bachelor)/15-18 (Master) report before January 12th (first presentation session).
2) Present a topic in a 30-minute talk.
3) Participate in the discussions following the talks.

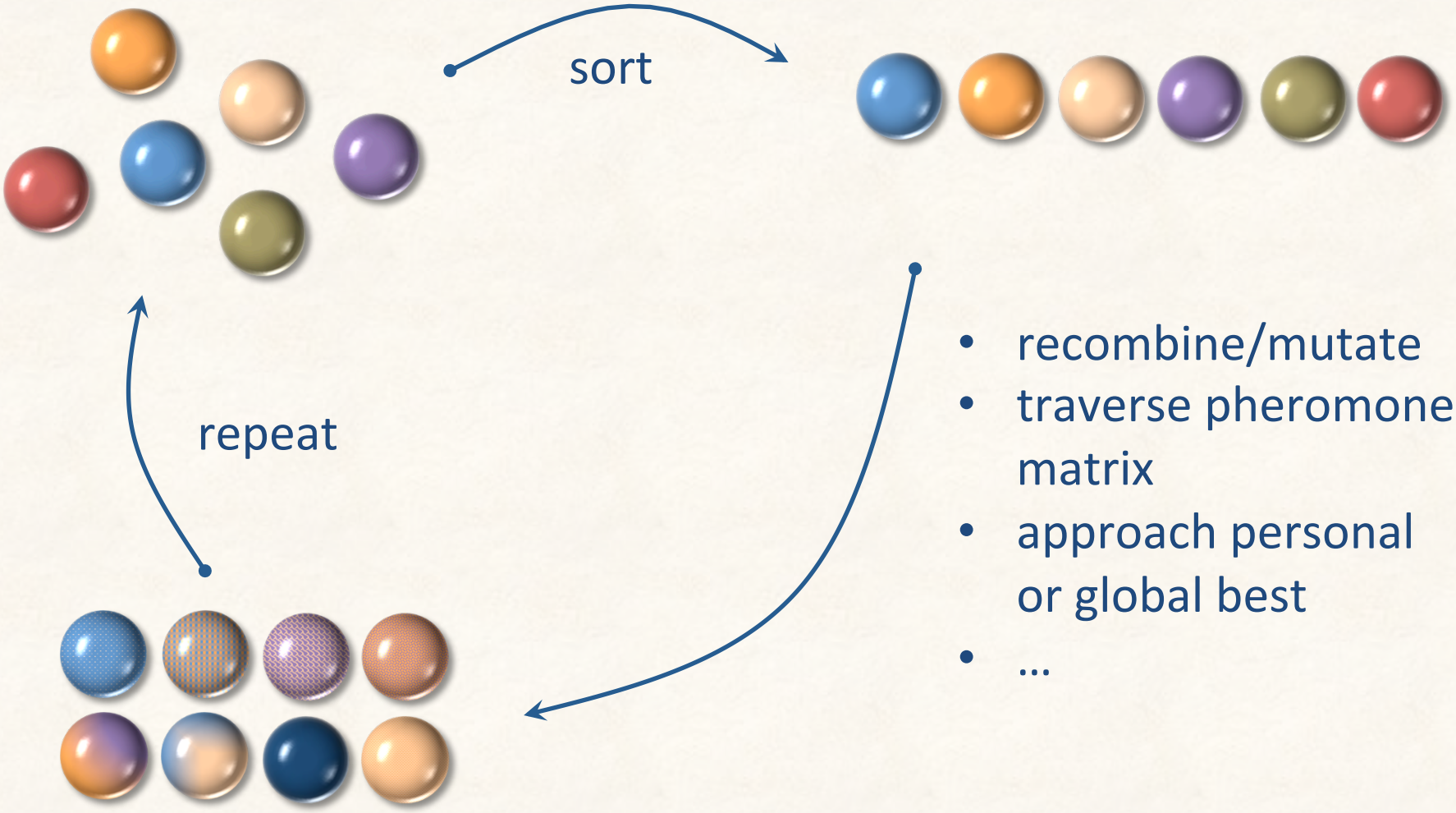
Introduction to swarm intelligence

Swarm behaviour is the collective **motion** of a large number of self-propelled entities.

Introduction to swarm intelligence

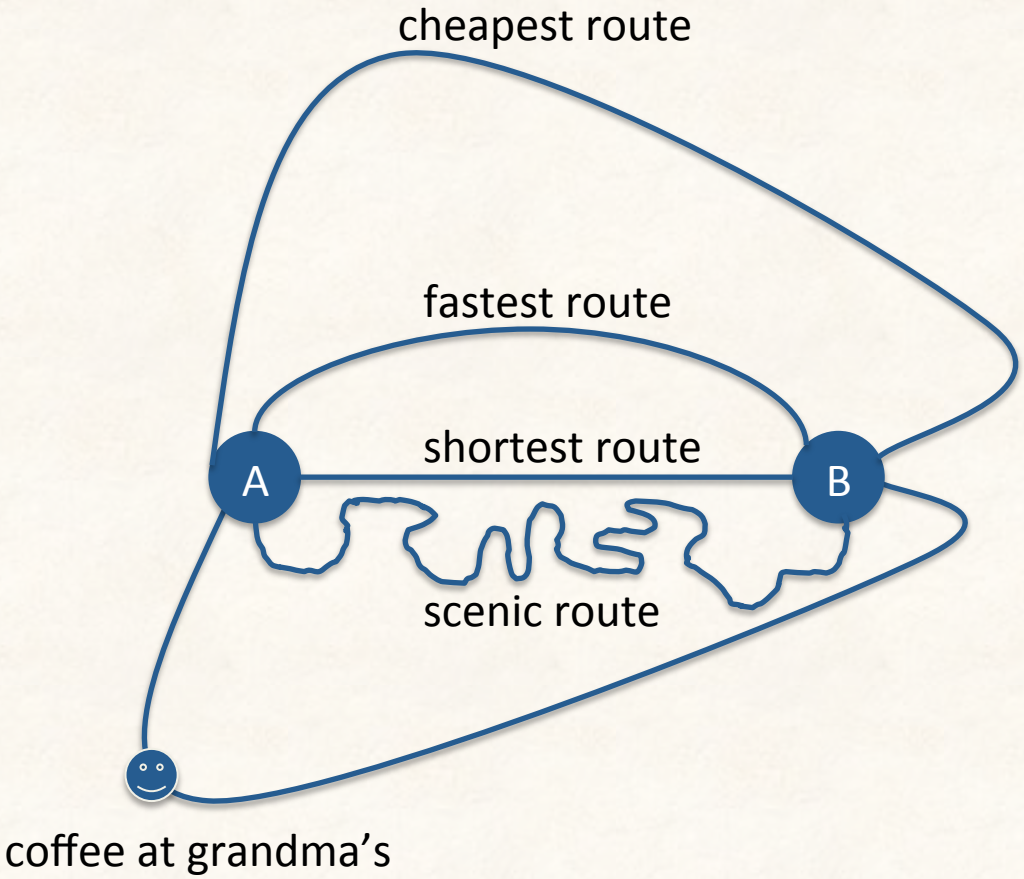
Swarm	Collective Intelligence	Collective Learning
Crowd simulation	Swarm aggregation	Swarm robotics
Animation and computer games	Self-organisation and emergence	
	Swarming	
	Ant Colony systems (sorting, clustering)	
	Optimisation (ACO, PSO)	
	Division of labour	

Metaheuristics



- recombine/mutate
- traverse pheromone matrix
- approach personal or global best
- …

Multi-objective problems



$f_1(a)$: distance

$f_2(a)$: time

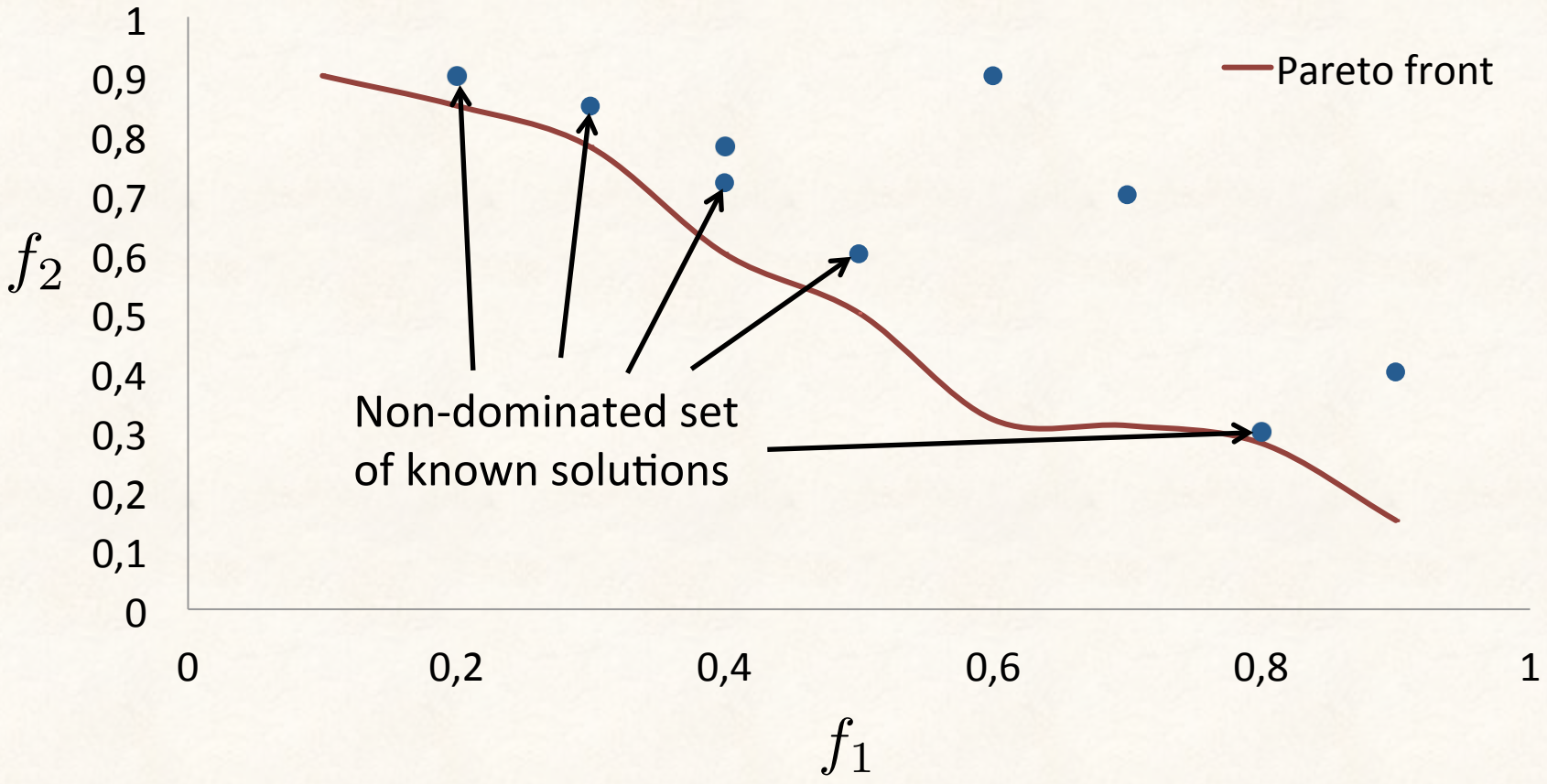
$f_3(a)$: expenses

$f_4(a)$: dull landscape

$f_5(a)$: social isolation

$$\min_{a \in X} \vec{f}(a) = \min_{a \in X} (f_1(a), \ldots, f_d(a))$$

Multi-objective optimisation



Topics

1 Reyes-Sierra, M., & Coello, C. C. (2006).
Multi-objective particle swarm optimizers:
A survey of the state-of-the-art.
International journal of computational intelligence research, 2(3), 287-308.

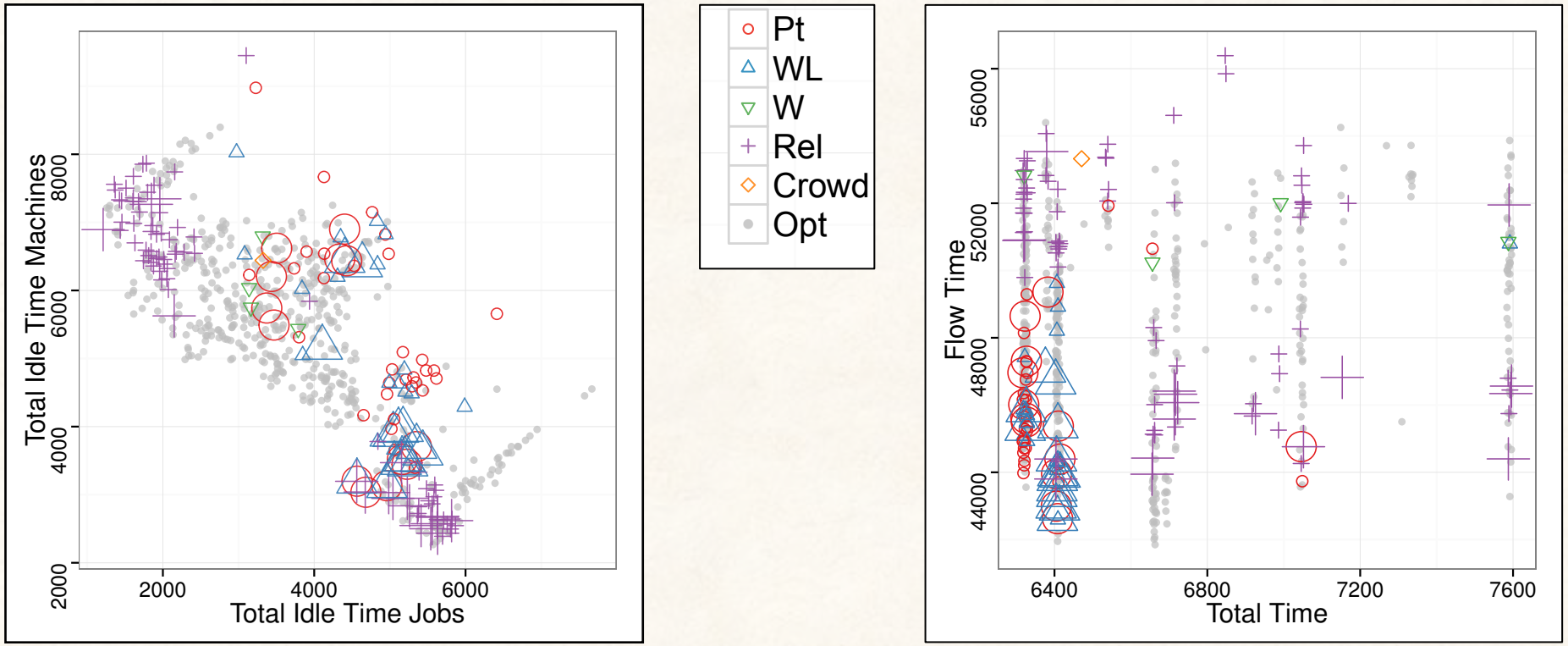
2 Schütze, O., Lara, A., & Coello, C. A. C. (2011).
On the influence of the number of objectives on the hardness of a multiobjective optimization problem.
Evolutionary Computation, IEEE Transactions on, 15(4), 444-455.

3 Bandyopadhyay, S., Chakraborty, R., & Maulik, U. (2015).
Priority based $\in$ dominance: A new measure in multiobjective optimization.
Information Sciences, 305, 97-109.

A Any application of MO-PSO or MO-ACO variants you're interested in.
Google Scholar and Web of Science are your friends! Spend them a visit.

Diversity in metaheuristics

Diverse solutions ensure that the algorithm covers more search space.



Moritz, R. L., Reich, E., Schwarz, M., Bernt, M., & Middendorf, M. (2015). Refined ranking relations for selection of solutions in multi-objective metaheuristics. *European Journal of Operational Research*, 243(2), 454-464.

Topics

4 Goldingay, H., & Lewis, P. R. (2014).
A taxonomy of heterogeneity and dynamics in particle swarm optimisation.
In Parallel Problem Solving from Nature–PPSN XIII (pp. 171-180). Springer International Publishing.

5 Song, M. L. (2014, June).
A Study of Single-objective Particle Swarm Optimization and Multi-objective Particle Swarm Optimization.
In Applied Mechanics and Materials (Vol. 543, pp. 1635-1638).

B Any specific variant to increase of metaheuristics with increased diversity you're interested in.
Google Scholar and Web of Science are your friends! Spend them a visit.

Swarm robotics

Topics

6 Brambilla, M., Ferrante, E., Birattari, M., & Dorigo, M. (2013).
Swarm robotics: a review from the swarm engineering perspective. Swarm Intelligence, 7(1), 1-41.

7 Dorigo, M., et al (2013).
Swarmanoid: a novel concept for the study of heterogeneous robotic swarms.
Robotics & Automation Magazine, IEEE, 20(4), 60-71.

8 Werfel, J., Petersen, K., & Nagpal, R. (2014).
Designing collective behavior in a termite-inspired robot construction team.
Science, 343(6172), 754-758.

9 Rubenstein, M., Cornejo, A., & Nagpal, R. (2014).
Programmable self-assembly in a thousand-robot swarm.
Science, 345(6198), 795-799.

Topics

10 Ducatelle, F., Di Caro, G. A., Pinciroli, C., & Gambardella, L. M. (2011).
Self-organized cooperation between robotic swarms.
Swarm Intelligence, 5(2), 73-96.

11 Gunn, T., & Anderson, J. (2013).
Dynamic heterogeneous team formation for robotic urban search and rescue.
Procedia Computer Science, 19, 22-31.

12 Brutschy, A., Scheidler, A., Ferrante, E., Dorigo, M., & Birattari, M. (2012, October).
"Can ants inspire robots?" Self-organized decision making in robotic swarms.
In Intelligent Robots and Systems (IROS), 2012 IEEE/RSJ International Conference on (pp. 4272-4273). IEEE

13 Pini, G., Brutschy, A., Scheidler, A., Dorigo, M., & Birattari, M. (2014).
Task partitioning in a robot swarm: Object retrieval as a sequence of subtasks with direct object transfer.
Artificial life, 20(3), 291-317.

C **Your favorite swarm robotics experiment.**
Google Scholar and Web of Science are your friends! Spend them a visit.

Heterogeneous swarms

When do we have heterogeneity,
when do we need it?

Topics

14 Masuda, N., O'shea-Wheller, T. A., Doran, C., & Franks, N. R. (2015).
Computational model of collective nest selection by ants with heterogeneous acceptance thresholds.
Royal Society Open Science, 2(6), 140533.

15 Sayama, H. (2012).
Swarm-based morphogenetic artificial life.
In Morphogenetic Engineering (pp. 191-208). Springer Berlin Heidelberg.

16 Stranieri, A. (2011).
Self-organizing flocking in behaviorally heterogeneous swarms
(Doctoral dissertation, Bruxelles: UniversiteLibre de Bruxelles).

17 Halász, A. M., Liang, Y., Hsieh, M. A., & Lai, H. J. (2013).
Emergence of specialization in a swarm of robots.
In Distributed Autonomous Robotic Systems (pp. 403-416). Springer Berlin Heidelberg.

D **Your favorite example of diversity in swarms.**
Google Scholar and Web of Science are your friends! Spend them a visit.

Evolutionary systems

We have barely any idea how evolution works, but some (disproven) theories turn out to be neat adaptive mechanisms.

Topics

18 Doncieux, S., Bredeche, N., Mouret, J. B., & Eiben, A. E. G. (2015).
Evolutionary robotics: what, why, and where to.
Frontiers in Robotics and AI, 2, 4.

19 Waibel, M., Keller, L., & Floreano, D. (2009).
Genetic team composition and level of selection in the evolution of cooperation.
Evolutionary Computation, IEEE Transactions on, 13(3), 648-660.

20 Gomes, J., Mariano, P., & Christensen, A. L. (2015, May).
Cooperative Coevolution of Partially Heterogeneous Multiagent Systems.
In Proceedings of the 2015 International Conference on Autonomous Agents and Multiagent Systems (pp. 297-305). International Foundation for Autonomous Agents and Multiagent Systems.

21 Ashlock, D., & Lee, C. K. (2013).
Agent-case embeddings for the analysis of evolved systems.
Evolutionary Computation, IEEE Transactions on, 17(2), 227-240.

E **Your favorite example of diversity in swarms.**
Google Scholar and Web of Science are your friends! Spend them a visit.

Choose a topic

These slides will be on the website by tomorrow.

Checklist for your decision (also applies for option A, B, C, D, and E):

1. Does the title and abstract sound interesting?
2. Get the paper (email me, in case it's unavailable).
3. How technical, theoretic is the paper?
4. Read parts of the methods and conclusion: Is the writing style understandable?
5. Read the paper.
6. Write me an email with your decision or tell me next week.

First come, first serve!