

Notes, Questions and Answers!

Dear All,

Please write your comments/feedback about the exam here. Thanks.

Q: I am not satisfied with the grades that I have got. Can I see the mistakes that i have done?

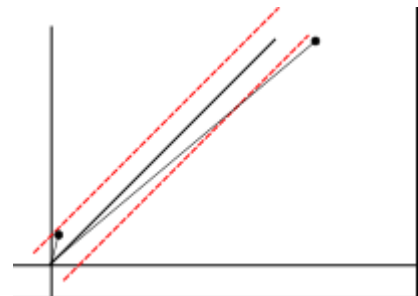
The students can review their exams in April. The exact date and location will be announced on the webpage.

Q: Could you post the statistical information of the exam?

Sanaz: Please note that this is a forum for questions and issues which are not clear to you. We are neither going to write a script book, nor explain things once again. This is only for clarification of things that we have not explained before.

Note: The epsilon-domination in 3.13 depends on your selection order. If a particle epsilon-dominates another you don't need to consider the particles which are epsilon-dominated ("you can cross them out"). In the lecture slides SI-3-86 is a special case where also a non-dominated particle is kept.

At 3.10 (b) sigma-method uses non-dominated particles.
E.g. the left particle has a worse sigma value than the right particle but because of domination the right one is not used.



Q: In 3.15 the solutions uses the euclidean distance. Why?

Answer by Sanaz:

In WAR -> we do not measure distances, but only count the number of objectives which are different in the two objective vectors by computing a.

In DWAR -> we have euclidean distances

We compute:

DWAR (for A):

$$d_{(AB)} = 1$$

$$d_{(AC)} = 1$$

$$d_{(AD)} = 1$$

$$d_{(AE)} = 1$$

$$d_{(AF)} = 1$$

→ DWAR (A) = sum of the above = 5

DWAR (for B) and the same for the C, D, E and F:

$$d_{(BA)} = 1$$

$$d_{(BC)} = 1.4142$$

$$d_{(BD)} = 1.4142$$

$$d_{(BE)} = 1.4142$$

$$d_{(BF)} = 1.4142$$

→ DWAR (B) = 6.6569

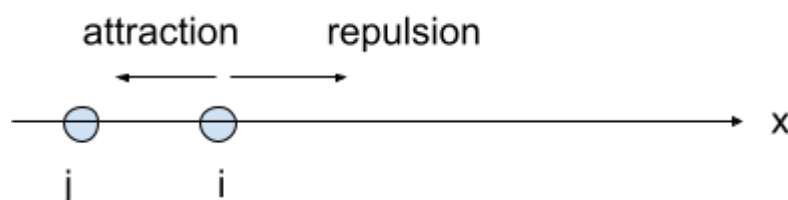
On the lecture slides, we have in fact computed the absolute distances. In case, we have such a question in the exam, I will clearly indicate, which distance measure should be used by the students.

Thanks to Peter, for indicating this. Sanaz

Q: This is from chapter 2. Does a negative force always mean repulsive behaviour. If you refer slide 2-11 with the increase in the $x_i - x_j$ in the positive direction (considering more than d) the force is negative. Does this necessarily indicate repulsion? According to logic it should mean the further x_i and x_j goes the attractive force will become larger.

Answer by Sanaz: The forces and their signs always depend on the positions of i and j . if $x_i > x_j$ (i.e., $x_i - x_j > 0$), as you have described above, then $f^i(i, j) > 0$ means repulsion and $f^i(i, j) < 0$ means attraction.

Note: you have to exactly define who is applying the force $f^i(i, j)$ or $f^j(i, j)$. I am talking about $f^i(i, j)$



Q: Do delta and comfortable distance d value point to the same thing? As at this point there is no movement of the swarm. $F_{attraction} = F_{repulsion}$

Answer by Sanaz: yes. Obviously the potential function depends on the factors such as the amount of repulsion and attraction (linear or non-linear, bounded and unbounded, etc.). Nevertheless, your point is correct. Both δ and d indicate the same thing :-)

Q: In chapter 2, slide number : 2-67, Density calculation : The formula to calculate the overall density, according to the slide says, $-\left(\sum_{j=1}^{U_j} D_j \ln_2(D_j)\right)$, my doubt is in the below example to calculate the maximum entropy, we have taken the value for $D_{total} = -16D_j \ln_2(D_j)$, shouldn't it be $-(86/16)D_j \ln_2(D_j)$? Because, the summation varies from $j=1$ to U_j and value of U_j is nothing but $86/16$ (correct me, if i am wrong). I did not get the concept of taking the value as 16.

Answer by Sanaz:

$|U_j|$ = number of Units --> in this case 16
the calculation on the slide is correct:

$D_{total} = \text{sum from } 1 \text{ to } 16 (-D_j \ln_2 D_j)$

$D_j = (86/16) / (86) = 1/16$

Therefore $D_{total} = \text{sum from } 1 \text{ to } 16 (-1/16 \ln_2 1/16) = 16 (-1/16 \ln_2 1/16) = -\ln_2 (1/16) = 4$

Q: SI-2-42: Do we define the zone of repulsion (zor) regardless of the attraction / repulsion function or can it be computed from the attraction / repulsion function? For me, it would make sense if the zor corresponds to the comfortable distance δ (where the function approaches 0). In the plot, the zor looks smaller.

Sanaz: "For me, it would make sense if the zor corresponds to the comfortable distance δ (where the function approaches 0)."

→ Yes. you are right.

Q: SI-3-104 : Convergence metric : $C(A,B) = \frac{1}{2}$ for the plot 2 right?

Sanaz: No. it is $\frac{1}{3}$, because 3 indicates the number of bs: $|B| = 3$

Q: SI-3-22: When the term "learning factors" is used for the first time, the explanation states that Φ_1 and Φ_2 are the learning factors determining the influence of the social and cognitive component. On the preceding slide it is explained, that Φ_1 and Φ_2 are random vectors in $[0,1]^n$. What are now the real learning factors: c or Φ ?

Sanaz: I would say (c, Φ) . C is usually selected to be constant and Φ is a random value. Both are called learning factors.

Q: SI-3-54: Are the charged particles charged from the beginning of the optimization or do we select the ones to charge, when a change occurs?

Sanaz: The charged particles are charged from the beginning.

Q: SI-2-23: Concerning center of swarm, what does symmetry of f mean?

Sanaz: Slide SI-2-23 and page number 31 script book! This has been explained by me several times. Now, please do me a favor and do not ask: what is the name of the script book.

Q: SI-2-64: Why do we measure the distance to the center of the environment and not the distance to the center of the swarm? The hyperball is not necessarily formed around the center of environment, isn't it? Hence, not all of the examples on SI-2-66 have the same entropy.

Thomas:

Neither is the only right or wrong solution and it depends on the task at hand.

On the mentioned slides it is defined as distance to environment center, but for other situations other definitions may be better suited.

In the example on the slides you can assume there is some kind of secondary condition that leads to expecting the center of the circle to be the environment center. This is probably just for easier understanding of the general concept. In most situations this approach will indeed likely not be the best (or most fitting) one.

Q: Exercises about chapter 2 : Assignment 10 about entropy. Could anyone please explain how did you calculate the entropy values?

Simone:

Calculate for each direction $\rightarrow H = 5$

In the matrix are 16 individuals.

So for x direction (columns):

$$\begin{aligned} H_x &= - [(0 * \text{ld}(0)) + (0 * \text{ld}(0)) + (8/16 * \text{ld}(8/16)) + (8/16 * \text{ld}(8/16)) + (0 * \text{ld}(0)) + (0 * \text{ld}(0)) \\ &\quad + (0 * \text{ld}(0)) + (0 * \text{ld}(0))] \\ &= - [\frac{1}{2} * \text{ld}(\frac{1}{2}) + \frac{1}{2} * \text{ld}(\frac{1}{2})] \\ &= - [\text{ld}(\frac{1}{2})] \quad \{\Rightarrow \text{solve logarithm dualis/binary}\} \end{aligned}$$

$$\Leftrightarrow h = - [\text{ld}(1) - \text{ld}(2)]$$

$$\Leftrightarrow 2^h = - [0-2]$$

⇔ $h = 1$

Furthermore, the other solutions are available for this assignment on the web page.

Q: SI-3-54: Do charged particles only get repelled from other charged particles or from the neutral ones as well?

Sanaz: They should get repelled from every both charged and neutral particles.

Marianne: Then, the uploaded solution of assignment 3-5 is wrong.

Sanaz: if you have been in the lecture, you can remember, that I have said that :)

Q: SI-4-61: Fitness-proportional pheromone update - is the amount by which the pheromones are updated proportional to a solution's fitness or is the probability of updating at all proportional to the fitness?

Sanaz: the second.

Q: SI-4-19: Crowded area in Minority.

Since the two particles are **dissimilar** (O_i being triangle and O_j being circle), the $d(O_i, O_j)$ value should be equal to 1, right? Or does it depends on the value of α too.? Can you please explain how did we compute $f(O_i)$, because according to me it should be 0.

Sanaz: Thanks for pointing out this. $d(o_i, o_j) = 1$ meaning that the part in the first equation denoted by $[1 - d(o_i, o_j) / (\alpha)]$, for $\alpha = 1$, will be 0. $f(o_i) = 0$ and the rest is still correct.

Note: In Exercises about chapter 4(solutions): Assignment 1:Ant clustering (a) the picking and dropping probabilities of agent 1 are wrong as N value is considered as 2 instead of 13.

$P_p = 0.07$ $P_d = 0.504$

Sanaz: Yes

It is said in the assignment, that an ant can only observe one pixel in each time unit - which should be equal to the number of objects on its path, right? Hence, $N = 2$ (and the other solutions as well) look correct to me. $+1 + 1$

Q: Assignment 2.7 (Tracking 2 different targets). In the uploaded solution, every particle moves to the target which is the nearest (relative to that particle). When starting with one

target being very close to the swarm and one target being far away, all the particles would move to the same target, or did I misunderstand that?

Sanaz: You are right. It can happen. We can avoid it in a way to only let a certain number of particles follow the objects.

Q: Exercises about chapter 3: Assignment 3: Neighborhood topology

Consider the following population of particles and a minimization problem. Which particle can be selected as global best for the particle with the index = 4: a) using the fully connected topology (known as standard or default)? b) using the ring topology?

Could anyone explain how you selected global best as index 2 in a fully connected network?

Sanaz: This is one of the assignments in the exercises. I am not going to explain it again here.

You simply select the particle having the globally best (in this case minimal) function value => index 2 with value 1.0

Q: In slide 3-39, the basic definition of turbulence factor has been mentioned, however I fail to understand as how it is implemented into equations as a factor. Can anyone please explain this?

Sanaz: It is called factor, but you simply change the position of certain particles according to the equations. This is usually done after, we have updated the positions.

Q: From slide 3-57, what is Rcon?

Simone: Please have a look at the slide: "A swarm is considered as converged when its expansion, i.e., the radius of the smallest circle encompassing the particles, is less than R_con". So R_con is the radius of the smallest circle.

Q:1) For calculating distance between individual particle to the center of the swarm $d = (x-c)$ and

probability(p) = $d_i / \sum d_j$

here how to assume the values of " x_i, C, d_j "

Q:2) what is charged PSO and Equation for charged Particle Swarm optimization(PSO)

Sanaz: Please refer to the assignments and the lecture!!!

Pavel: The main idea is to introduce two opposing forces within PSO: An attraction to the center of mass of the swarm and inter particle repulsion. The force of attraction facilitates convergence and the repulsive behaviour brings in diversity.

The equation changes a bit, we just need to add an accelerating factor a (let's say) to the original equation

Final equation: momentum factor + social component + cognitive component + $a(i)$

Simone: Have a look at the exercise solutions Chapter 3 Ass.5, there are some motion equations for charged PSO.

Notice: But as said in the answer for "Q: SI-3-54: ..." on Page 5, these equations are wrong.

Simone: Oh, you're right.

Q:3) Working of Particle Swarm Optimization in flat landscapes

Simone: Is that a question? If you refer to the slides, do it in the questions below directly...

Q: Is pareto dominance properties applicable to 3d or multi dimensional spaces also? Let's say we have three functions: horsepower, price and energy consumption. Can we use pareto dominance here as well?

Simone: Have a look at MO-PSO in the slides 3-65: Buying a new car.

Sanaz: Yes. We always talk about m objective functions.

Q: In PSO, P_i is the previous best solution as we know. However the cognitive value has also been considered as 0 if the system is continuously improving. What is conflicting is the equation: $P_i(t) - X_i(t) \rightarrow$ So if the swarm improves shouldn't there be a value. Only if the swarm isn't improving and also not degrading and is constant as the previous best $P_i(t) = X_i(t)$ in which case the cognitive value becomes 0. Hope I was clear enough.

Sanaz: if the system is continuously improving. $P_i = x_i(t)$

It depends when you update p_i . We update p_i before moving $x_i(t)$ to $x_i(t+1)$ then $p_i = x_i(t)$

Q: Assignment 4.6 a&c: I guess there are graphs missing in the solutions PDF. Could you please upload these pictures/update the PDF?

Simone: Could you explain what you are missing. Assignment 4.6 is about selection, and I think there are all necessary solutions and plots.

I think what was meant is that the pdf is broken and does not display parts of the plots. At least for me... Would be nice to have the missing parts for reference.

HINT: Use another pdf reader

Q:SI-3-26: in the case that both individuals (i and j) have the same δ value, how can it be that one individual is neighbor of the other but not the other way around?. As they have same communication radius, if individual (i) is contained in the vicinity area of the individual (j), consequently the individual (j) is contained in the vicinity area of individual (i)! Could you please elaborate more?

Sanaz: "in the case that both individuals (i and j) have the same δ value, how can it be that one individual is neighbor of the other but not the other way around?" Sure. both must be able to see each other.

Q: SI-4-34: Adaptive response thresholds - Why does the threshold decrease when the task is performed (learning)? Does this refer to the individual, whose threshold decreases, performing the task or does an individual's threshold decrease when other individuals already perform the task? Because, intuitively, the threshold needs to decrease (i.e. the individual gets engaged earlier) when the status of the task is not done. But when already other individuals are busy with a task, an individual's threshold for this specific task does not have to decrease, because the others already take care of this task. So I intuitively conclude that an individual's threshold increases when the task is already being performed (by others), which is the contrary of what is written on the slides.

Sanaz: your intuition is in fact correct. But in the learning phase, we want to learn if the selected value and the trend (decreasing or increasing) has been good or not. If the trend has been successful, we try to continue the trend until the task is done. It means: if we decrease the threshold, and the tasks are done one after the other, we can decrease it more to finish more tasks.

Your way of thinking is also correct. Both depend on the application.

Q: Exercise 4, Assignment 4b: "Write the action sets for the solution 1-4-5-6-7" -- The solution states that we have to write down the action set for $7 = \{3\}$, even though we have found the shortest path already arriving at 7. Is this correct or can we leave it out? +1

Sanaz: This is correct. The action set is: $a_7 = \{3\}$, even if we are at the end.
In general, if I ask you to write the probability of finding the 1-4-5-6-7, you have to multiply the probabilities which are produced from each action set. Your question is now relevant, if we want to take the probability at 7. Because 7 is the end (by definition, according to the problem statement), you stop considering the probability of the actions in the action set at 7.

Q: Exercise 4, Assignment 6: What would be the selective pressure for action **a** the following example? (the left column is the action set at time t , the right column for $t+1$)

s	d
t	a
a	a
a	e
u	f
v	g
w	h
x	i
y	j
z	k

The selective pressure seems to depend only on the set at time $t+1$. With this example I wanted to know if the set at t really is irrelevant.

With what we figured until now we assume the selective pressure for our example to be 0.2 (i.e. same as EX3-Assignment6 a) (b)). Would that be correct? +1

Sanaz: An interesting question. We do not really get into the details of this, which I used to teach for several years in the other university. There is a whole science behind it :-)

In your example, the selection pressure can be calculated as follows:

Considering action "a": you have 2 actions at t and at $t+1$ you still have 2 actions.

So: I would say that the selection mechanism has a selection pressure of 0.1 and would consider the two "a"s separately. It could be that the selection mechanism selected one of the "a"s twice. But since we cannot know it, I would consider them as we have had two different individuals each of which has been selected once.

Now it could get really interesting, we we had -also- selected let's say s twice. Then we can discuss the issue for several hours :-)

Q: In the exam 2013/2014 task 7.d): "Name two coordination mechanisms in multi-agent systems.". What is meant here with "coordination"? Is it about localization or more how swarms can be coordinated to solve tasks .. or something else?

Sanaz: We have omitted these topics from the lecture. So this question is not relevant anymore.

Q: SI-4-21: How does the formula detects "a region with a high quantity of most moved objects" if only the phi-value of the single object i is considered? In my opinion, it only yields an increased deposit probability for objects that have been moved a lot already.

Sanaz: You are right.

Q: SI-4-50:

Hasn't it to be $k \cdot 0,2$ instead of $k \cdot 0,1$?
because v is chosen between $[0, 0.2]$

Sanaz: You have not been at the lecture! I told it several times that I have a typo.

Q: Assignment 1 chapter 3: it should be $(n-1)!/2$ for cyclic and non symmetric routes. $(n-1)!$ for cyclic and symmetric routes. (the other way around!). Correct me if i am wrong please.

Sanaz: You must refer to the basics and fundamentals in Computer Science. But how can it be, that you can have more options for a symmetric than a non-symmetric case?

I thought that for the symmetric case we count the solution and it's reversed symmetric solution but for the non symmetric case we only count one solution not the reversed symmetric solution → Check the wikipedia :-)

Q: Exercise chapter 4 Assignment 2.b. Can anybody elaborate more on the solution?

Sanaz: The solution is only a sample solution. You had to be at the exercises to discuss the answer. d

Q: Exercise chapter 2 Assignment 11: how can the D_{overall} be equal zero as it consists of the summation of distances which all of them are positive numbers?

Sanaz: The "ideal" D_{overall} must be zero. Obviously, if you have not reached the pre-defined positions, you will calculate $D_{\text{overall}} > 0$

So by calculating a D_{overall} which is larger than zero, you know that the formation has not yet converged to the desired (ideal) form.

Q: Leader Selection - dominated particles select their global bests (leaders) from the set of non-dominated particles. What about non-dominated particles themselves? Do they select a global best at all? Or is a non-dominated particle its own global best (which would make the social component superfluous in the motion equation)?

Sanaz: This is a good question which has to be defined in the algorithm. They either select themselves (for example, when we use Sigma method), or select another non-dominated solution (by taking Pareto-dominance or random approach).

Good luck for the exam :-)

See you tomorrow at 8:00