ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

CS-411 : Digital Education & Learning Analytics

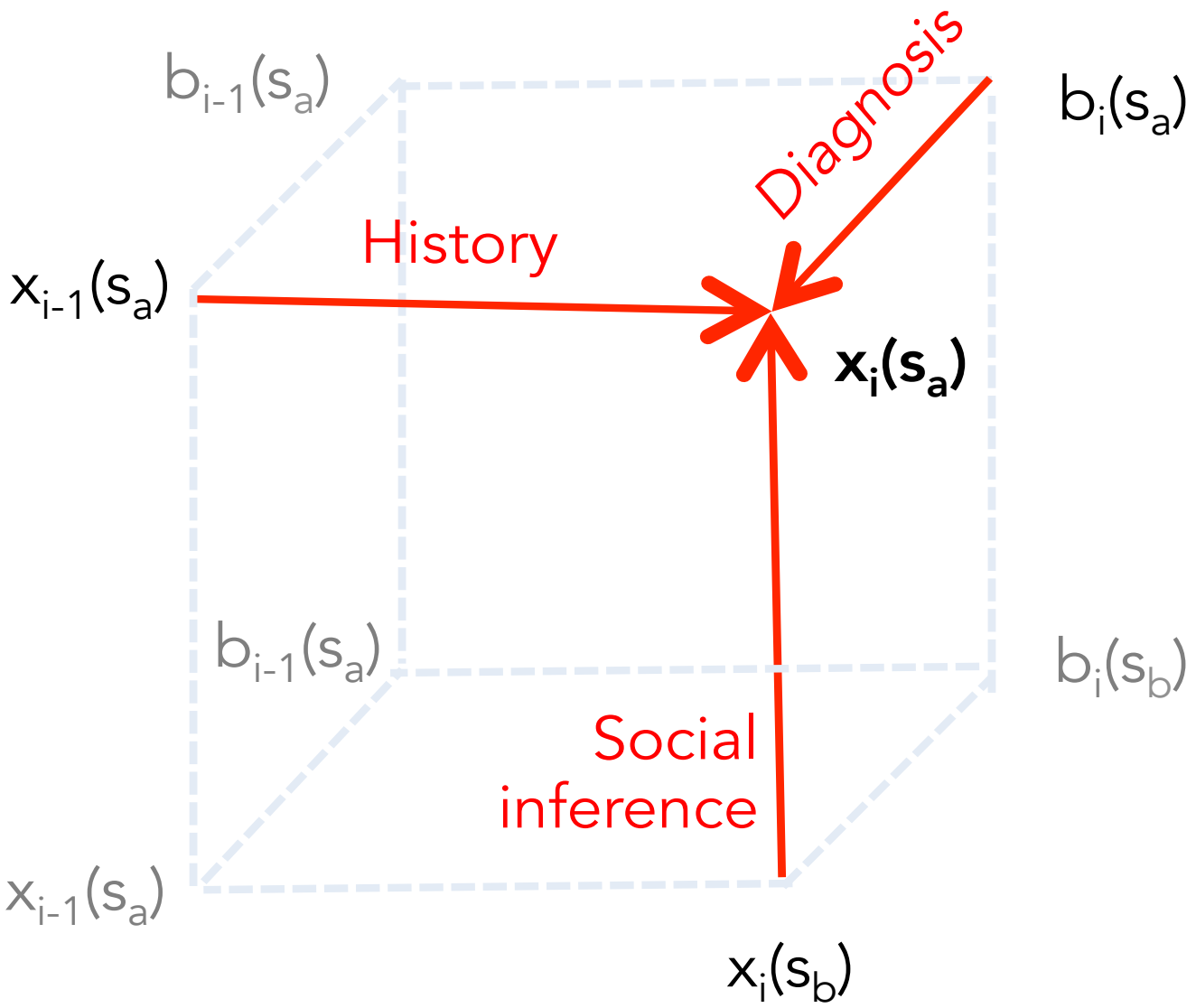
Chapter 9:

Learner modeling

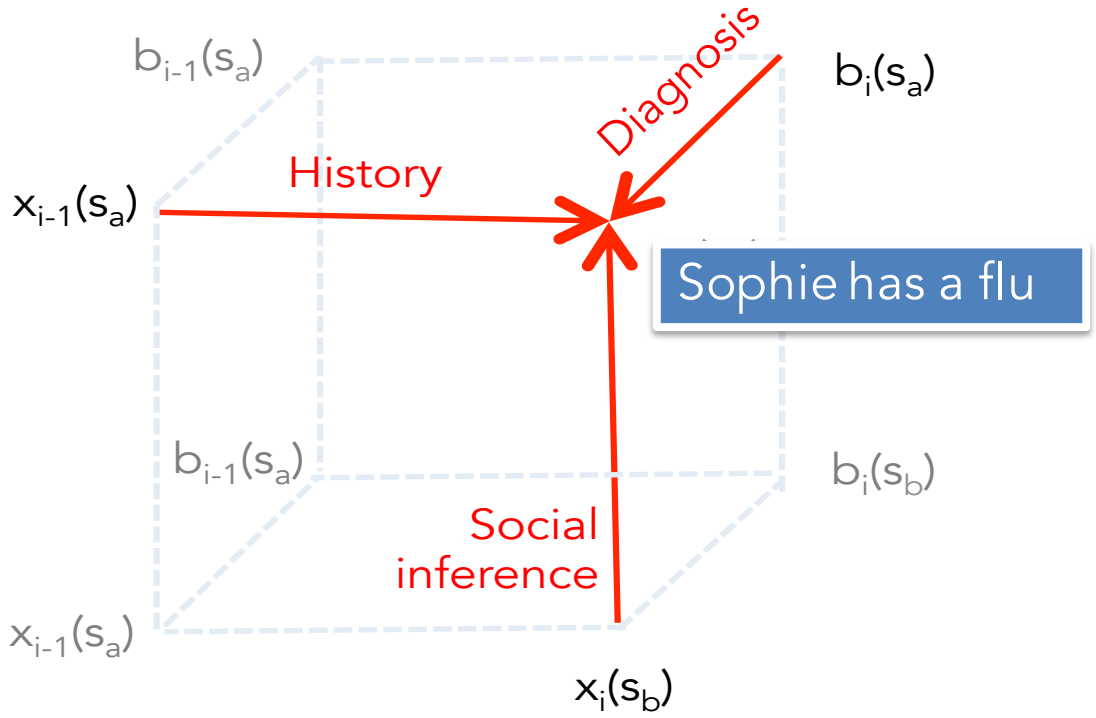
Part 2: Learner States

Pierre Dillenbourg and Patrick Jerman

The learning analytics cube: 3 axes of inference



A comparison with medical diagnosis

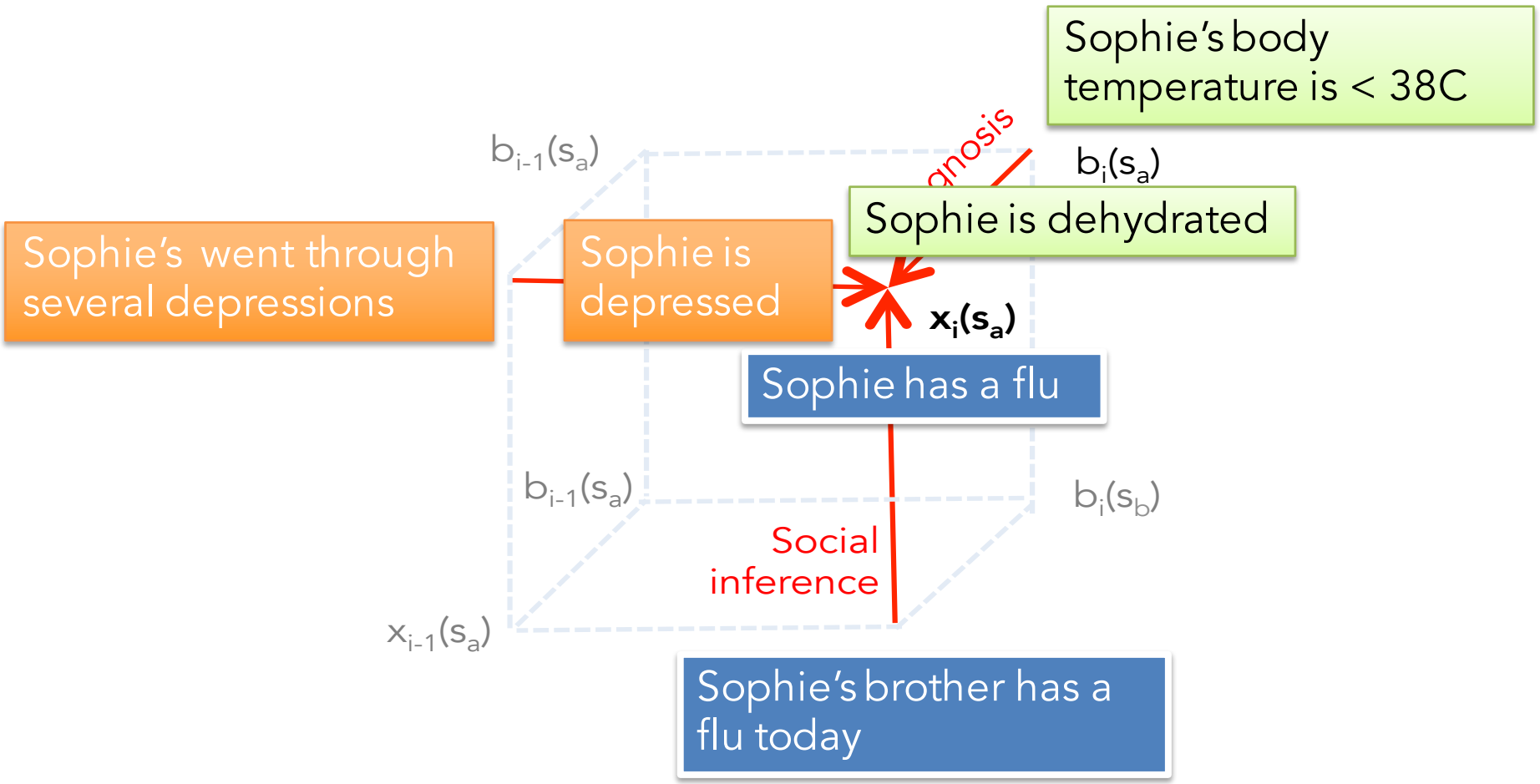


Sophie's body temperature is > 39C

Sophie's had a flu last year at the same period

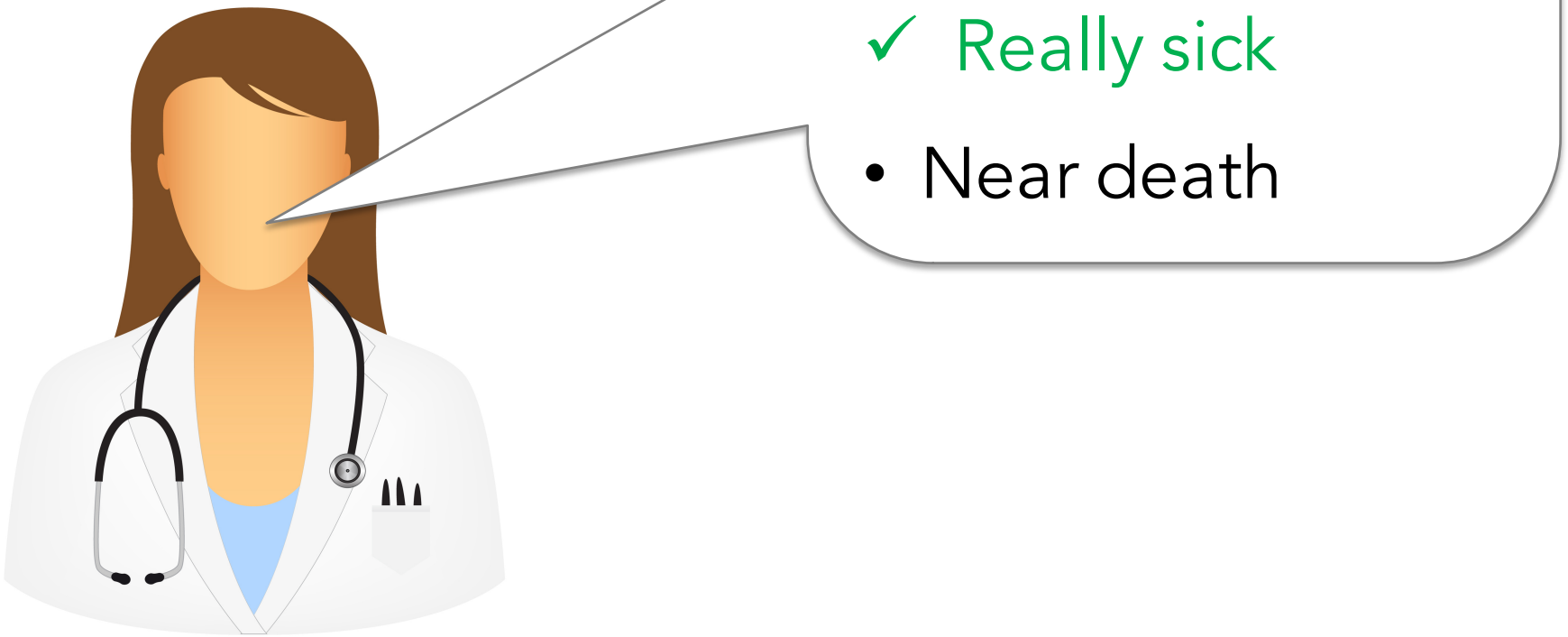
Sphie's brother has a flu today

A comparison with medical diagnosis



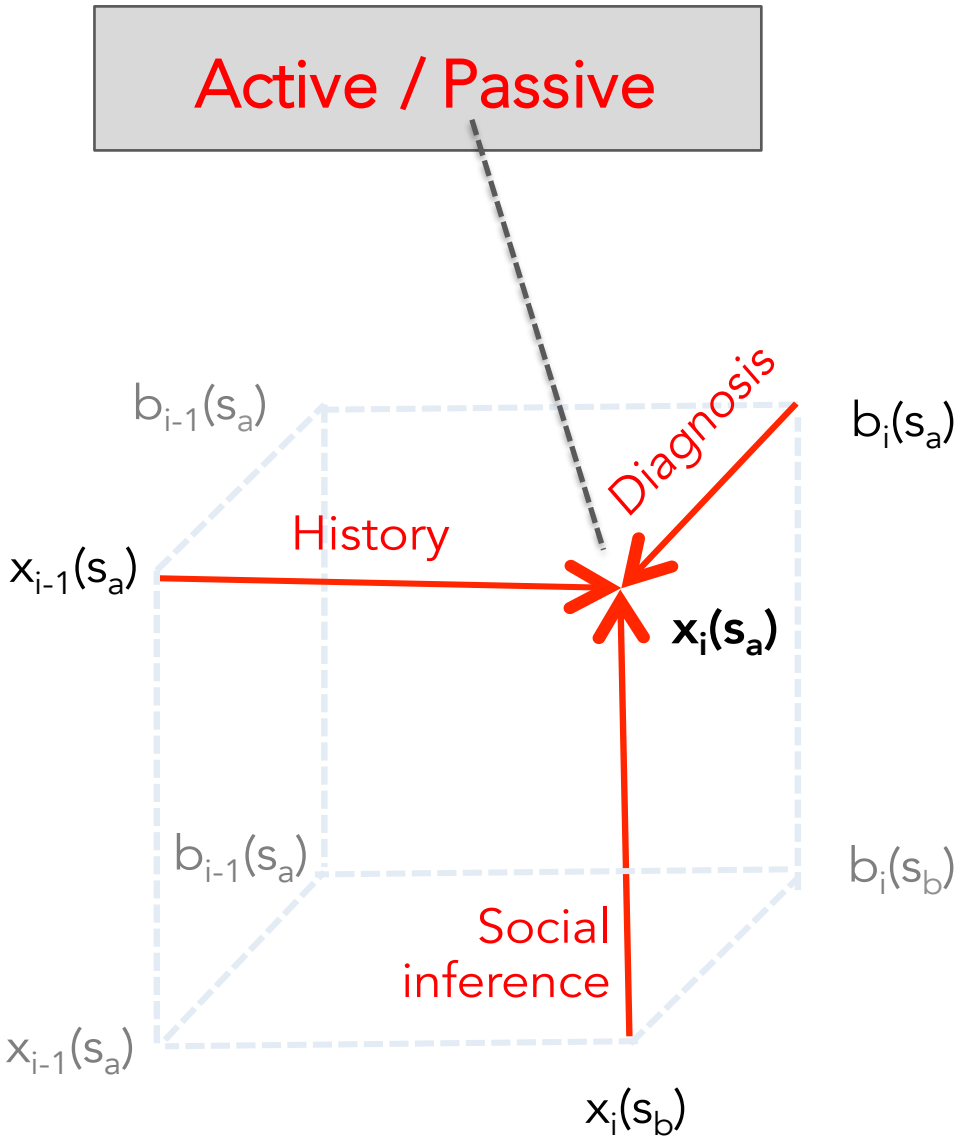
Multiple inference axes may generate contradictory hypotheses

A comparison with medical diagnosis



Library of States

Plane of Modeling		Plane of Activity π_1	Plane of Activity π_2	Plane of Activity π_3
	Individual Model (π_1)	$X_i(s)$ Active / Passive On leave / Drop / Latecomer Disoriented Linear rigidity Impasse Trapped Over/Under generalization Deep/surface Gaming	$X_i(s_1)$ Social loafing Free rider / Sucker Individualistic Leader On/Off role	$X_i(s_1)$ With me Central Isolated Bridge
	Group Model (π_2)		$X_i(s_1, s_2, s_3, \dots)$ Undersized/Oversized Cognitive/Emotional conflict Misunderstanding Group think Distributed	$X_i(s_1, s_2, s_3, \dots)$ Cluster
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

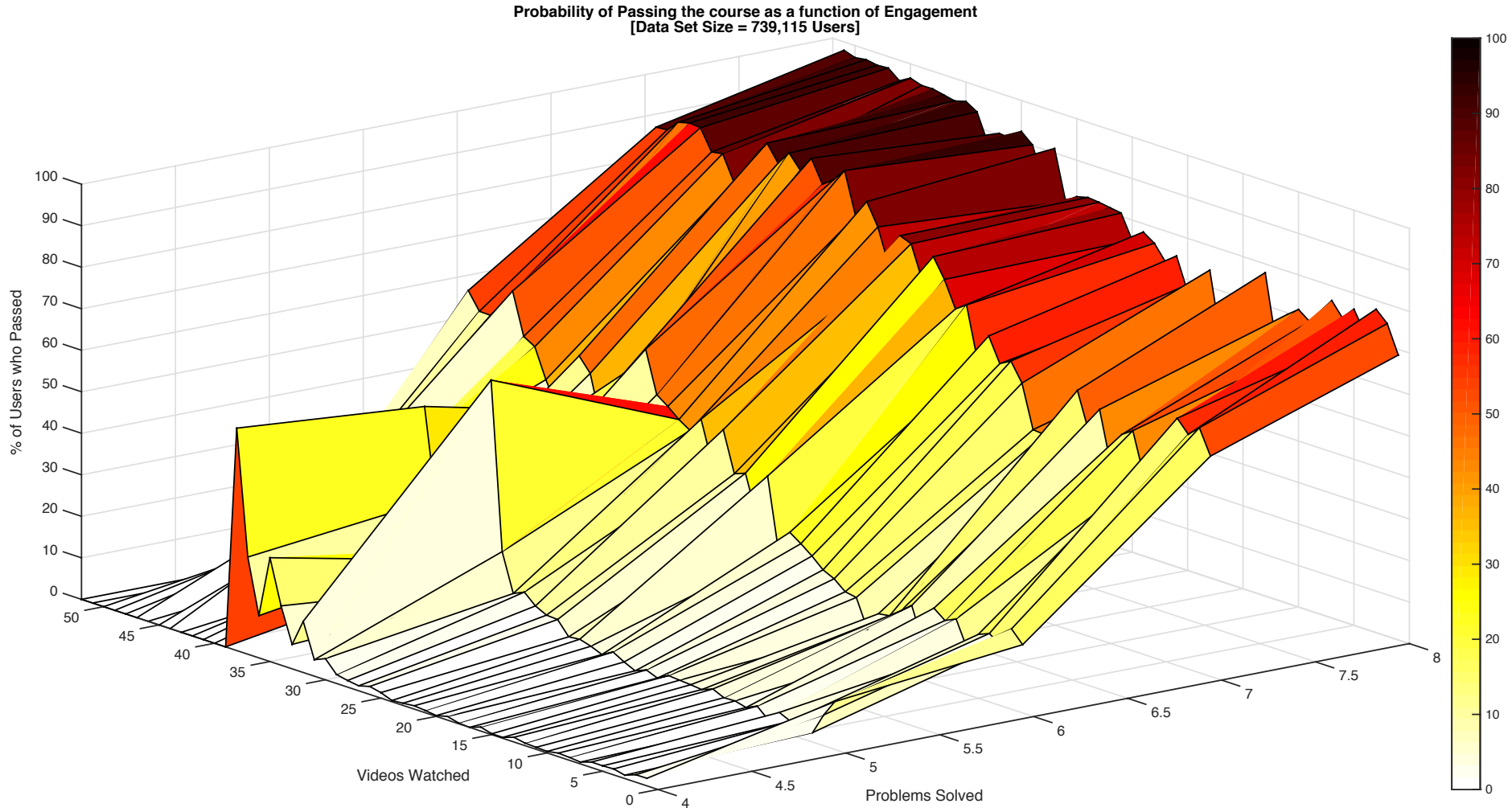


MOOC

Video
- Play
- Pause
- Skip
- Re-play
- Speed-up / down
- ✓ Asnwer quizz

Assignments
- ✓ Submit on time
- ✓ Submit late
- ✓ Resubmit

Forum
- Post
  - ✓ Initiate thread
  - ✓ Post question
  - ✓ Respond
- Read
  - Read only
  - ✓ Read + Rate


Probability of Passing the course as a function of Engagement
[Data Set Size = 739,115 Users]
% of Users who Passed
100
90
80
70
60
50
40
30
20
10
0
Videos Watched
50
45
40
35
30
25
20
15
10
5
0
Problems Solved
4
4.5
5
5.5
6
6.5
7
7.5
8
100
90
80
70
60
50
40
30
20
10
0

Library of States

Plane of Modeling		Plane of Activity π_1	Plane of Activity π_2	Plane of Activity π_3
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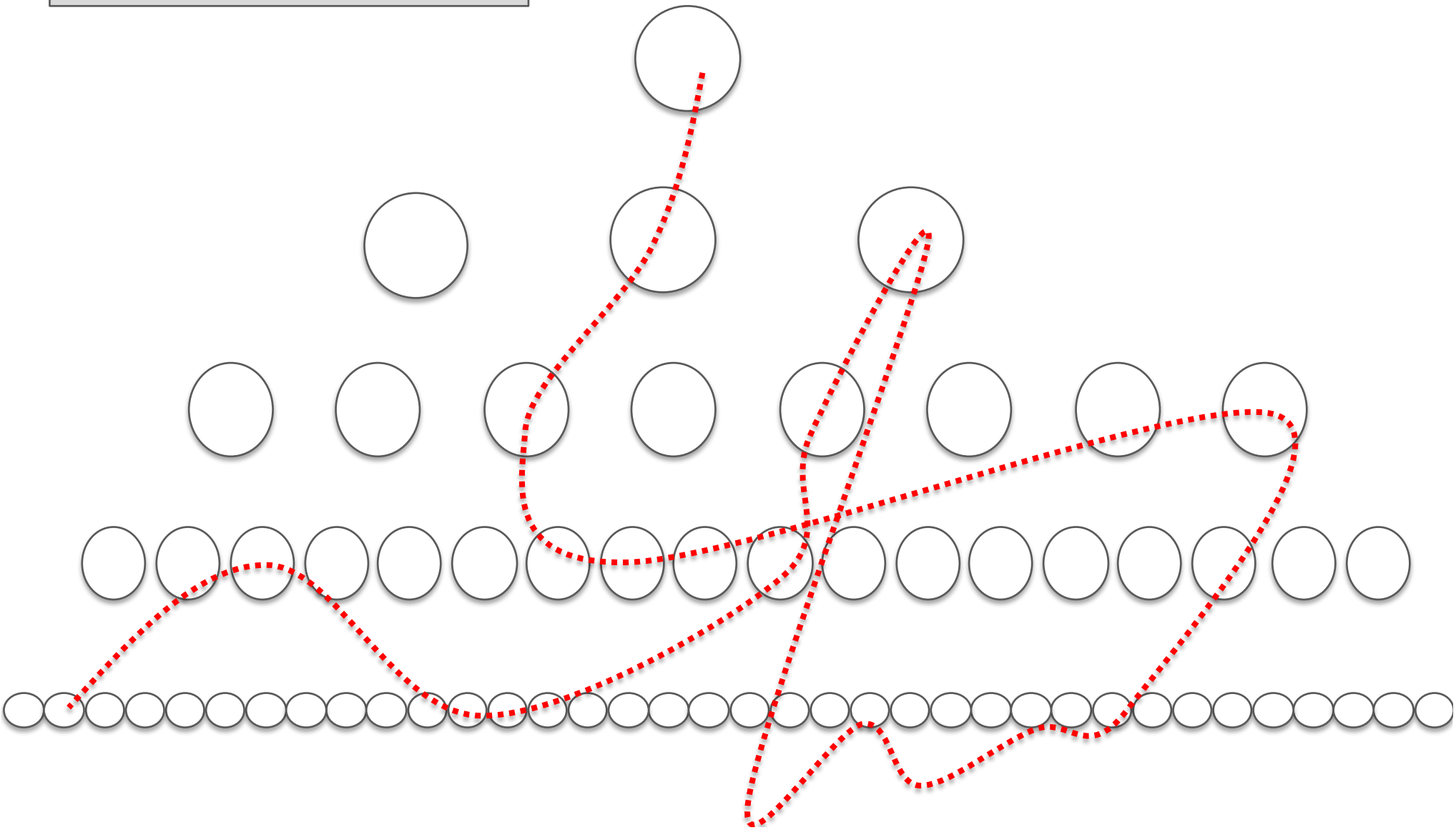
	Group Model (π_2)		$X_i(s_1, s_2, s_3, \dots)$ Undersized/Oversized Cognitive/Emotional conflict Misunderstanding Group think Distributed	$X_i(s_1, s_2, s_3, \dots)$ Cluster
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

Disoriented



« *Lost in Cyberspace* »

Disoriented

Search as a competence

NavigationPath = f (hyperspace-design, navigation-tools, prior-knowledge, navSkills)

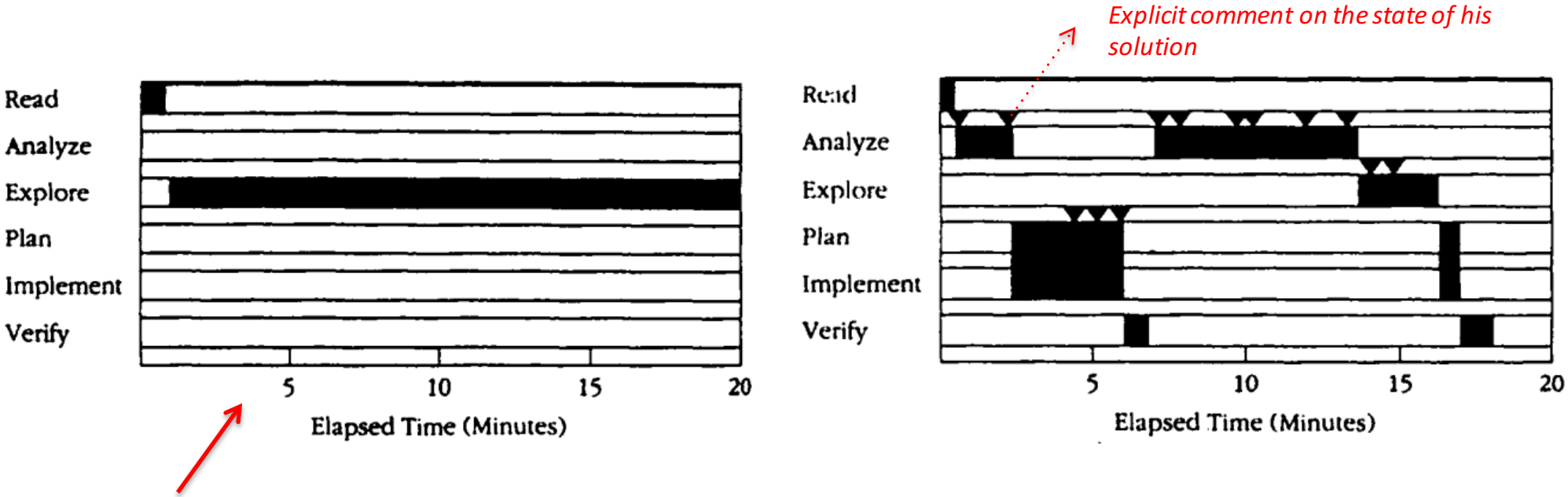
Clear structure
Follow HCI standars

Maps / Bars (TOC
Where I am
Where I have been
Where I can go

Mental Map

#links = f (x_i (s))

Adaptive Nav



Linear rigidity: This state can be inferred if the sequence of problem-solving steps in $b_i(s)$ is significantly more linear than the expected heuristic process. Linear rigidity could, for instance, be detected by the absence of "undo" or "edit" actions in $b_i(s)$.

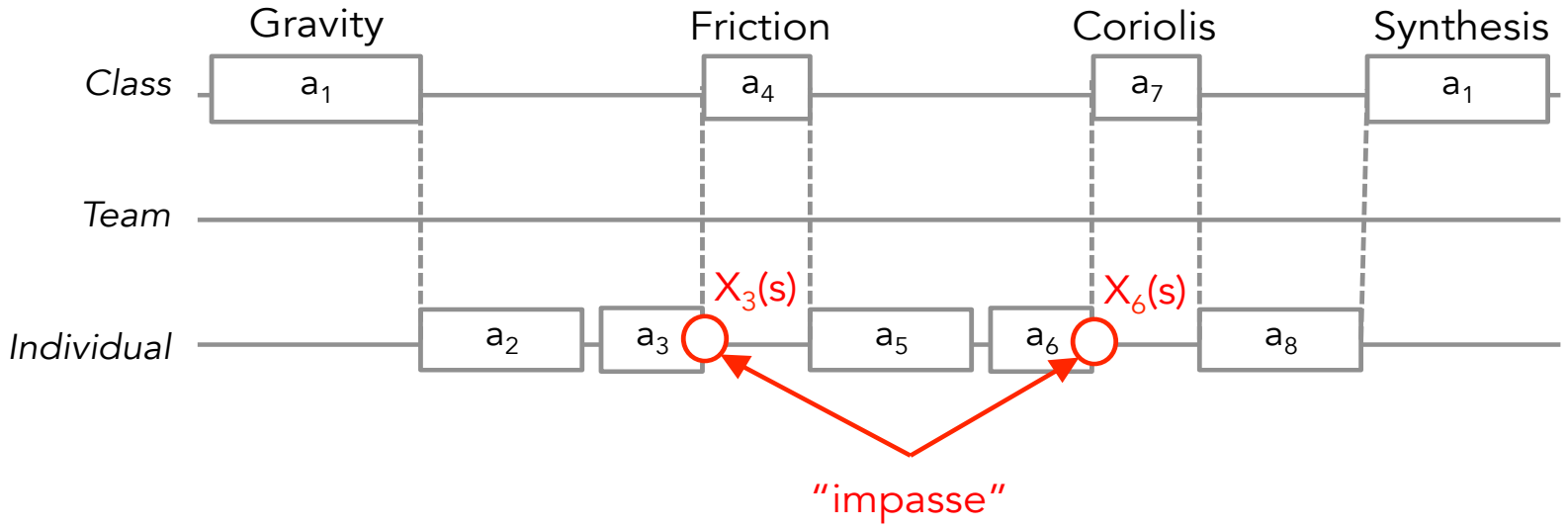
This state is important when teaching problem-solving skills. In a seminal paper, Schoenfeld (1988) showed that university students who encounter difficulties in mathematical problem solving do actually follow a linear model of problem solving; starting from the initial state, they apply one operator, then another, up to the moment where they get stuck, that is, when no other step seems applicable. Conversely, good problem solvers follow a heuristic path; they try some operators, backtrack when there is a deadlock, and try another one. Schoenfeld noticed that this inefficient model of problem solving as a linear process is indeed reinforced by the behavior of those teachers who are usually considered "good teachers"; they smoothly present a proof or a demonstration in a linear fashion, which they know by heart, writing one line below another on a clean blackboard, without any errors. This state is more or less the opposite of the previous state "disoriented" but applies to a different type of activity, problem solving in this case and information search in the previous state.

http://howtosolveit.pbworks.com/f/Schoenfeld_1992%20Learning%20to%20Think%20Mathematically.pdf

EDUCATIONAL PSYCHOLOGIST, *23*(2), 145–166

When Good Teaching Leads to Bad Results: The Disasters of "Well-Taught" Mathematics Courses

Alan H. Schoenfeld
University of California



Impasse: This state can be inferred if $b_i(s)$ includes an error to which the learner has been deliberately guided by the teacher or the designer

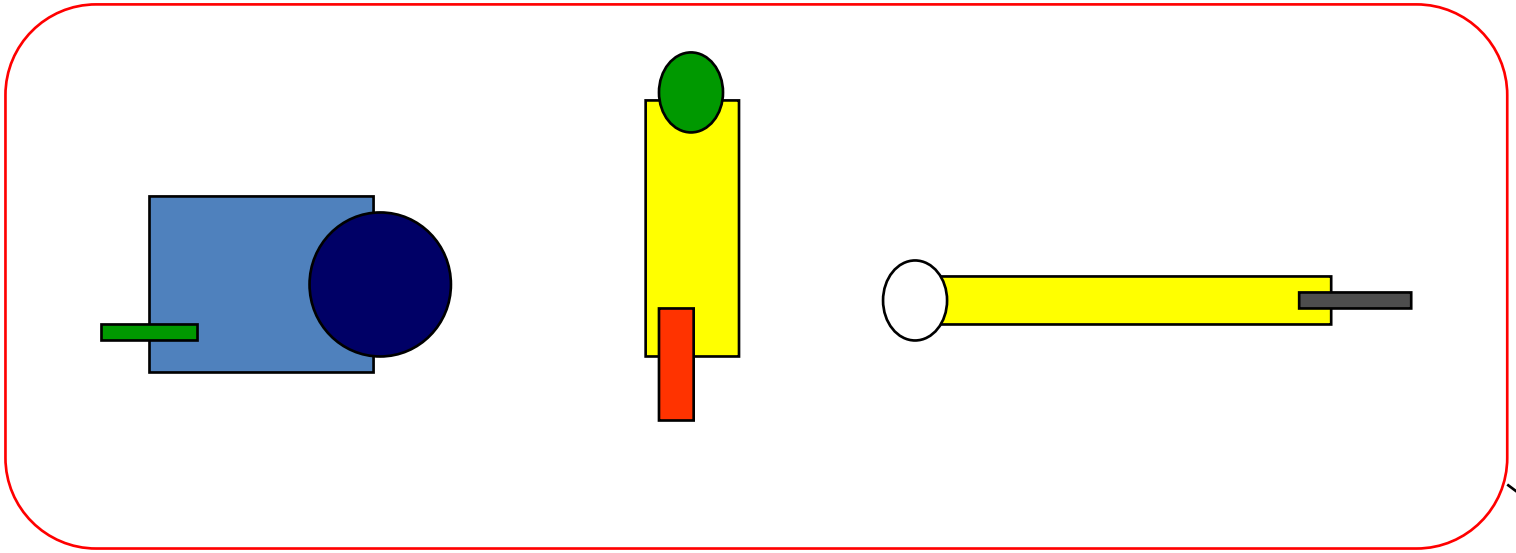
In a_1, students learn the laws for predicting the distance of a ballistic shot, based only on gravity. In a_2, they have to predict the shoot distance with an accuracy of 0.5 meters on a distance of 30 meters, which they manage to do with the basic equation. In a_3, the shooting distance is set to 30 kilometers. The students will fail this activity because they need more parameters: $x_3(s)$ = "*impasse*." This designed deadlock, called "impasse" by some colleagues (Van Lehn, 1988) prepares the students for the next lecture (a_4) about friction forces. The same operation is then repeated with a second impasse in $X_3(s)$ in order to introduce the Coriolis force in a_7. This graph illustrates a design pattern as old as education itself, "*learning from mistakes*." Students do learn from some of their mistakes, but only in the right conditions; namely, if they are aware of the mistake they have made, and if they find the resources that will allow them to repair their misunderstanding in their environment. It is, for instance, important to keep the activity that leads to an impasse very short, otherwise the resulting state could be negative: $x_3(s)$ = "*<u>un</u>motivated*."

http://www.instructionaldesign.org/theories/repair-theory.html

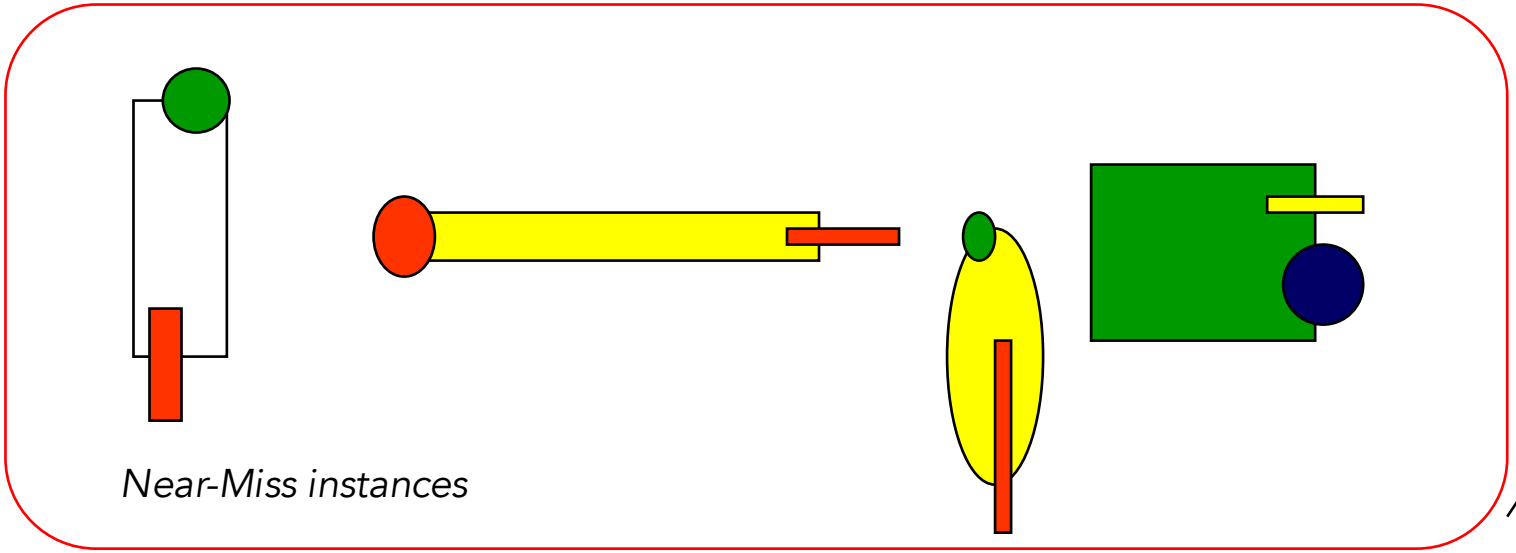
Lesson B

CHAPTER 6

WHAS IS A SPUC ?

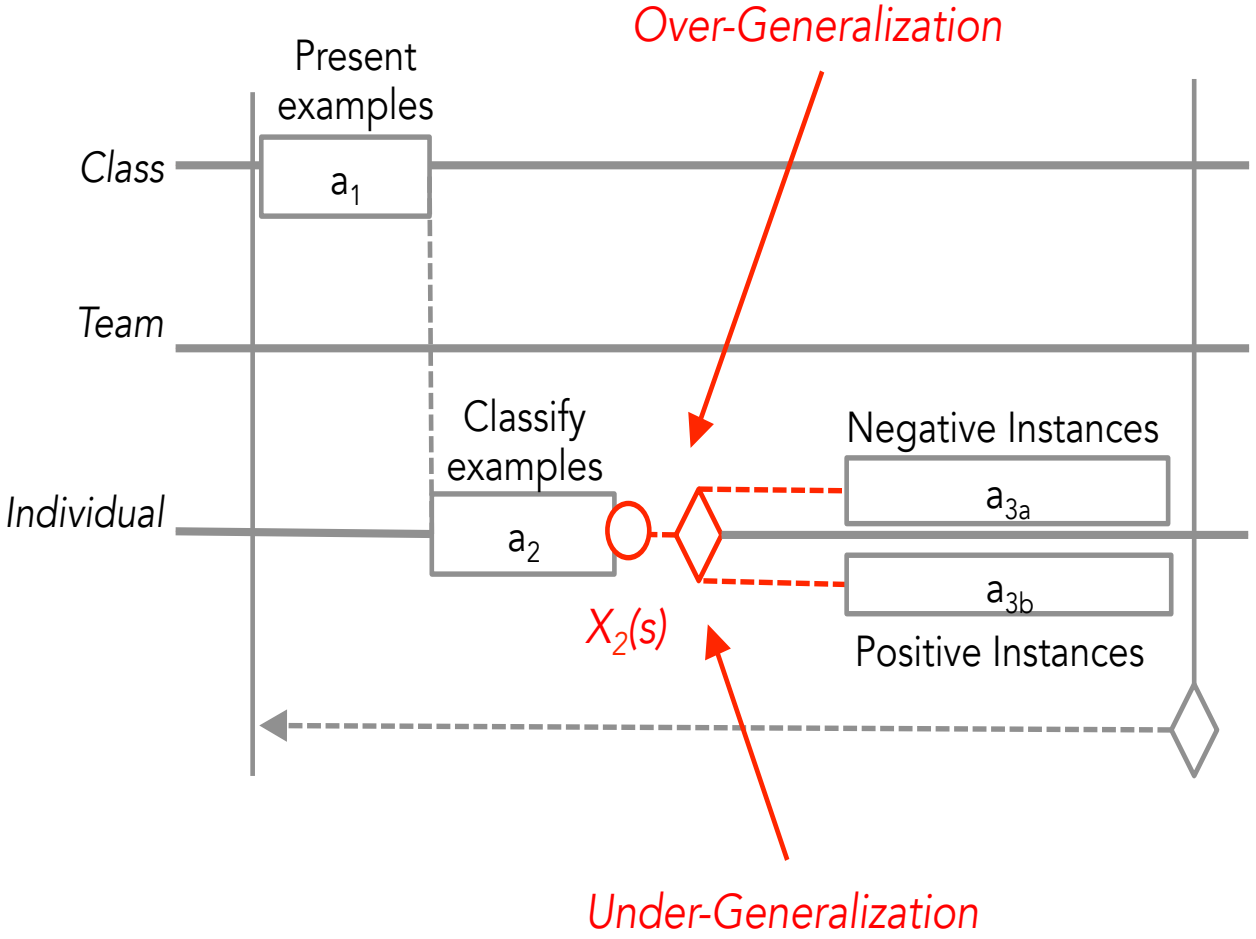


Positive instances



Near-Miss instances

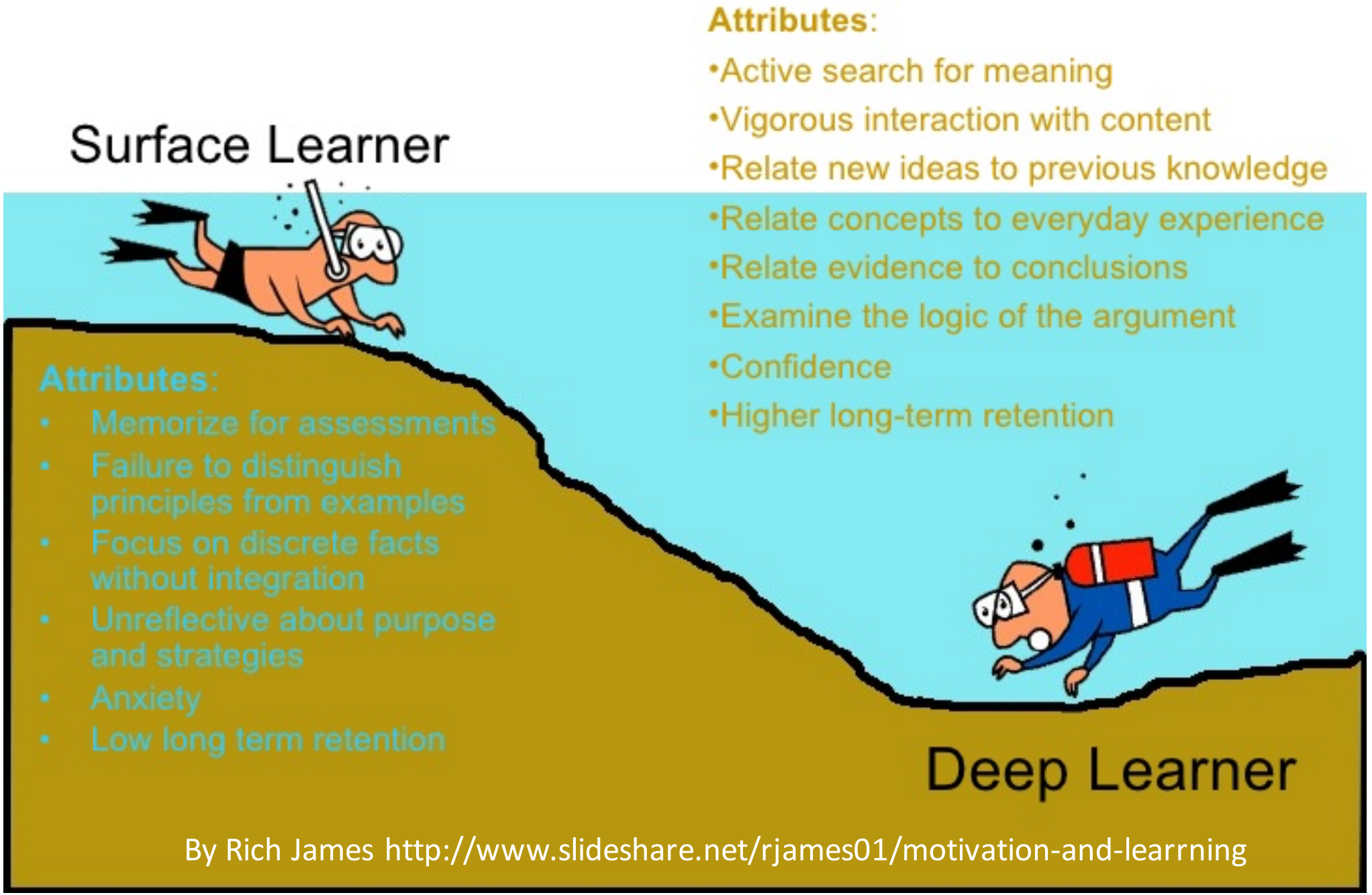
Negative instances



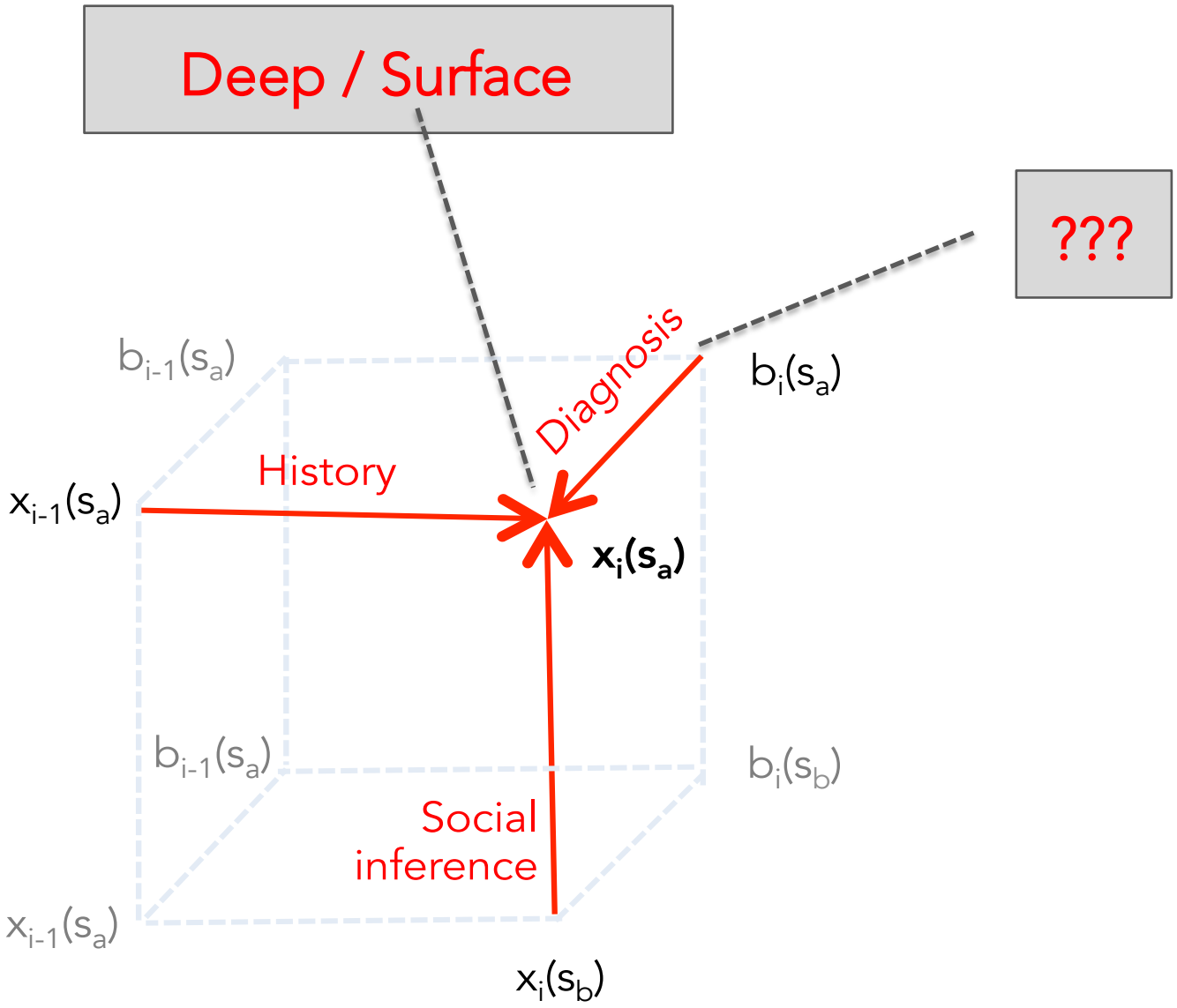
Over/Under Generalisation: These states can be inferred when $B_i(s)$ reveals that while learning a concept, the learner classifies as positive some instances that are negative—overgeneralization—or conversely, if the learner classifies as negative some instances that are positive—undergeneralization

As an example of undergeneralization, pupils tend to be confronted with rhombuses presented in their canonical forms (the longer diagonal being vertical) and do not recognize those presented, for instance, as a parallelogram (2 sides being horizontal). As an example of overgeneralization, a learner may believe that all French words that end with "-ment" ("longuement," "patiemment," "fréquemment,") are adverbs. These states are not negative, per se. If the teacher or the system detects them, he or it will be able to select the next positive or negative example to be presented, respectively for under- versus overgeneralization.

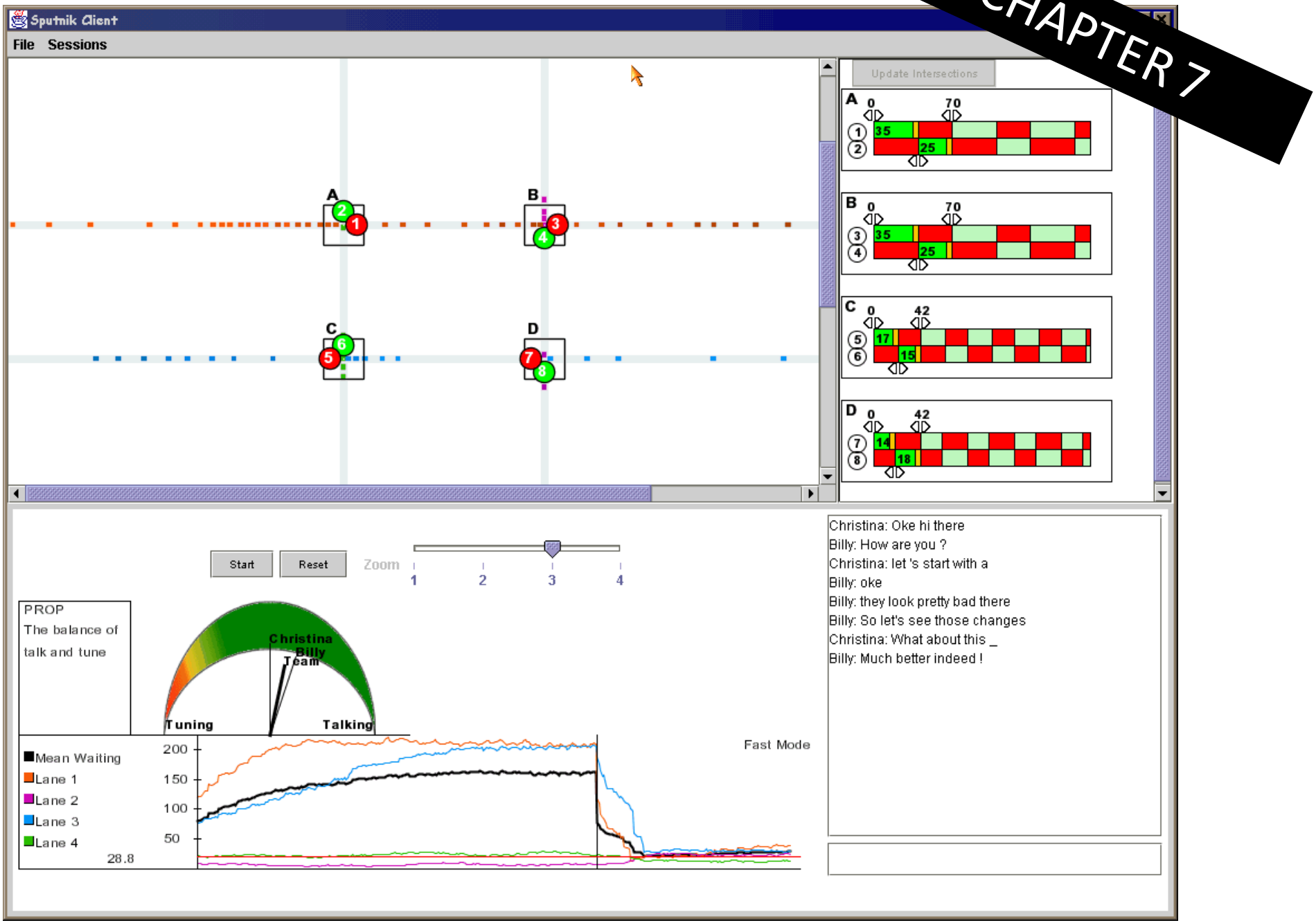
What are characteristics of deep and surface learning?

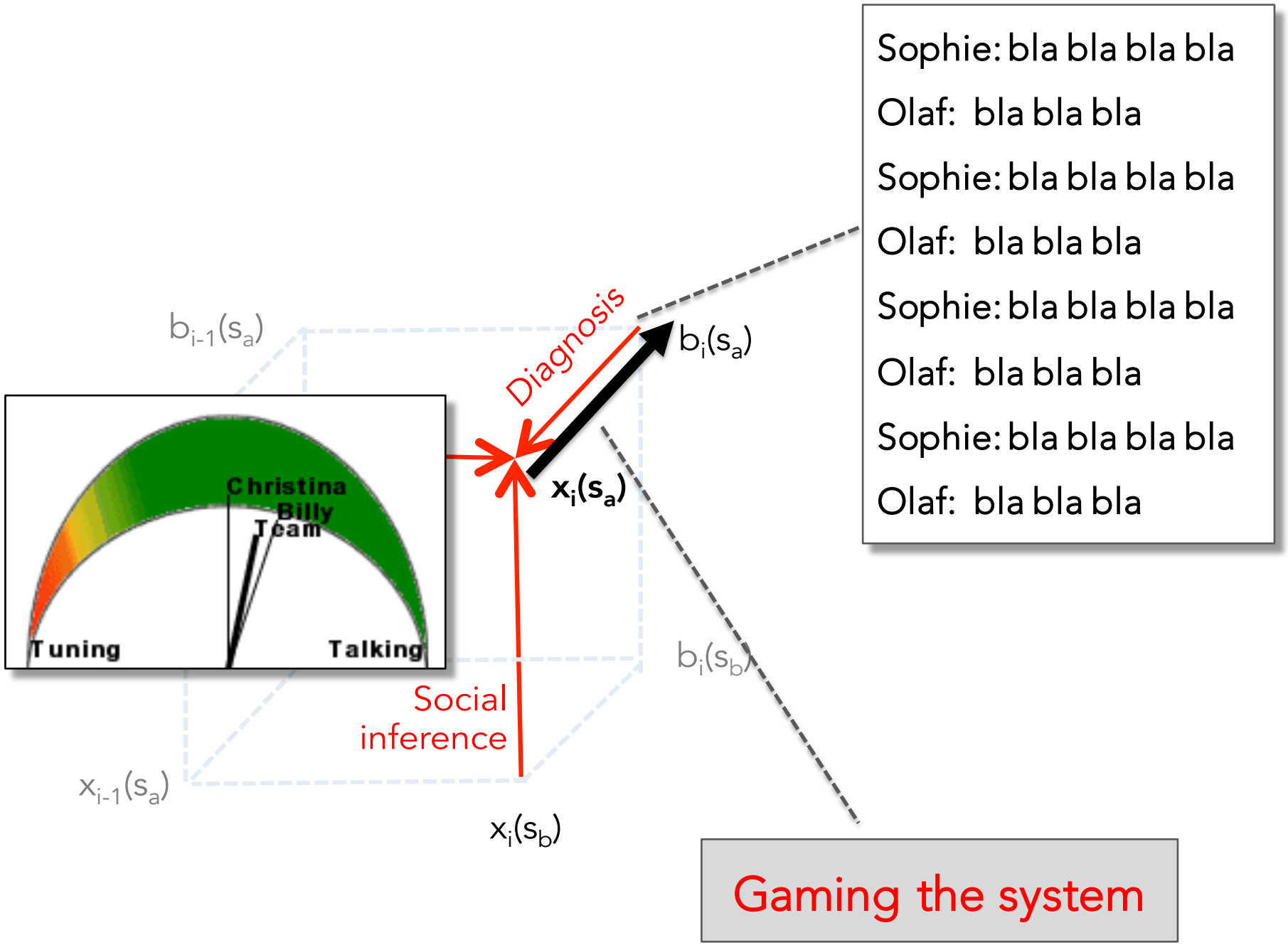


By Rich James http://www.slideshare.net/rjames01/motivation-and-learrning


Deep / Surface
???
$b_{i-1}(s_a)$
Diagnosis
$b_i(s_a)$
History
$x_{i-1}(s_a)$
$x_i(s_a)$
$b_{i-1}(s_a)$
$b_i(s_b)$
Social
inference
$x_{i-1}(s_a)$
$x_i(s_b)$

CHAPTER 7


Sputnik Client
File Sessions
Update Intersections
A
B
C
D
Start
Reset
Zoom
1
2
3
4
PROP
The balance of talk and tune
Christina
Billy
Team
Tuning
Talking
Mean Waiting
Lane 1
Lane 2
Lane 3
Lane 4
200
150
100
50
28.8
Fast Mode
Christina: Oke hi there
Billy: How are you ?
Christina: let 's start with a
Billy: oke
Billy: they look pretty bad there
Billy: So let's see those changes
Christina: What about this _
Billy: Much better indeed !


Sophie: bla bla bla bla
Olaf: bla bla bla
Sophie: bla bla bla bla
Olaf: bla bla bla
Sophie: bla bla bla bla
Olaf: bla bla bla
Sophie: bla bla bla bla
Olaf: bla bla bla
$b_{i-1}(s_a)$
Diagnosis
$b_i(s_a)$
Christina
Billy
Team
Tuning
Talking
$x_i(s_a)$
$b_i(s_b)$
Social
inference
$x_{i-1}(s_a)$
$x_i(s_b)$
Gaming the system

Library of States

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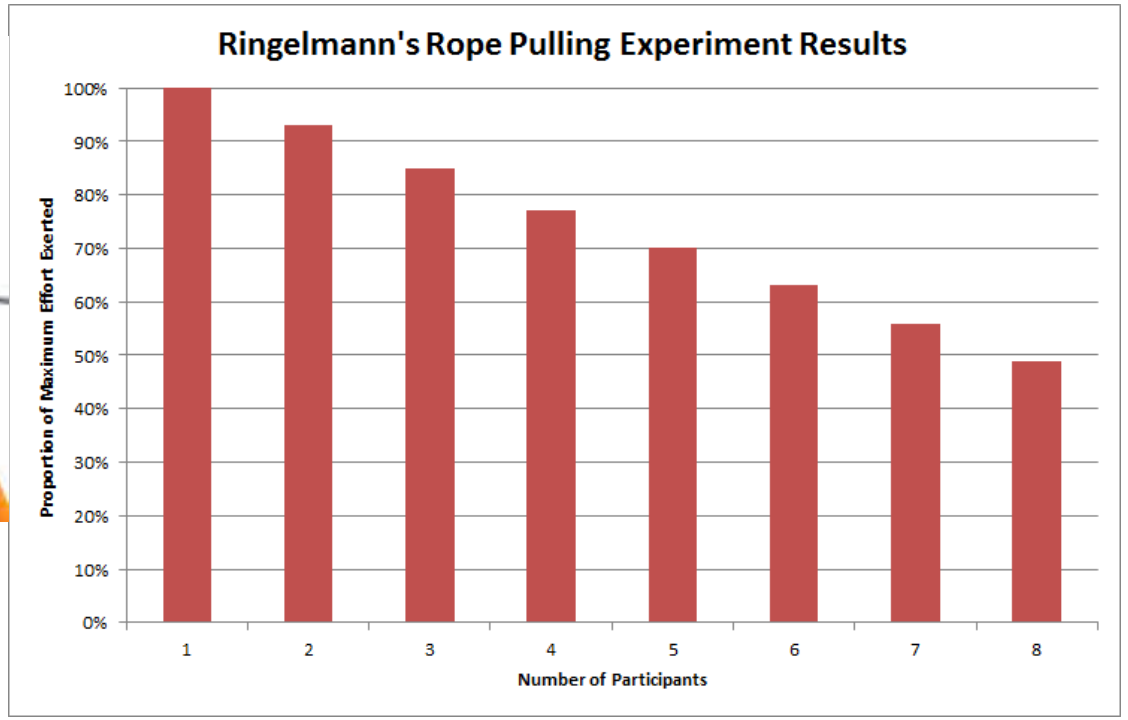
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

Social loafing is the phenomenon of a person exerting less effort to achieve a goal when they work in a group than when they work alone… when individual contributions cannot be measured

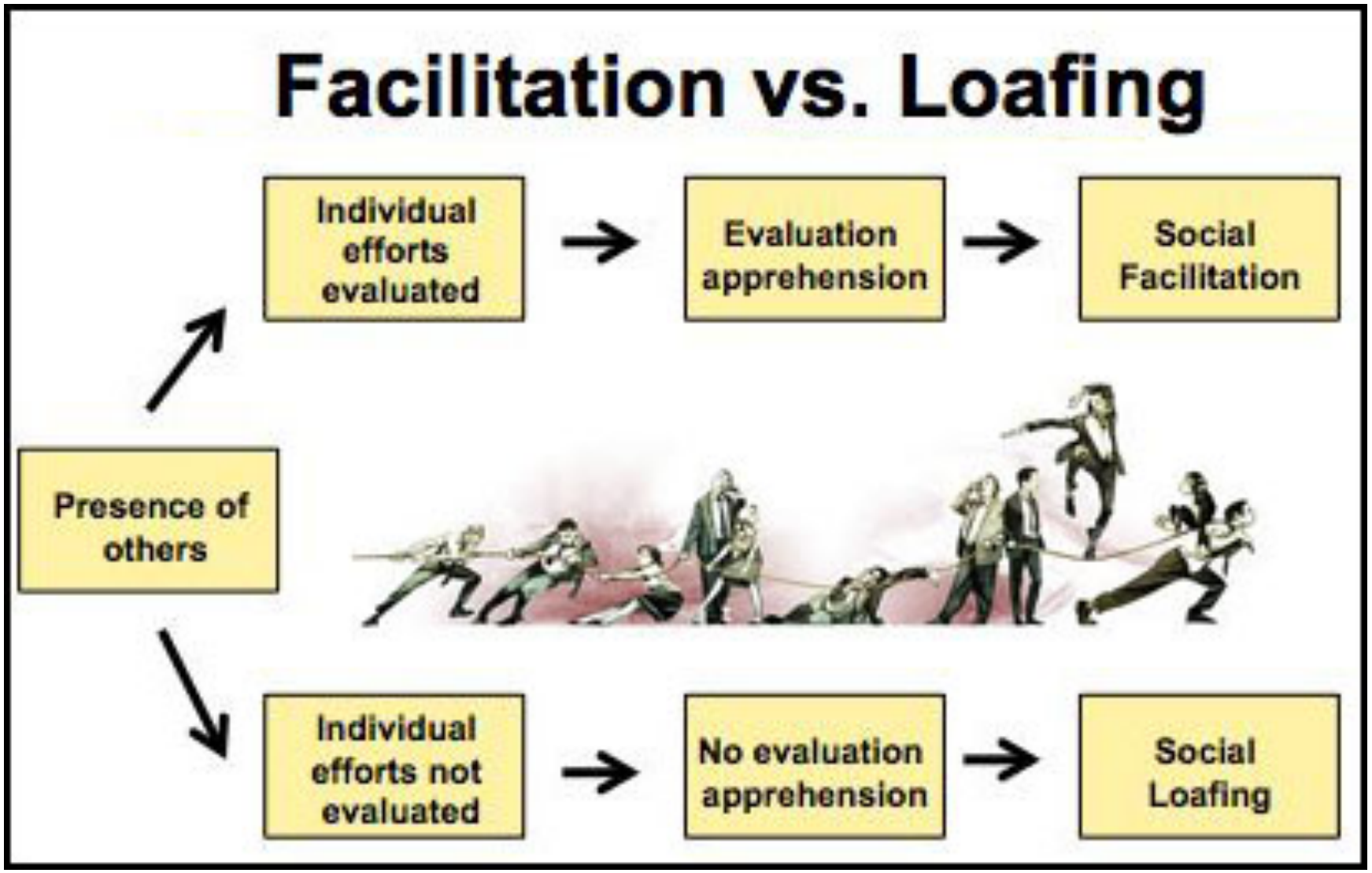


Ringelmann, M. (1913) "Recherches sur les moteurs animés: Travail de l'homme" [Research on animate sources of power: The work of man], Annales de l'Institut National Agronomique, 2nd series, vol. 12, pages 1-40

Karau, Steven J.; Williams, Kipling D. (1993). "Social loafing: A meta-analytic review and theoretical integration". *Journal of Personality and Social Psychology*. **65** (4): 681–706. doi:10.1037/0022-3514.65.4.681

Social facilitation is the tendency for people to perform differently when in the presence of others than when alone…. on simple or well-rehearsed tasks ….. (and worse on complex or new ones)

Strauss, Bernd (July 2002). "Social facilitation in motor tasks: a review of research and theory". *Psychology of Sport and Exercise*. **3** (3): 237–256. doi:10.1016/S1469-0292(01)00019-x.



http://www.rcgates.com/psyc/sp18.html

Free rider effect: learners reduce their effort when the realize that this lower effort will not affect the performance of the group

Social Loafing

https://eva157.files.wordpress.com/2013/12/155-free_rider.jpg

Sucker effect: learners reduce their effort when the realize that the other group members do not produce the same efforts

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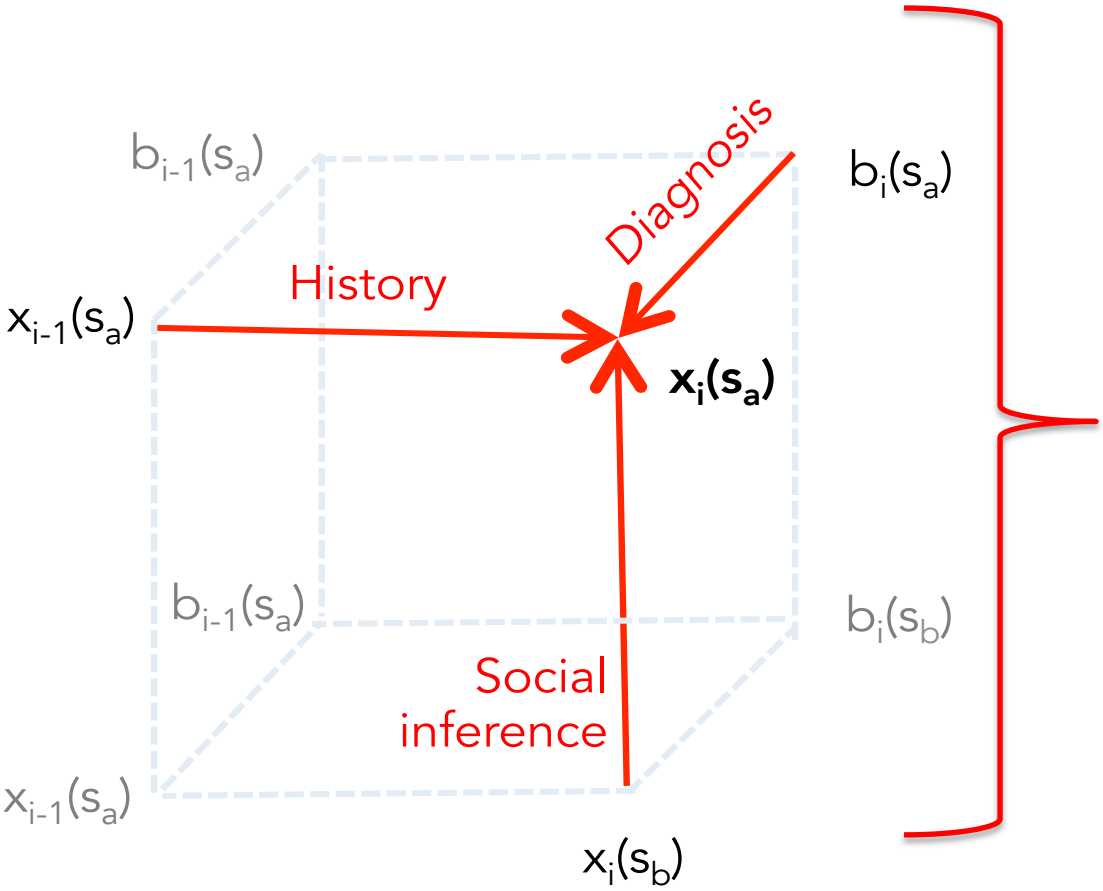
http://www.davidlewisphd.com/courses/8001/EDD8001/1989-Salomon_Globerson.pdf

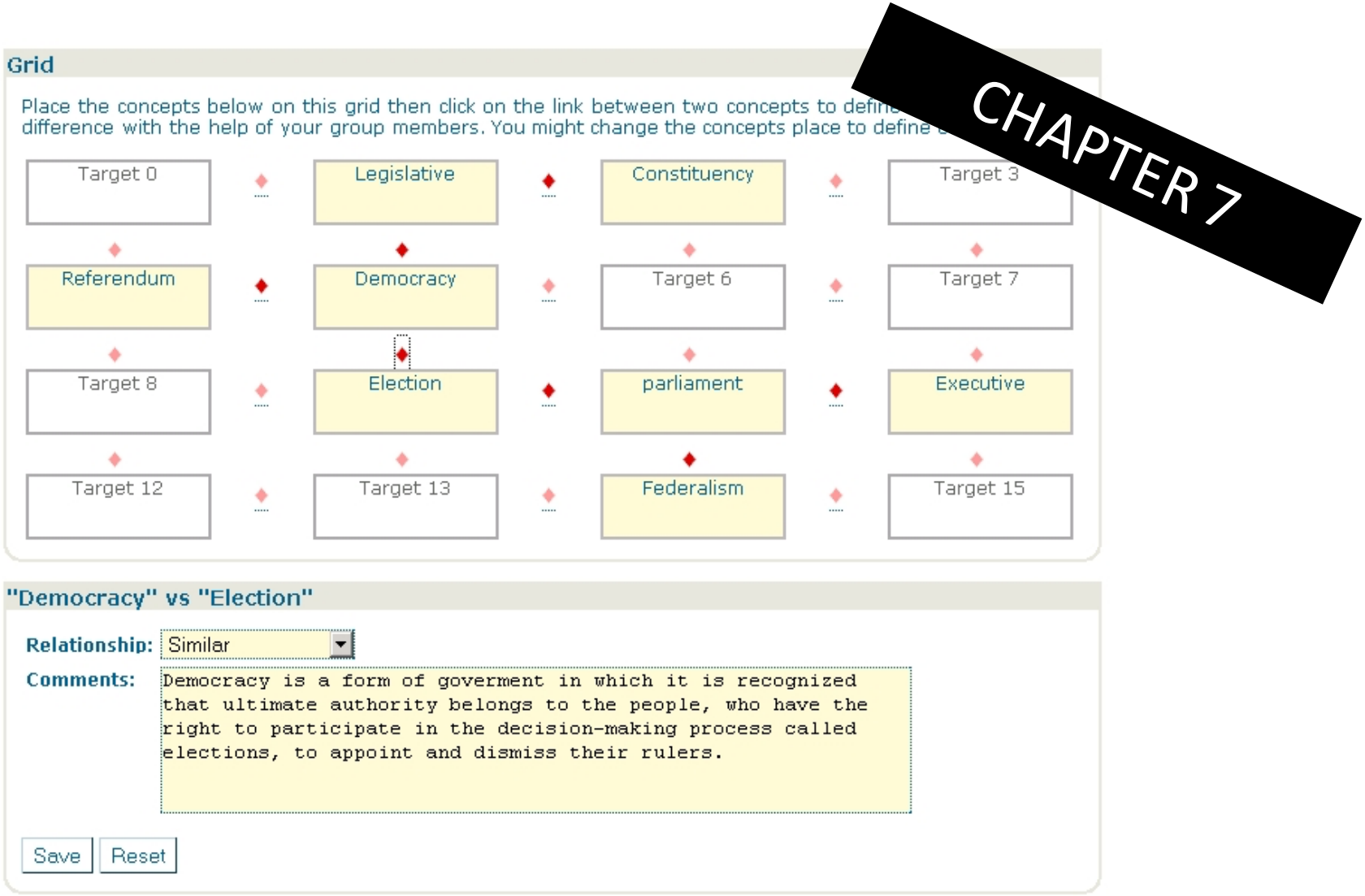


Free rider / sucker: These states can be inferred if there is a disequilibrium in the distribution of actions among $b_i(s_1)$, $b_i(s_2)$, …, $b_i(s_n)$, n being the size of teams at π_2

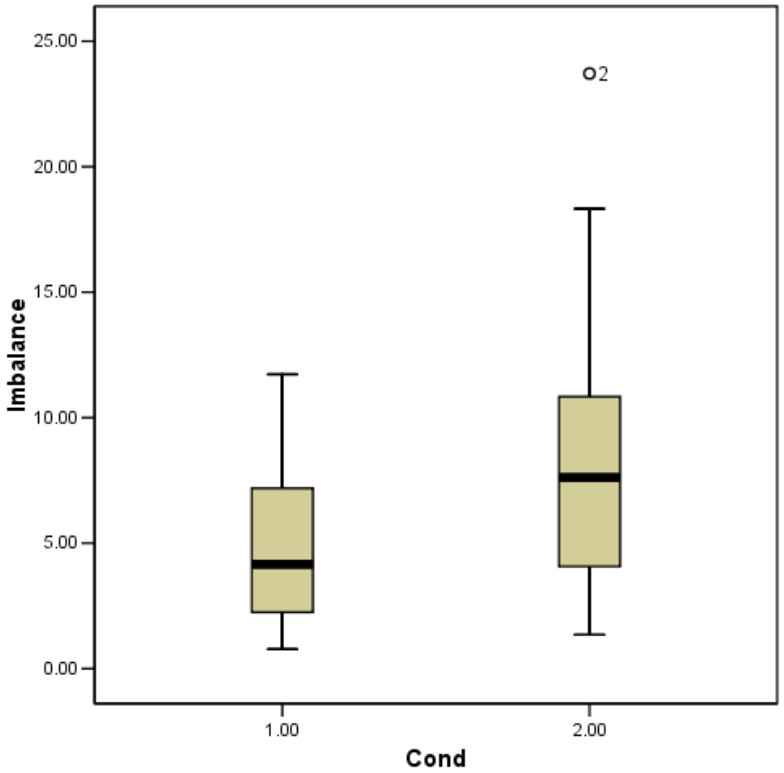
➔ (1) Avoid too large differences of level/knowledge in your team formation operators.

➔ (2) Design orchestration graphs that maximize inter-dependence:

the task cannot be solved without everyone contribution: JIGSAWs



➔ (3) : Design technologies that help regulating the balance of participation.



CHAPTER 7

Library of States

Plane of Modeling		Plane of Activity π_1	Plane of Activity π_2	Plane of Activity π_3
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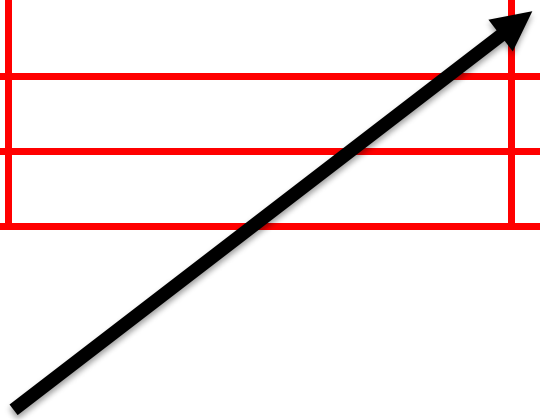
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

Under/Over-sized group

What to do if the number of team members doe snot match (anymore) the number of roles in the team ?

CHAPTER 5

Aggregation	Distribution	Social	BackOffice
(A) Listing	(D) Broadcasting	(S) Group formation	(B) Grading
(A) Classifying	(D) User selection	(S) Class Split	(B) Feedback
(A) Sorting	(D) Sampling	(S) Role assignment	(B) Anti-plagiarism
(A) Synthesizing	(D) Splitting	(S) Role rotation	(B) Rendering
(A) Visualizing	(D) Conflicting	(S) Group rotation	(B) Translating
	(D) Adapting	(S) Drop out management	(B) Summarizing
		(S) Anonymisation	(B) Converting
			(B) Updating



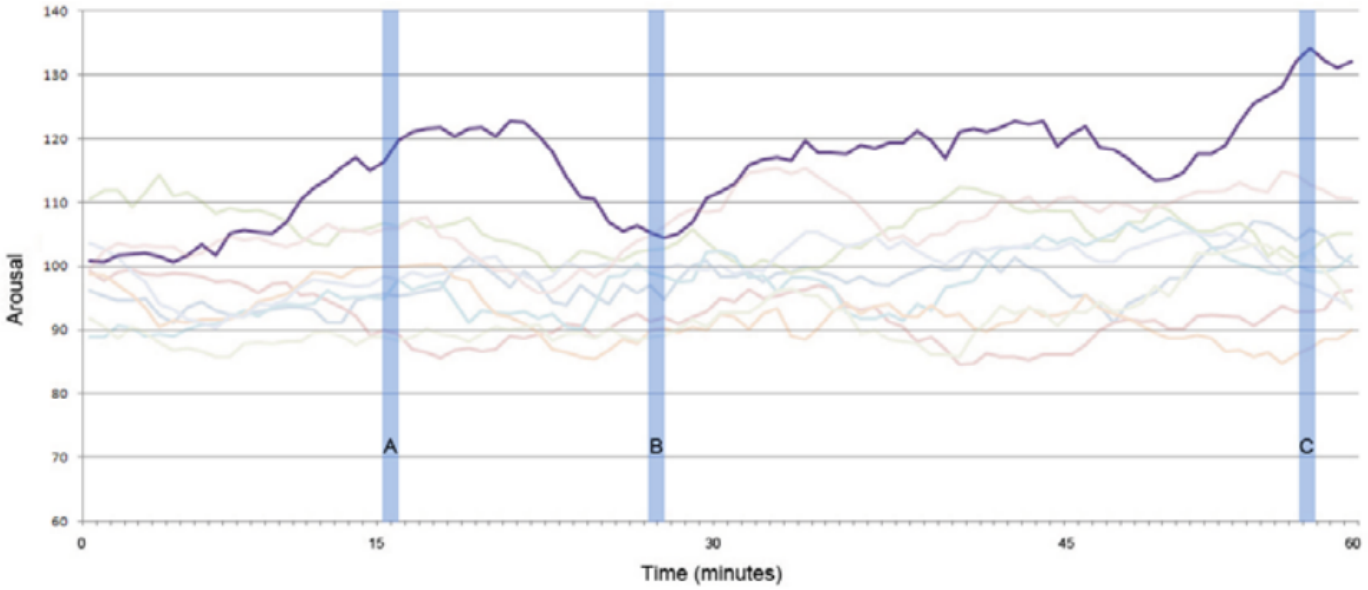


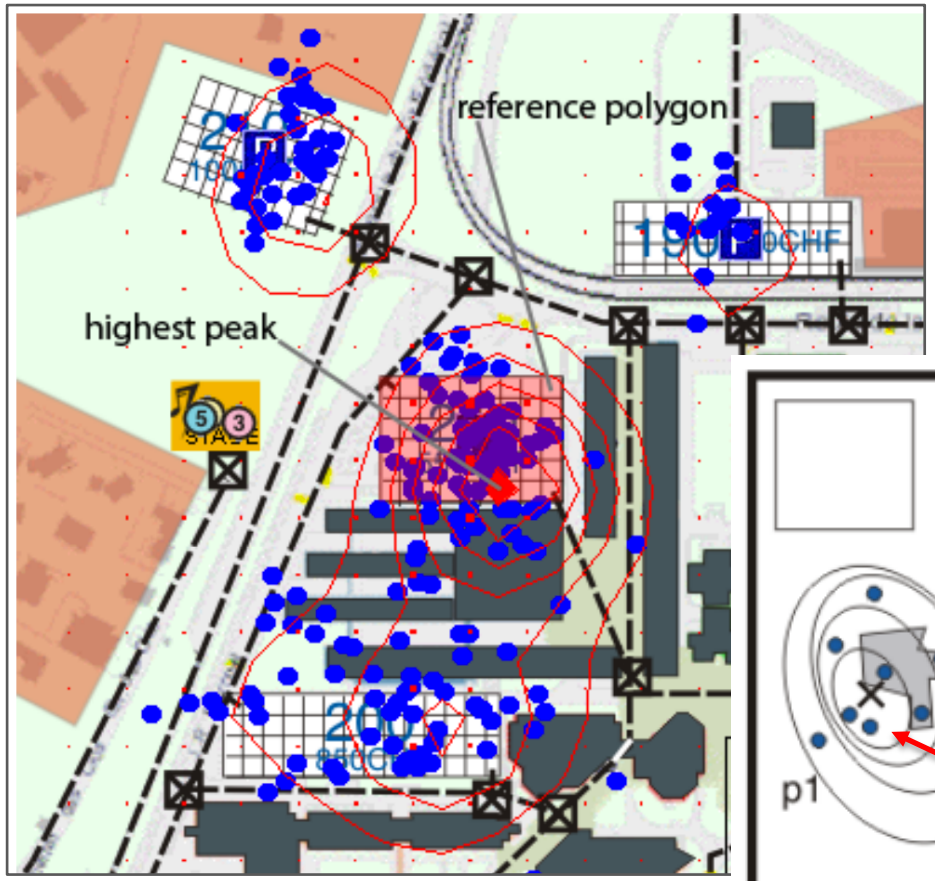
Figure 5.12: Three sections of one group's arousal pattern display different levels of arousal for the group.

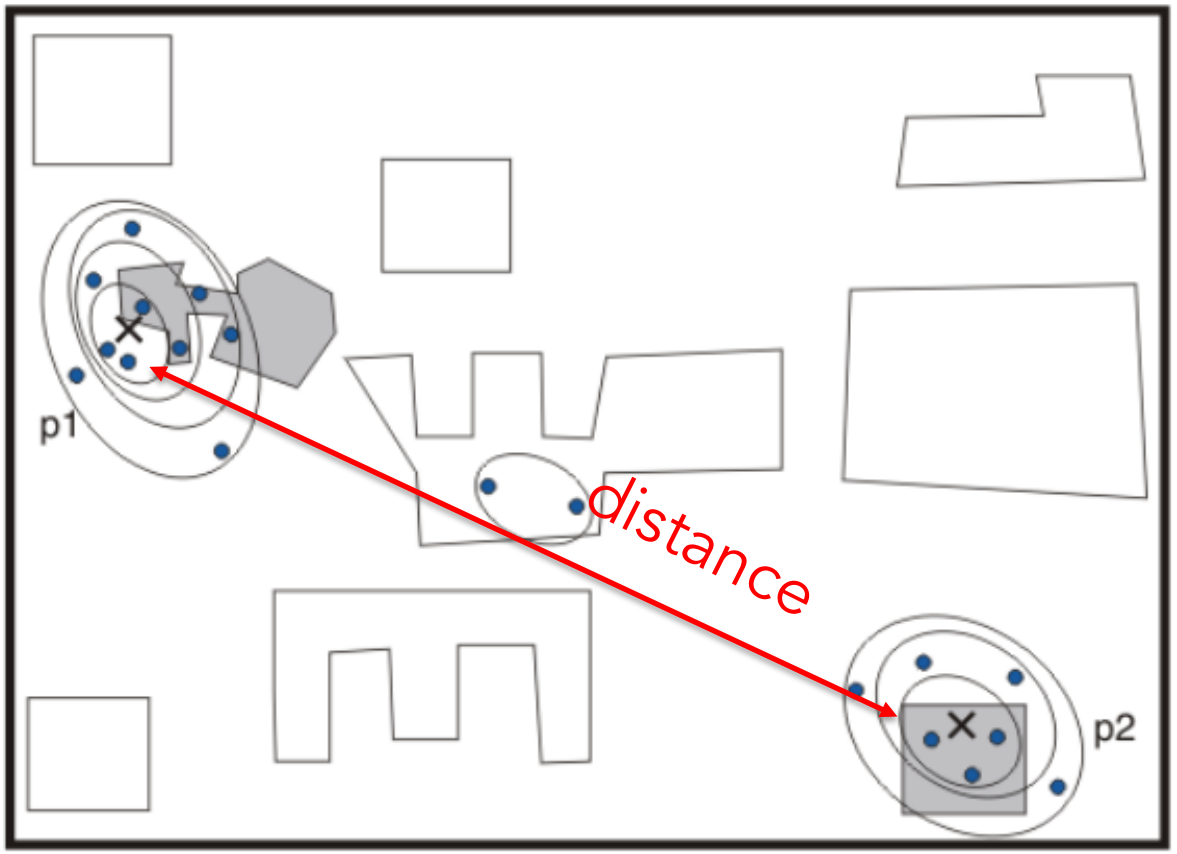
A: Yes, but it's like now we're arguing because.
B: We don't agree on the suspect.
A: We don't agree.
C: Yeah but...
A: And then I take my phone and I throw it in your face.
B: It's possible.
C: But you're not gonna hit me on the head.
A: Why not?
C: I don't know, we're human afterall.
A: Also...
C: And then, This is not how at an adult age we handle things.
A: Wait, I hope you're joking when you speak like that. Look at what's happening, all the crimes everyday all the... wars everywhere.

Cognitive / Emotional Conflict

https://documents.epfl.ch/users/b/ba/bachour/www/Dissertation-KhaledBachour-compressed.pdf

Misunderstanding

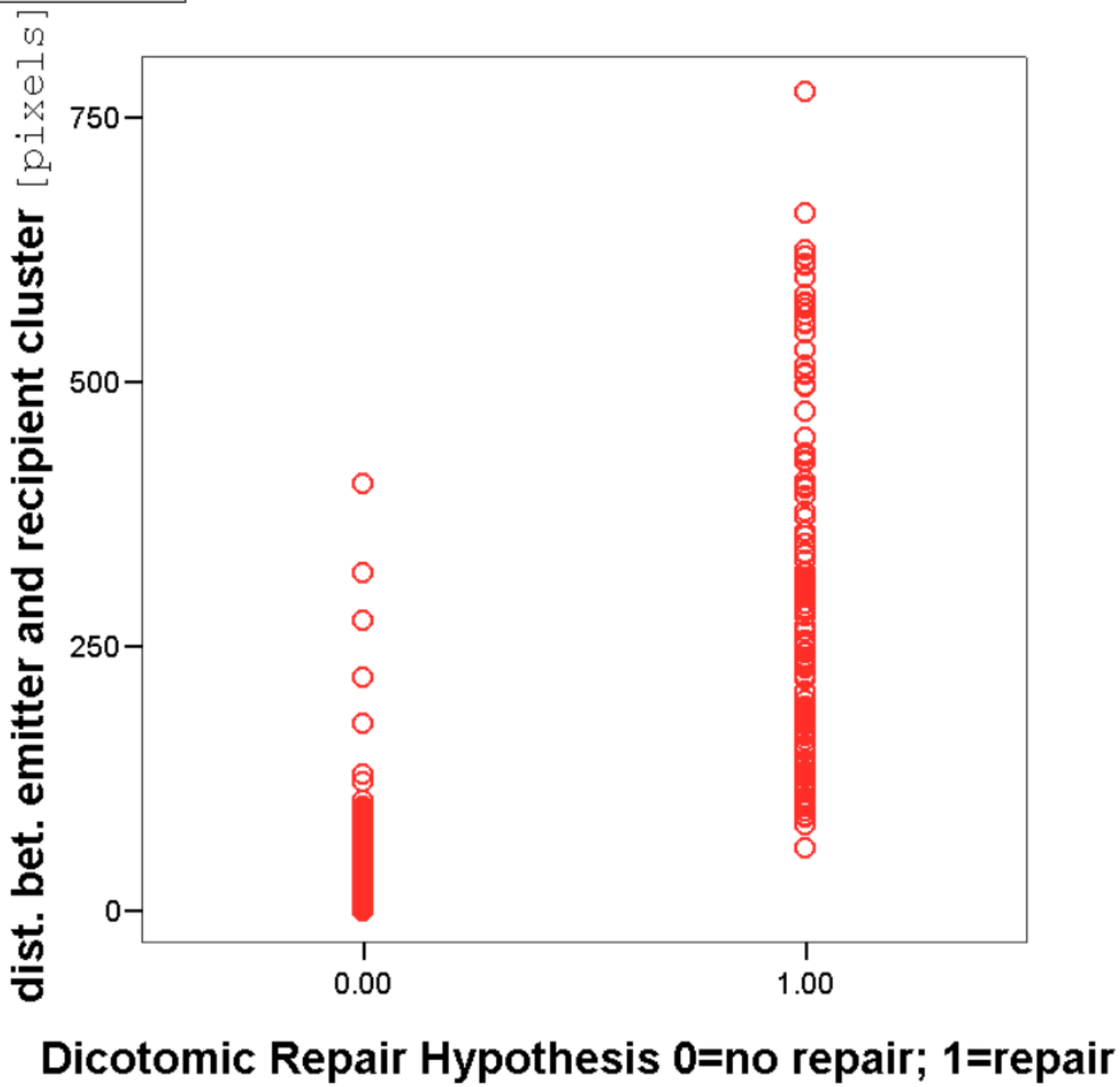




https://infoscience.epfl.ch/record/124743/files/EPFL_TH4116.pdf

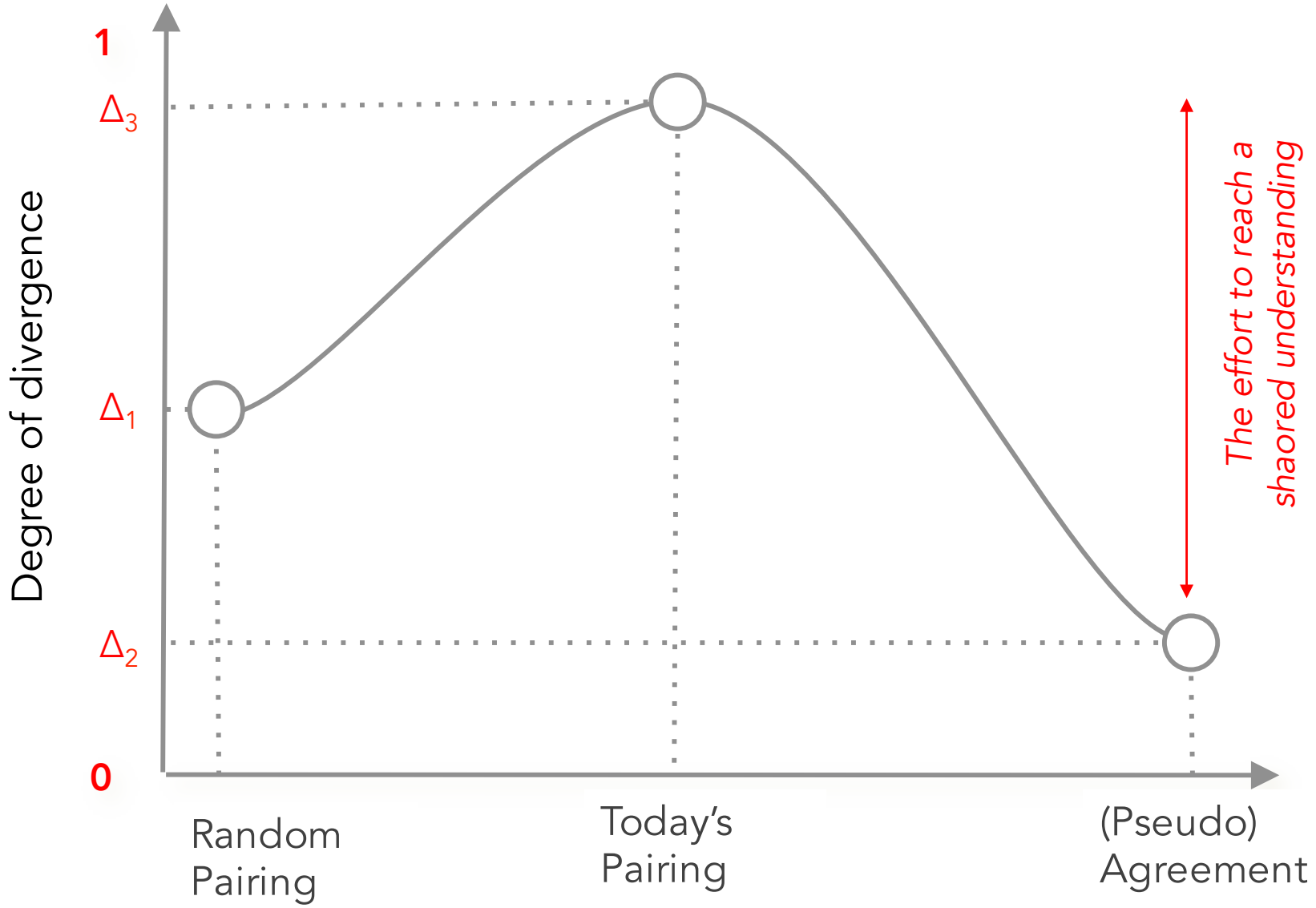
Misunderstanding

https://infoscience.epfl.ch/record/124743/files/EPFL_TH4116.pdf



Misunderstanding

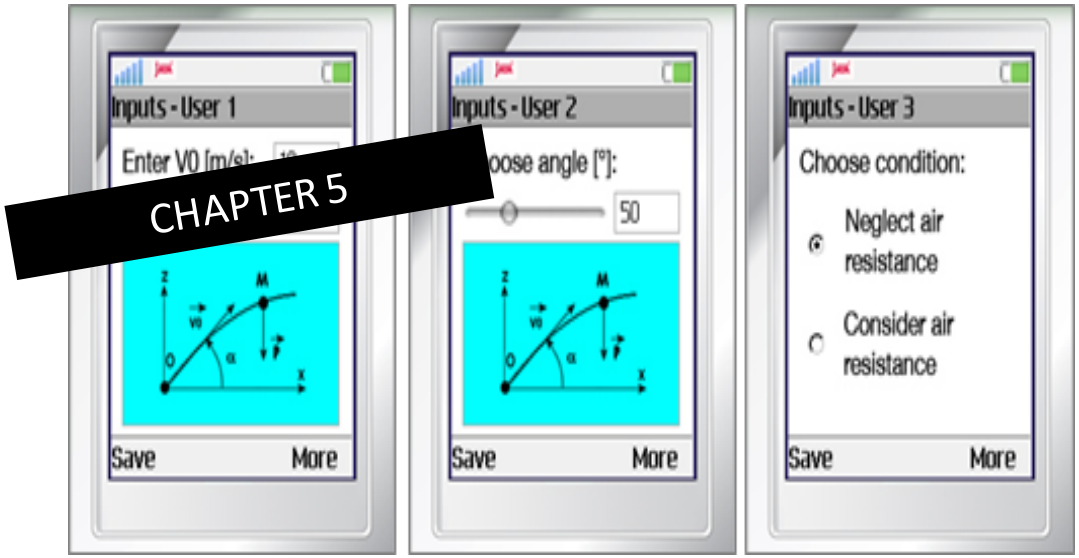
CHAPTER 7



Group Think: This state can be inferred when $b_i(s_1, s_2, s_3, \ldots)$ reveals that team members agree upon a solution without having sufficiently considered the other solutions. This state is the opposite of conflict; it corresponds to a special case of surface learning at π_2—sometimes the social pressure to reach consensus (Whyte, 1952) or the teacher's pressure, leads the team to select the first solution that results in a consensus (even if it is not the optimal solution), without exploring alternatives. This state is negative, because the team neglects solutions that could have been better. When this state is detected, it should trigger specific reactions from the teacher or the system, such as pointing out ideas that have been mentioned by some members, but that the team neglected in order to reach faster consensus. This state can be inferred if the activity interfaces keep traces of all the solutions that have been explored by the team.

https://www.youtube.com/watch?v=W4zVD5aK2Z4

State (π_2,π_2) Distributed: This state can be inferred when $b_i(s_1, s_2, s_3, \ldots)$ reveals a clear division of labor among team members. Even when there is no predefined role for an activity, roles often spontaneously appears during teamwork.



	Temperature	Pressure	Volume
Lena	3	**14**	2
Louis	**13**	2	4
Manu	3	1	**12**
Olga	**9**	1	3

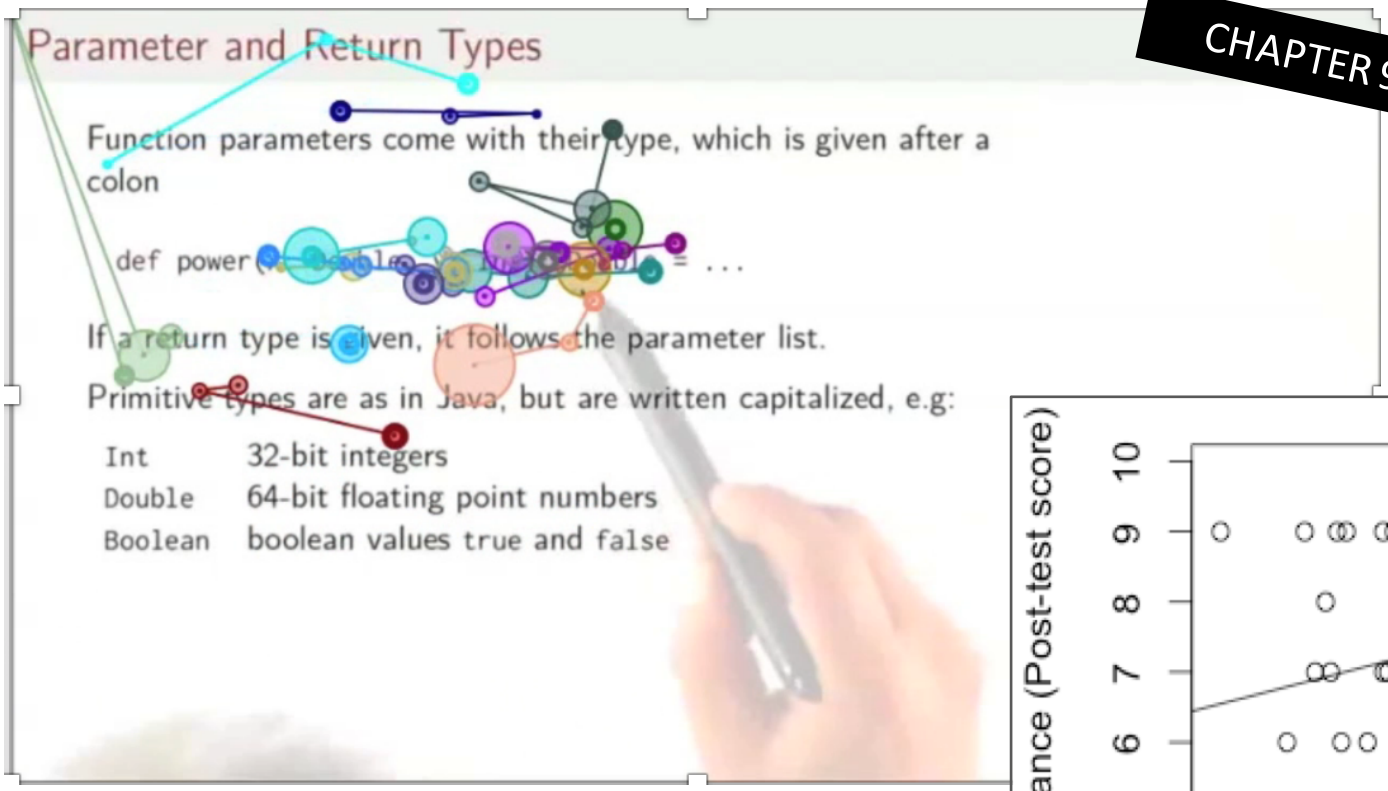
	Temperature	Pressure	Volume
Lena	7	6	6
Louis	6	8	4
Manu	4	4	8
Olga	5	4	4

State (π1,π2) On role/Off role: These states can be inferred if bi(s) includes actions that do or do not correspond to the role assigned to s by the social operator and/or does not include the actions that correspond to this role.

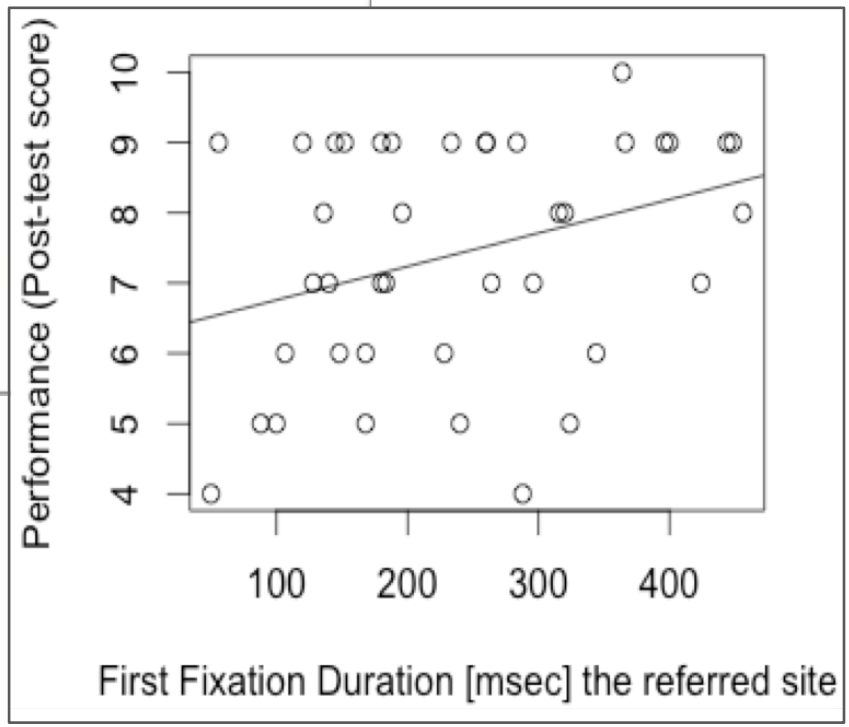
Library of States

Plane of Modeling		Plane of Activity π_1	Plane of Activity π_2	Plane of Activity π_3
	Individual Model (π_1)	$X_i(s)$ Active / Passive On leave / Drop / Latecomer Disoriented Linear rigidity Impasse Trapped Over/Under generalization Deep/surface Gaming	$X_i(s_1)$ Social loafing Free rider / Sucker Individualistic Leader On/Off role	$X_i(s_1)$ With me Central Isolated Bridge
	Group Model (π_2)		$X_i(s_1, s_2, s_3, \dots)$ Undersized/Oversized Cognitive/Emotional conflict Misunderstanding Group think Distributed	$X_i(s_1, s_2, s_3, \dots)$ Cluster
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

Withmeness



CHAPTER 9 – Part 1



Joint attention is a proxy

for mutual understanding

Library of States

Plane of Modeling		Plane of Activity π_1	Plane of Activity π_2	Plane of Activity π_3
	Individual Model (π_1)	$X_i(s)$ Active / Passive On leave / Drop / Latecomer Disoriented Linear rigidity Impasse Trapped Over/Under generalization Deep/surface Gaming	$X_i(s_1)$ Social loafing Free rider / Sucker Individualistic Leader On/Off role	$X_i(s_1)$ With me Central Isolated Bridge
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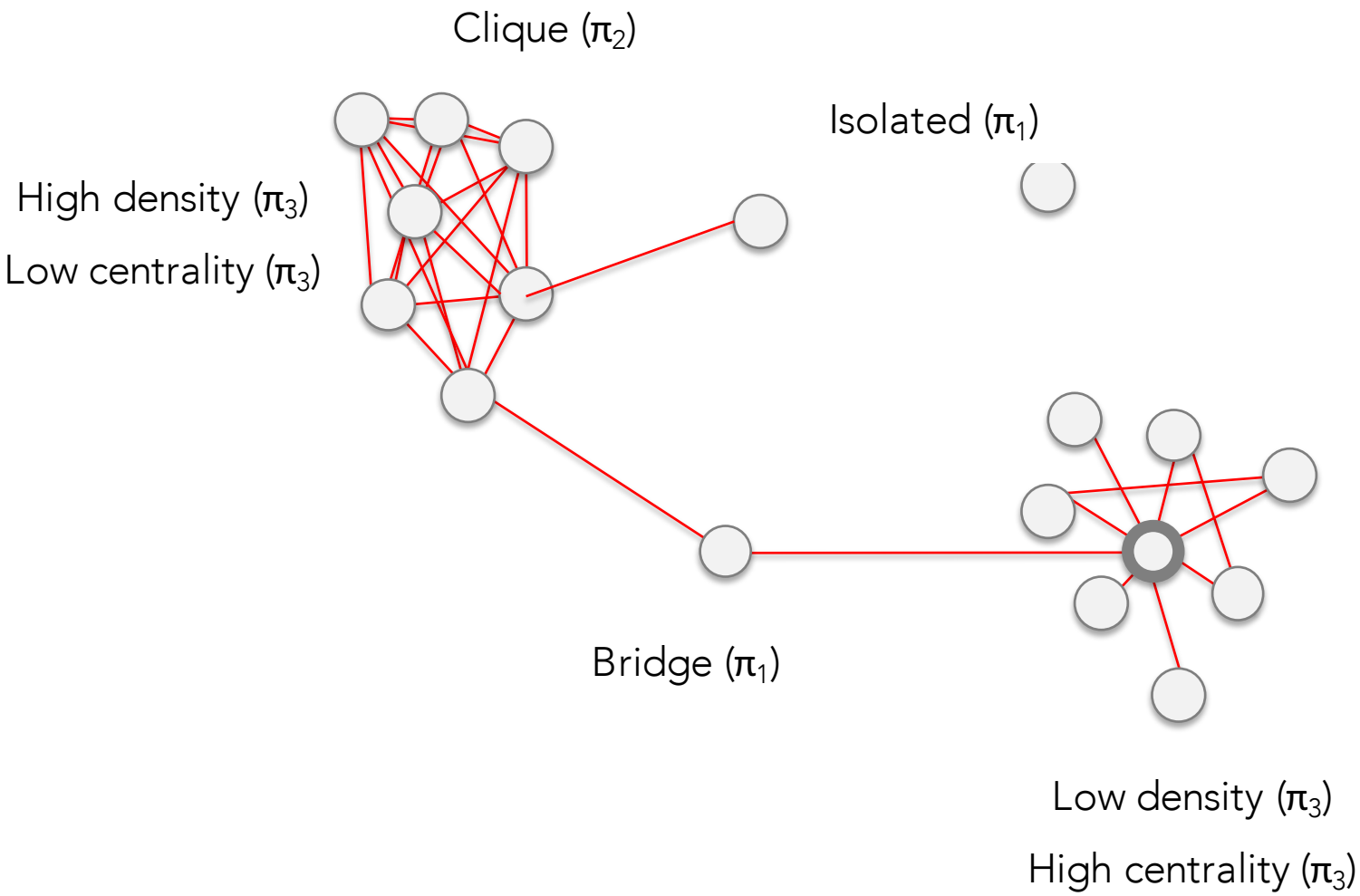
	Class Model (π_3)			$X_i(S)$ Good/Bad spirit Slow Split

Social Network Analysis


Clique (π_2)
Isolated (π_1)
High density (π_3)
Low centrality (π_3)
Bridge (π_1)
Low density (π_3)
High centrality (π_3)

« Don’t diagnose what you can’t treat »

John A. Self

It is interesting to identify state X, if this information feeds a decision