Robot Learning Simultaneously a Task and How to Interpret Human Instructions

Jonathan Grizou, Manuel Lopes, Pierre-Yves Oudeyer

1. Motivation

2. Problem

3. Solution

4. Results

5. Conclusion

Social Learning in Robotics

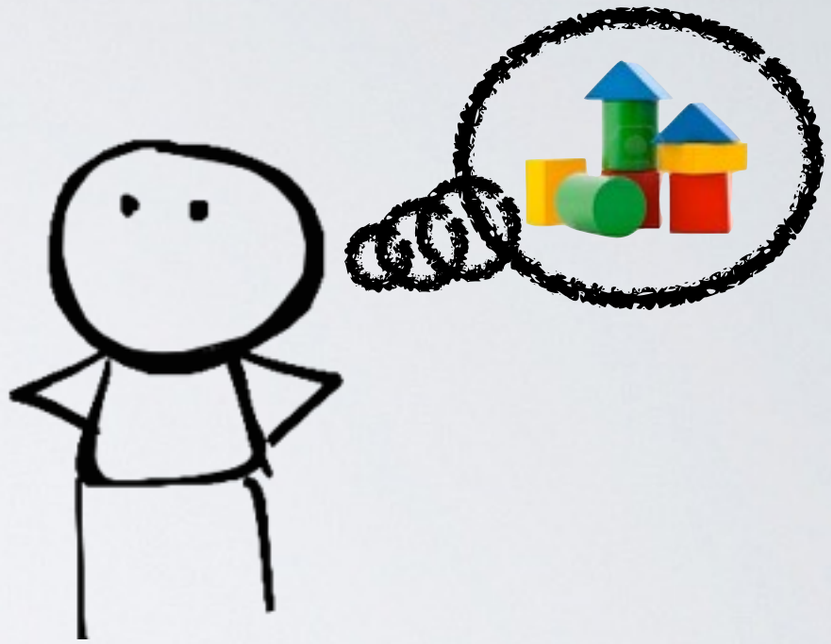
-What: Teach robots new skills.

-How:

1) Without programming (often not easy, requires an expert)

2) By demonstrating, talking, looking, pointing, directing, advising, rewarding, giving feedback...

In Practice



In Practice

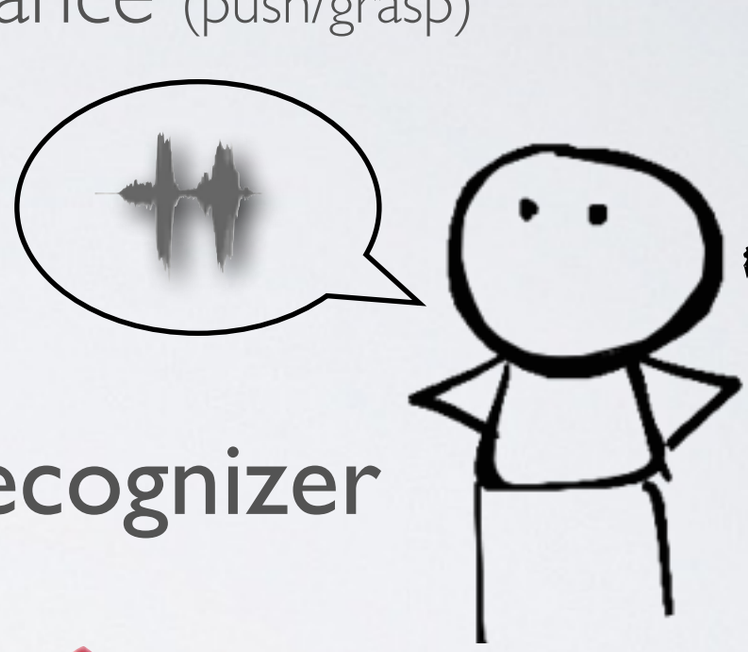
Feedback (correct/wrong)
Guidance (push/grasp)

1. Motivation

In Practice

Feedback (correct/wrong)

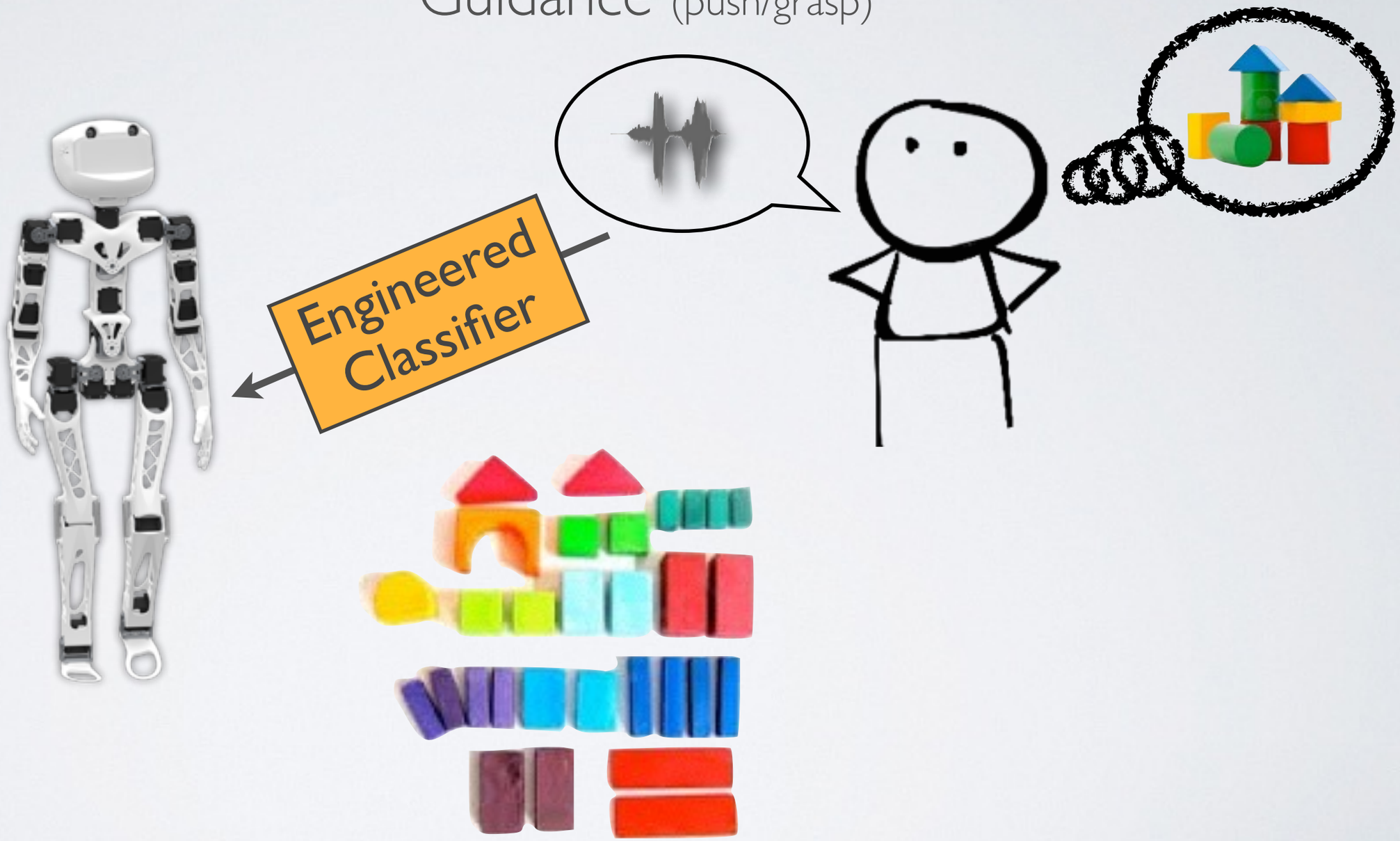
Guidance (push/grasp)



Speech Recognizer

In Practice

Feedback (correct/wrong)
Guidance (push/grasp)



1. Motivation

Different people, with their own preferences, skills, and limitations.

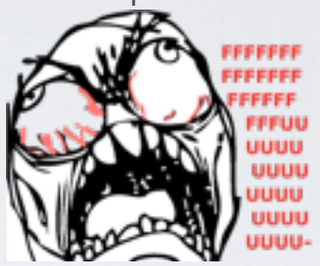
Different Languages

Engineered Classifier

Engineered Classifier

Engineered Classifier

Facial expressions



Engineered Classifier

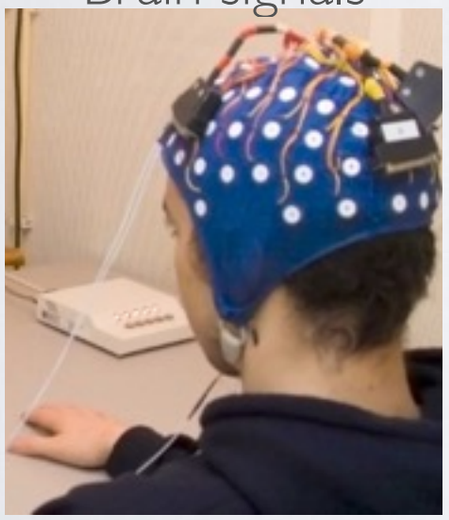
Hand signs

Engineered Classifier

Gestures

Engineered Classifier

Brain signals



Engineered Classifier

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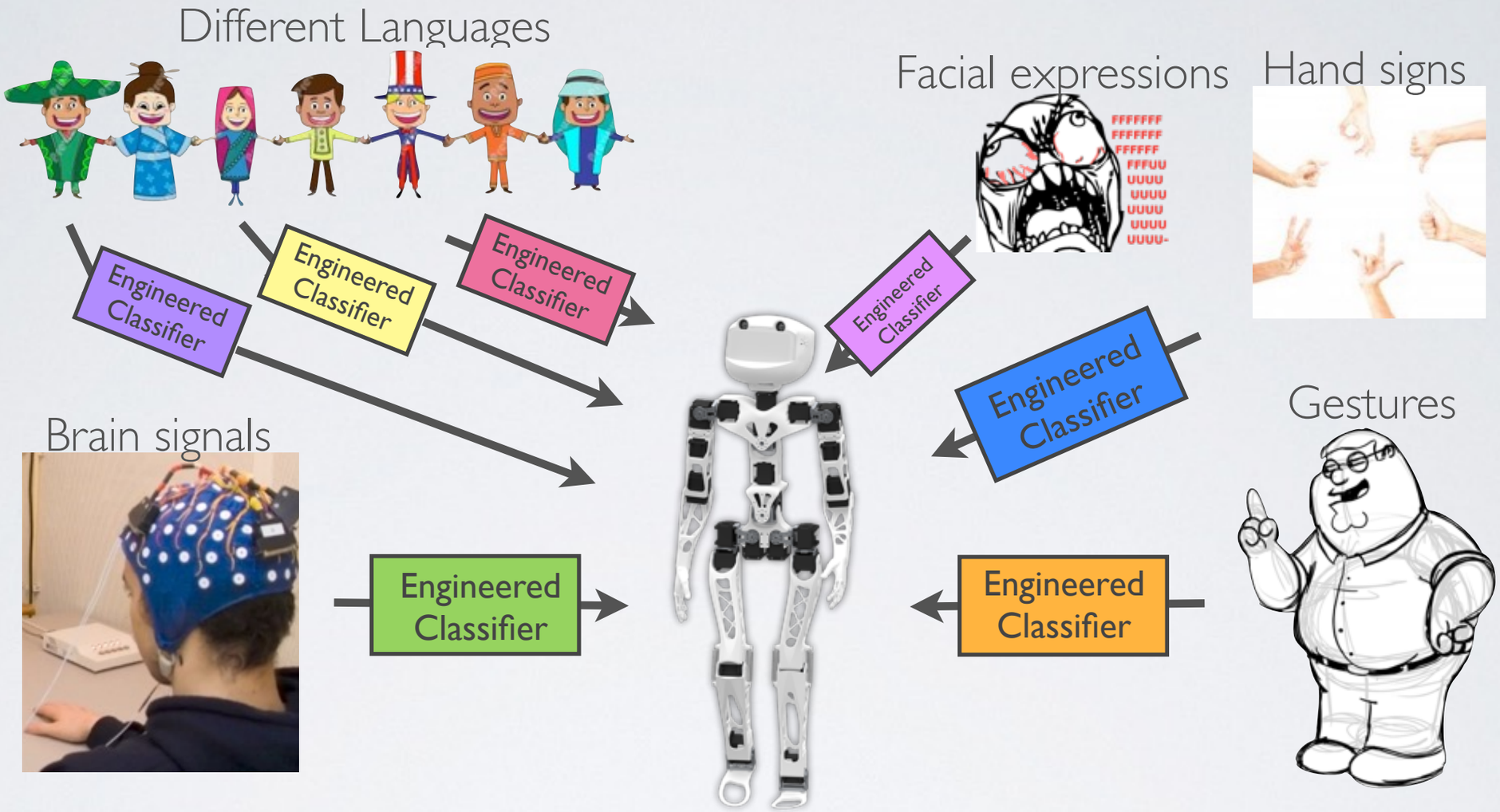
1. Motivation

Different people, with their own preferences, skills, and limitations.



Requires to build a personalized database for each user and modality

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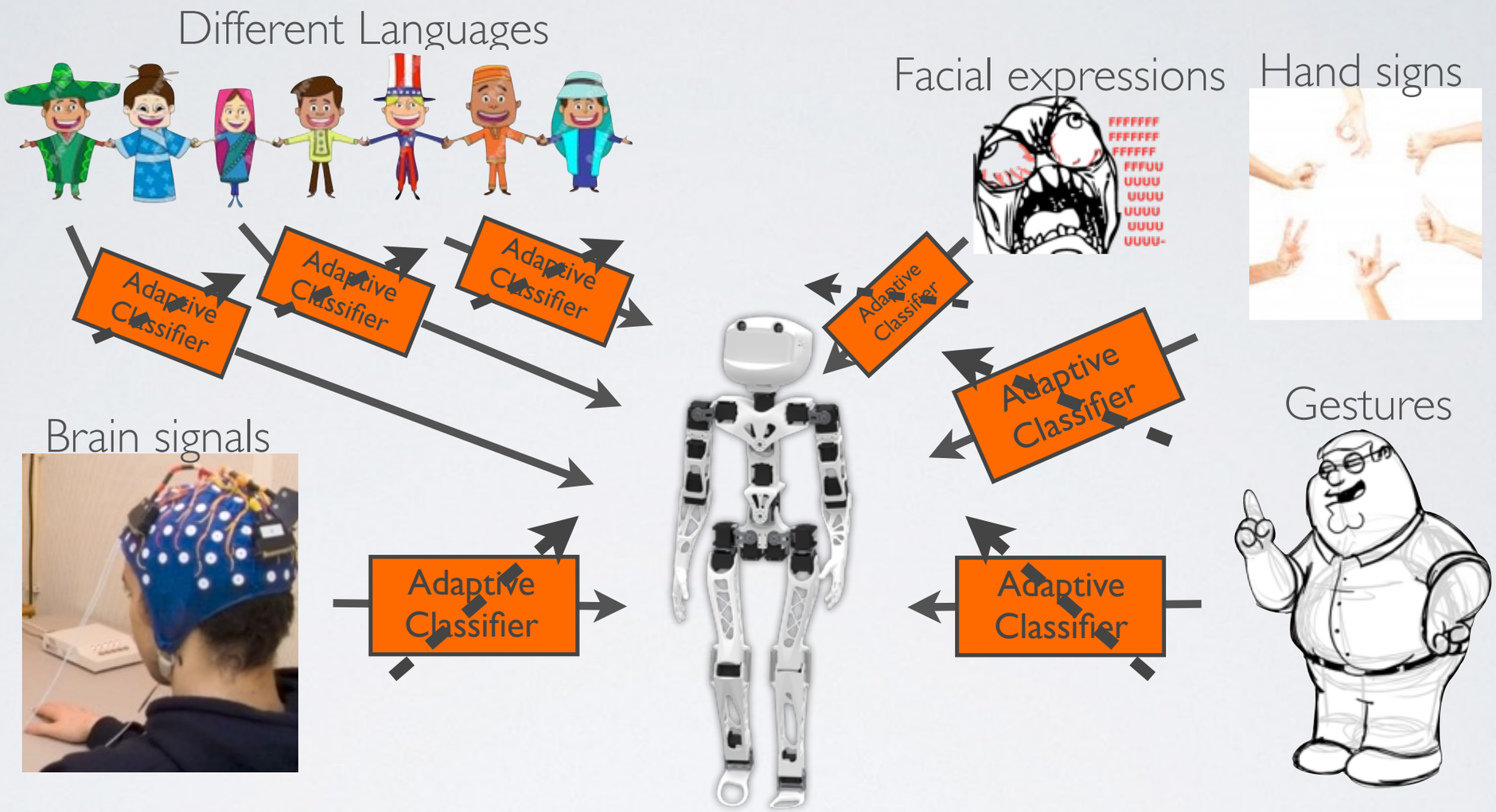

Can we adapt <u>automatically and online</u>
to each user's own preferred teaching signals ?

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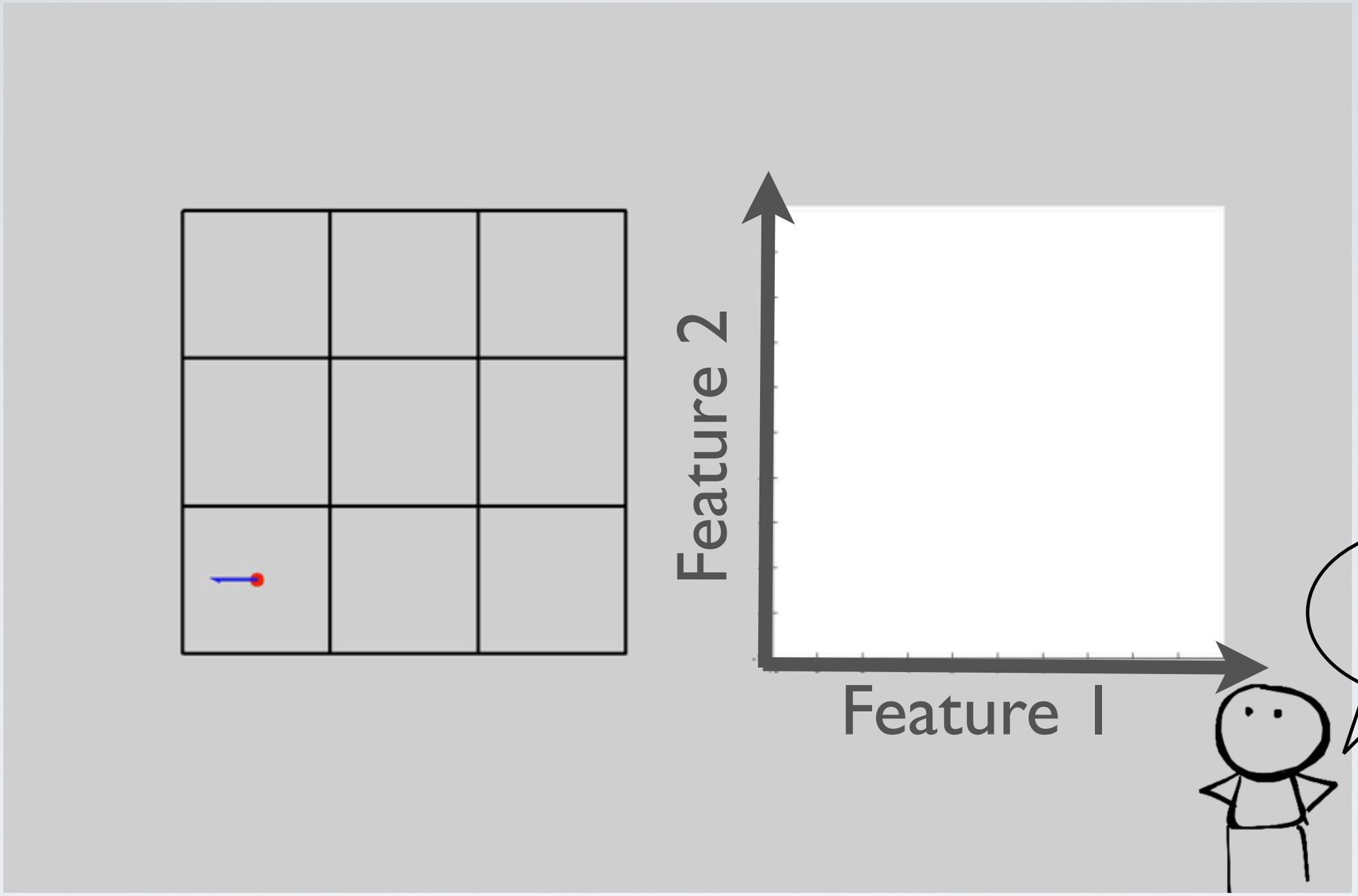
2. Problem



Sequential task

{state, action, instruction} interaction loop

Instruction are feedback or guidance on the robot action

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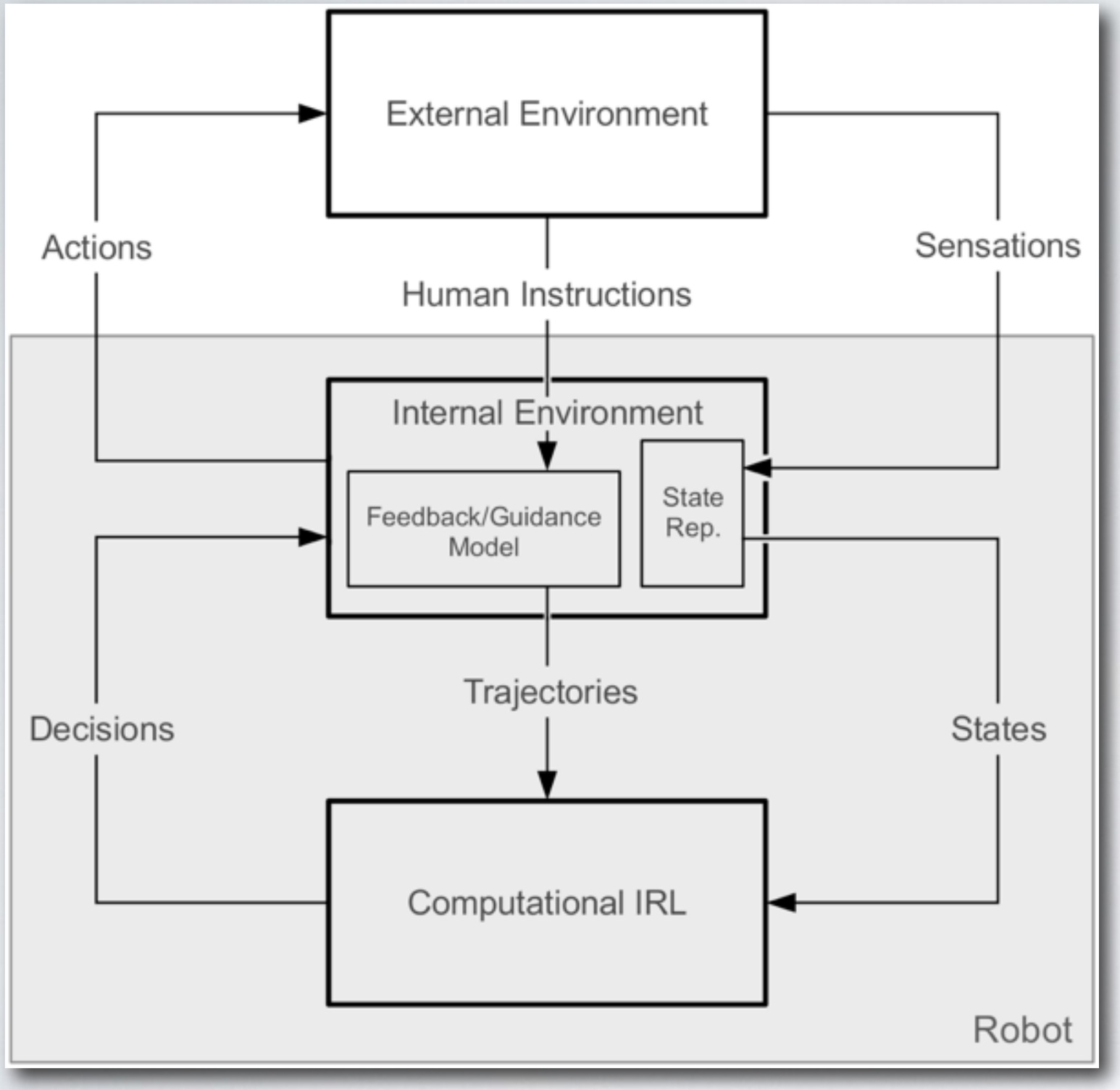

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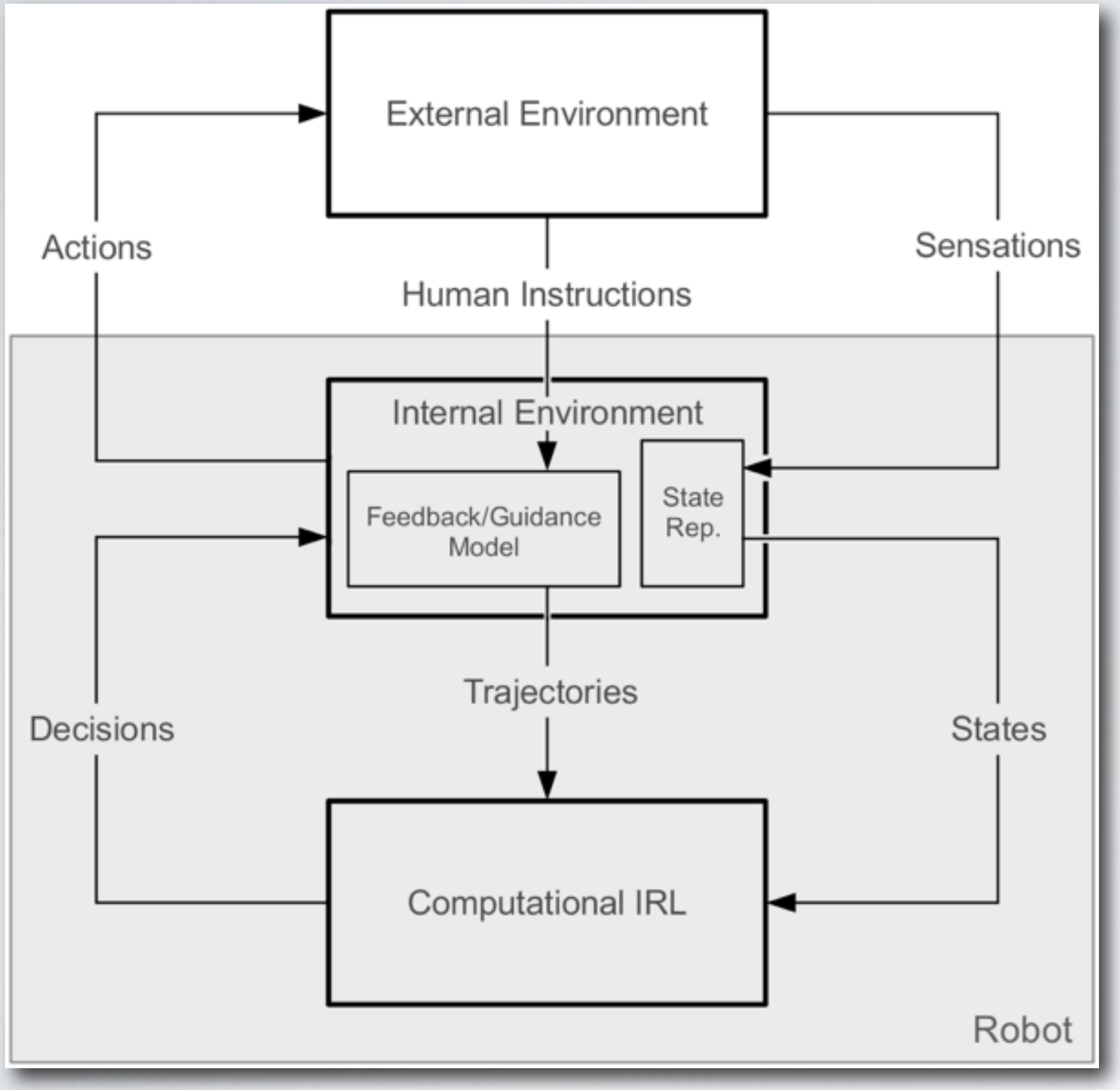

For successful communication the human and the robot need to share a common background.

Usually it is the meaning of the instructions or demonstrations.

In our case, the robot is aware of the set of possible tasks and meanings.

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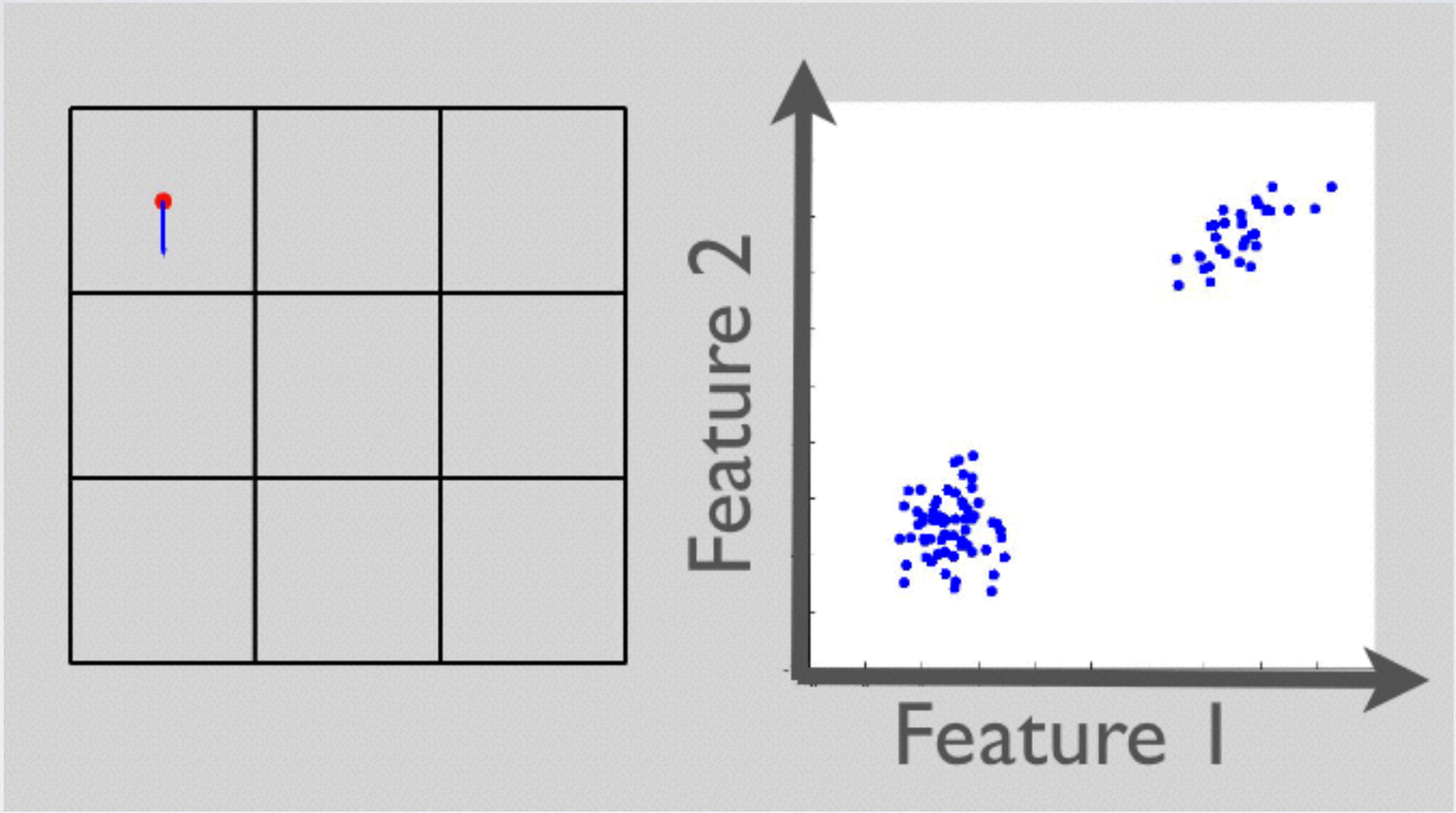
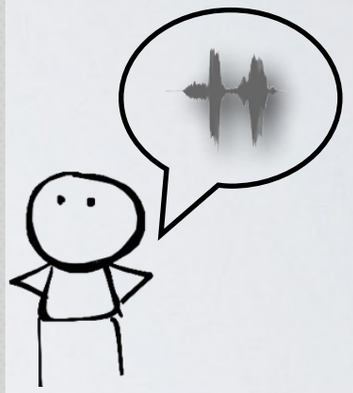
What: Finding the task that best explain the instructions signals





How:

1- assigning hypothetic meanings for each possible task

2- computing the likelihood of the resulting dataset

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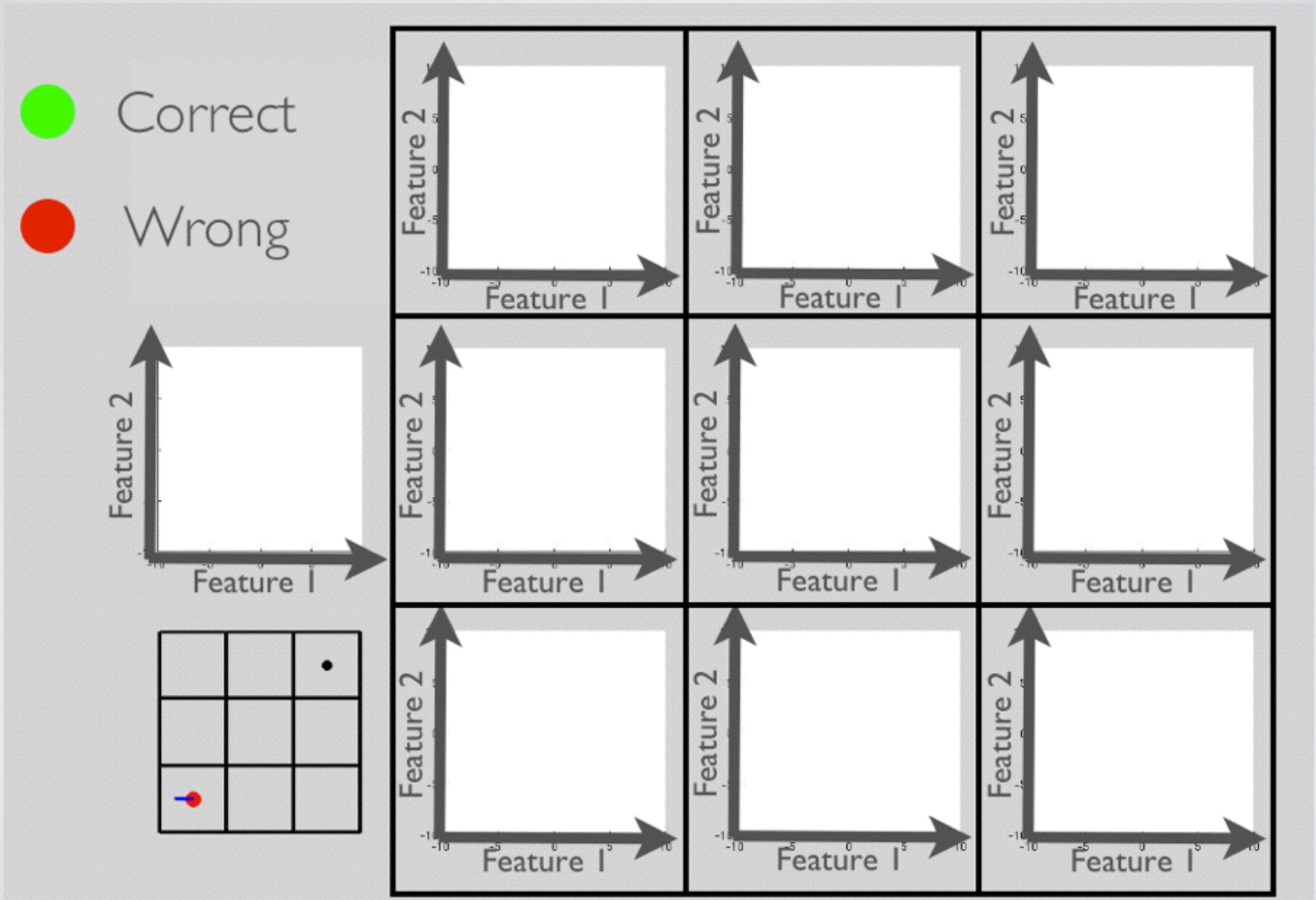

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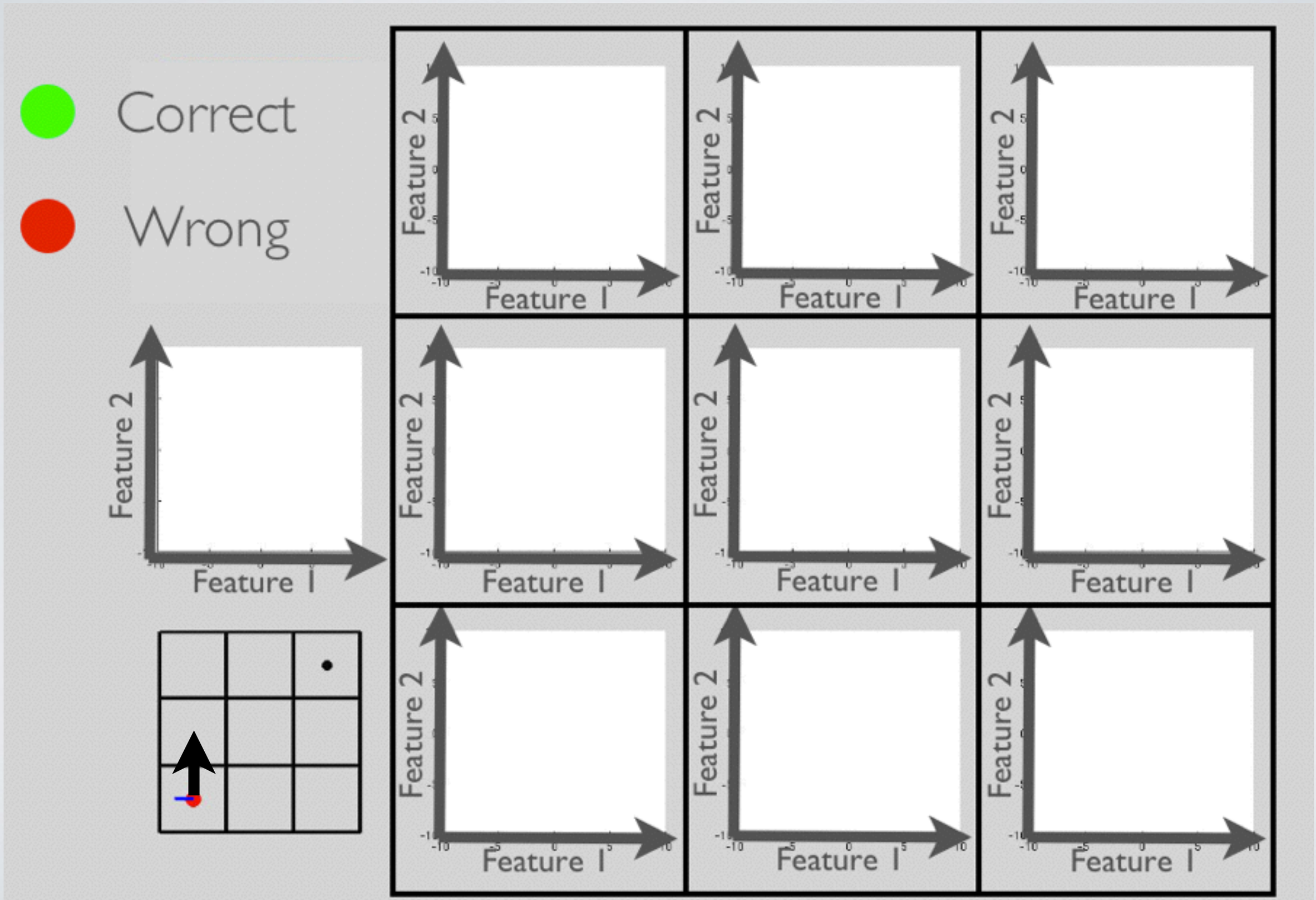

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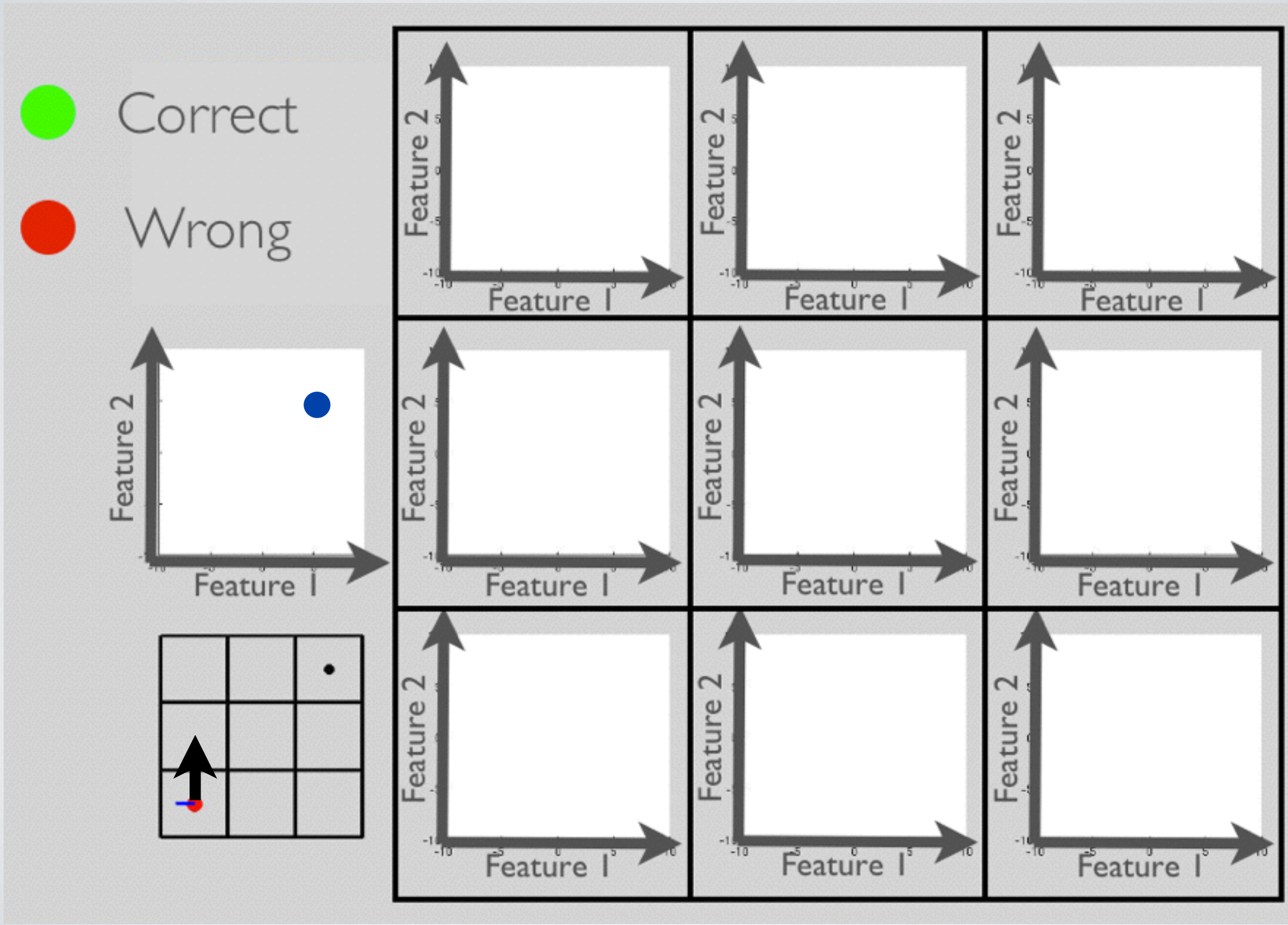

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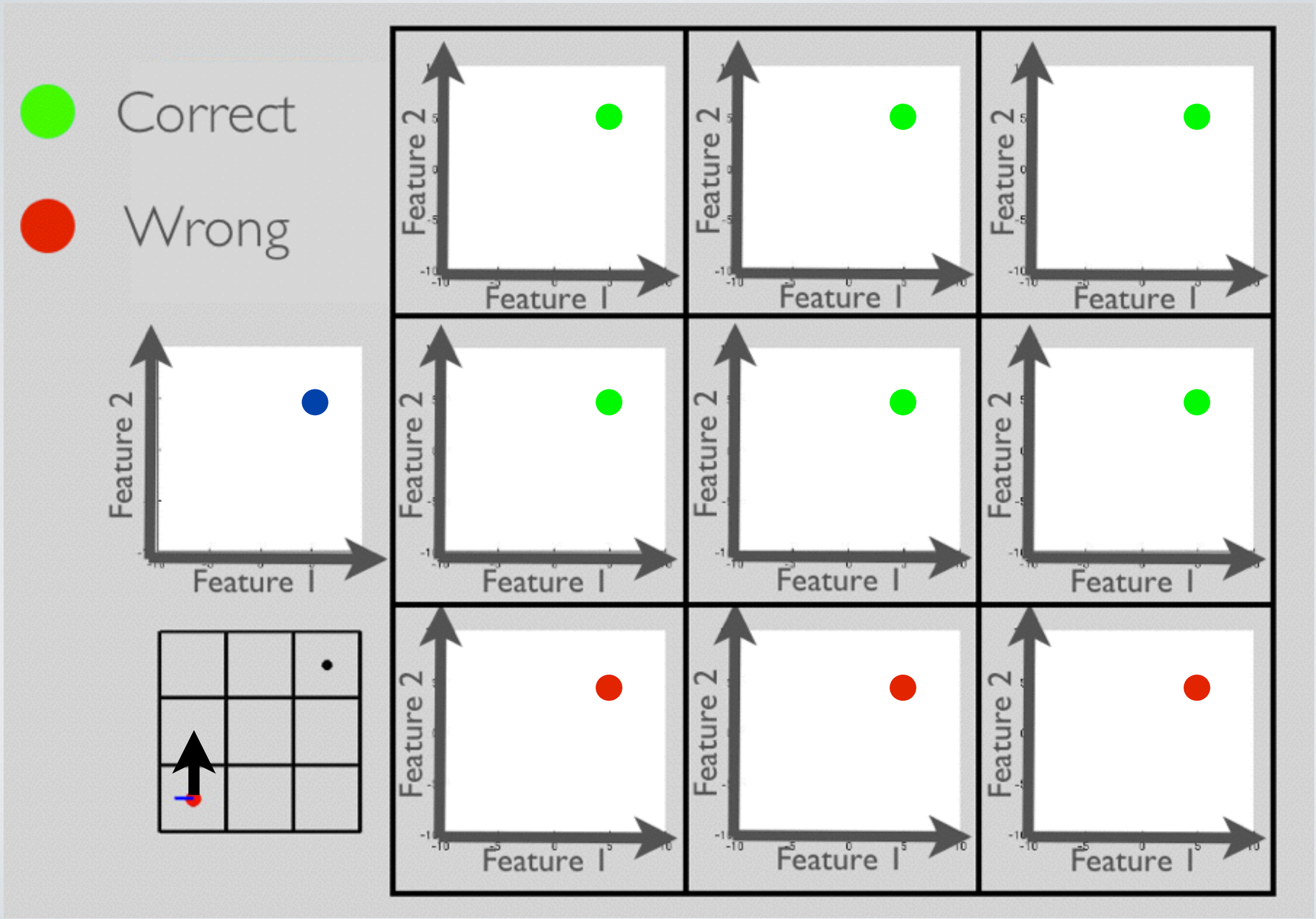

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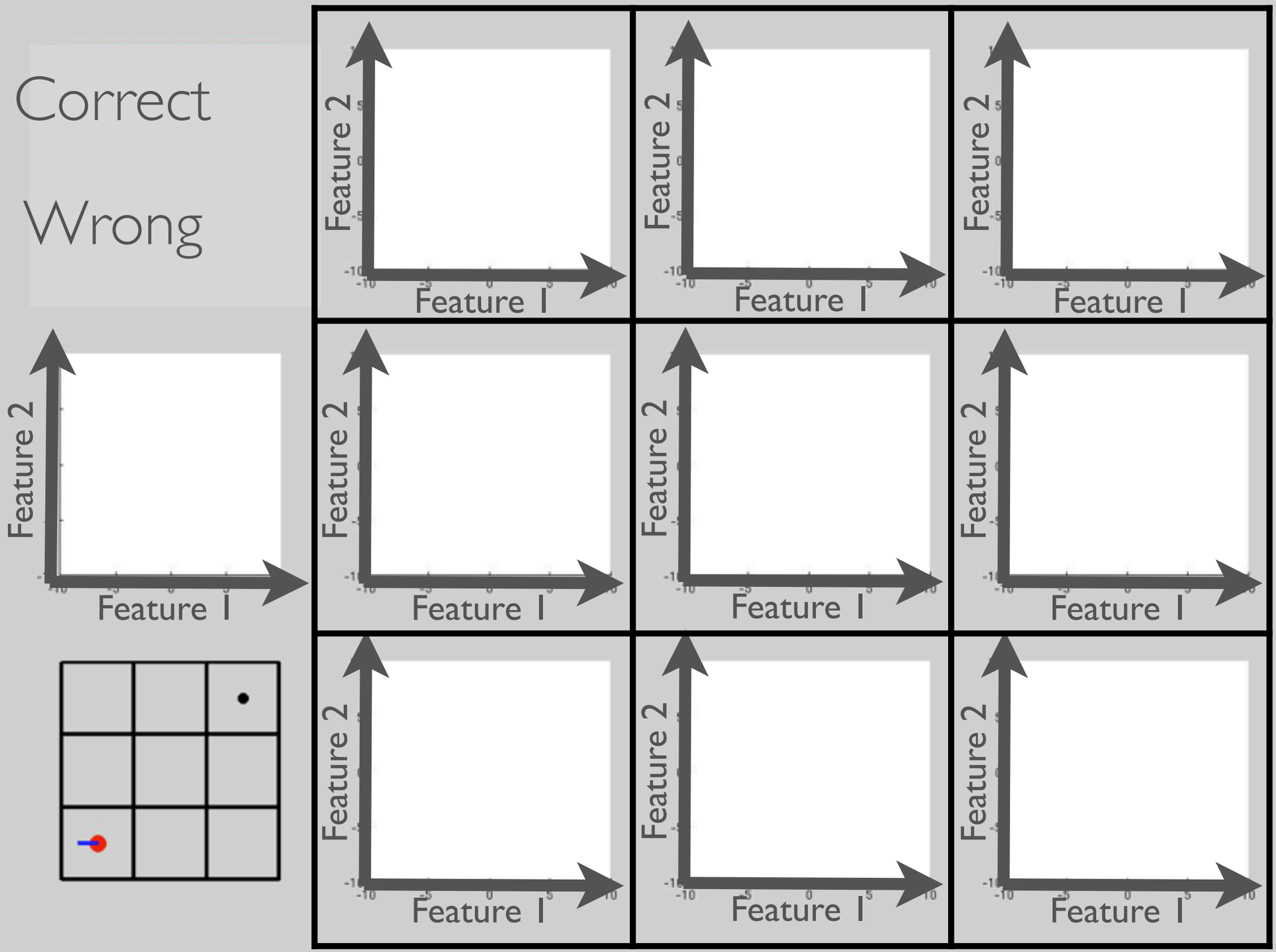
3. Solution

Correct

Wrong



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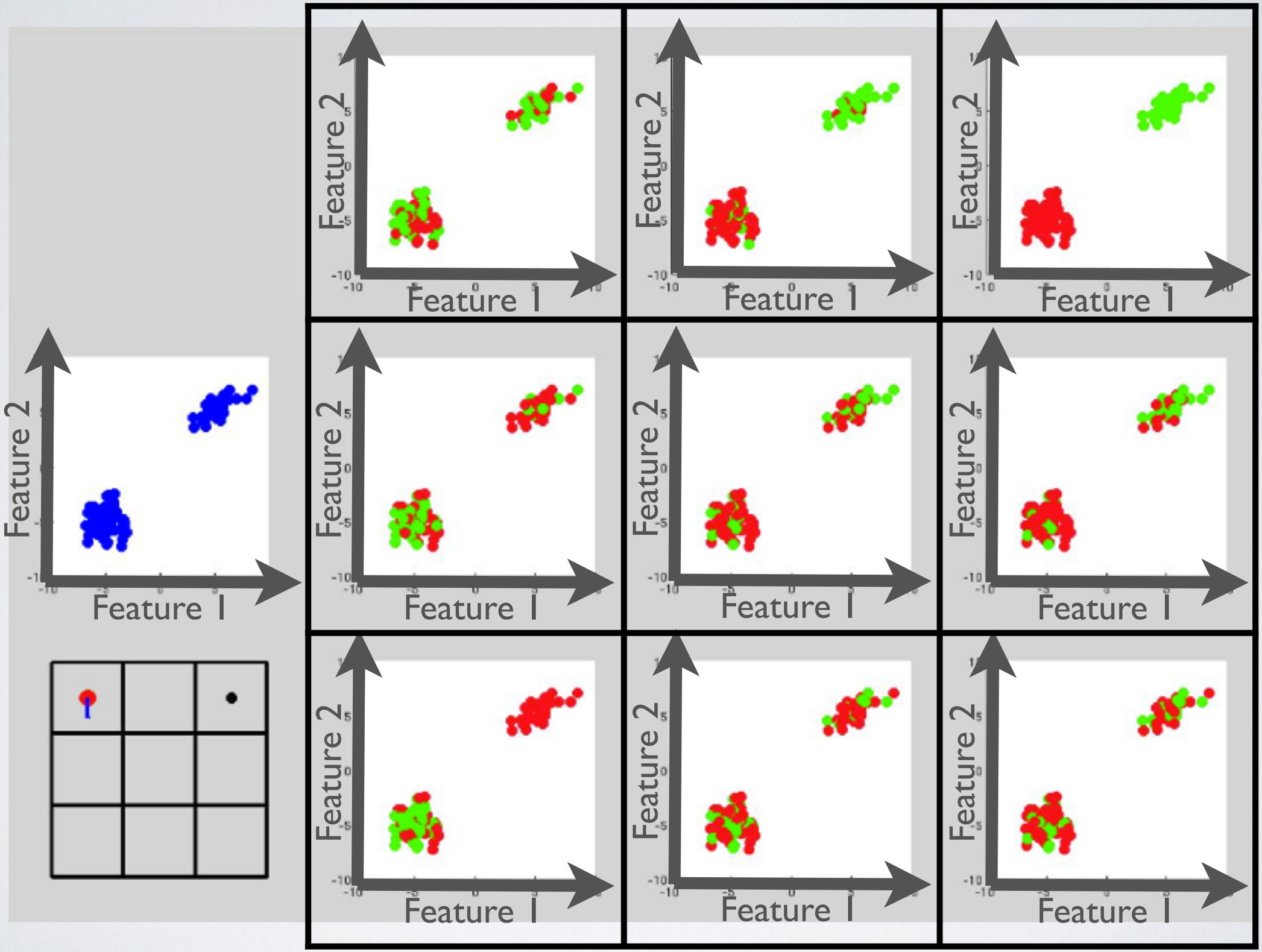

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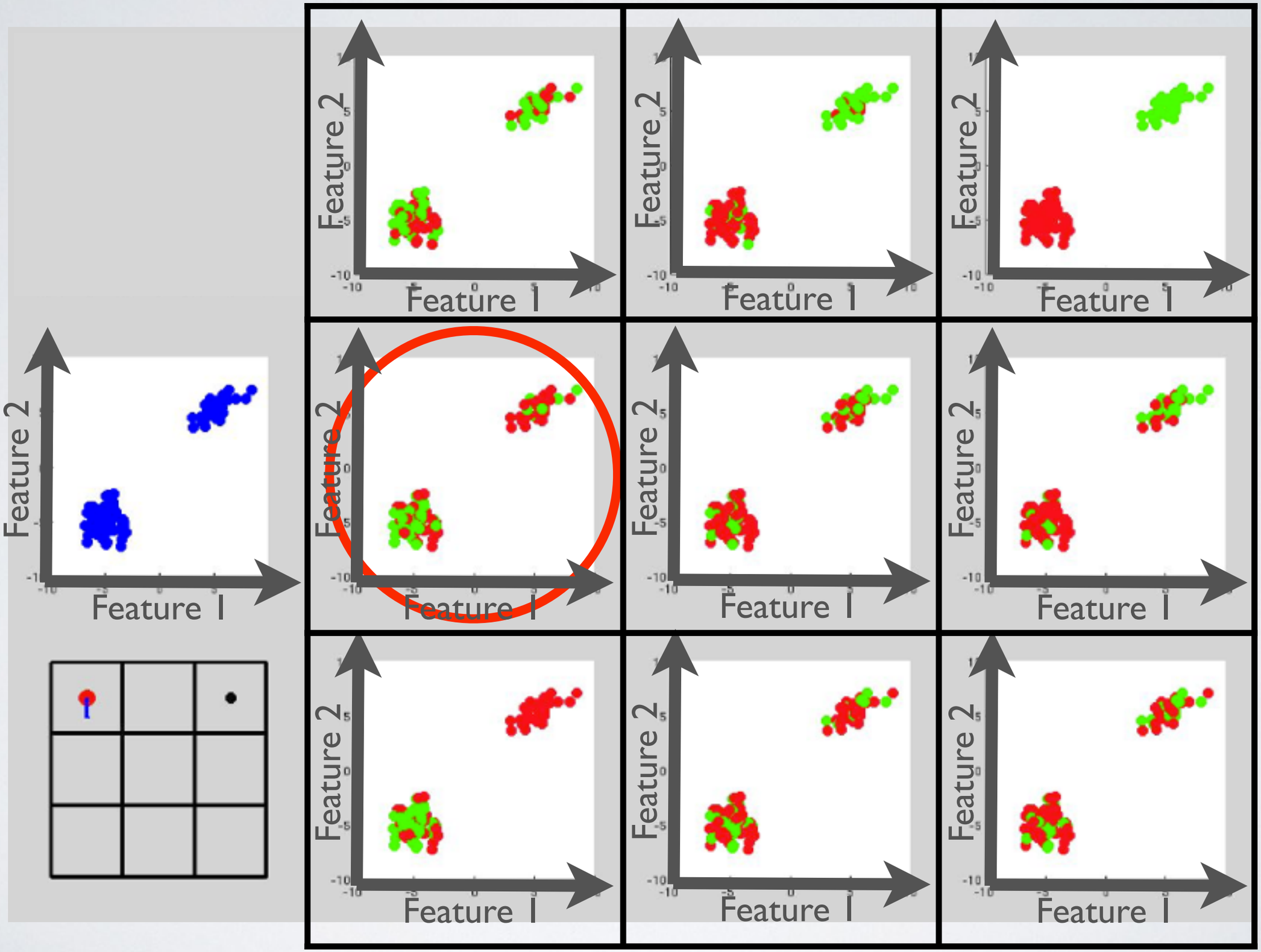

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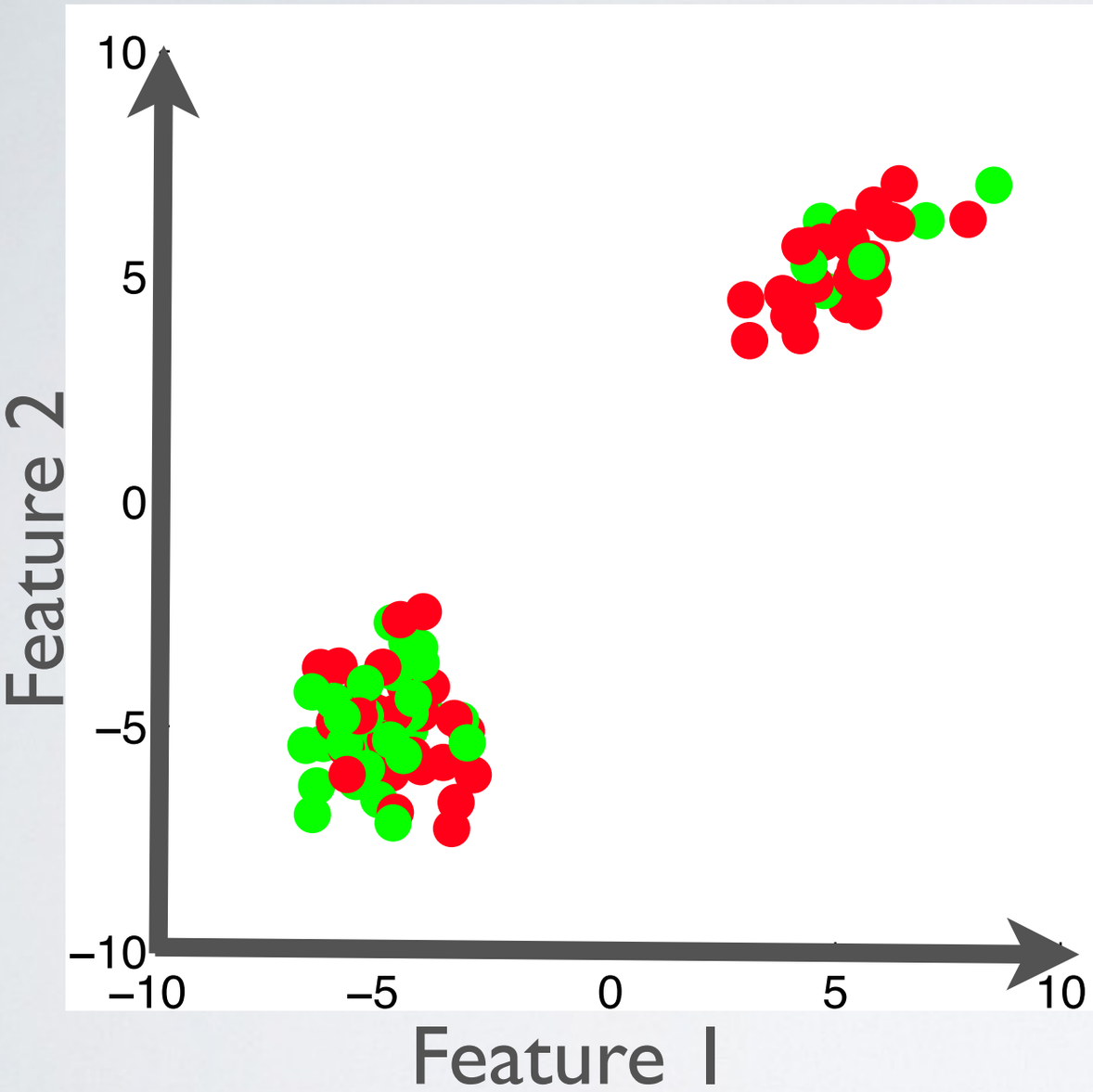

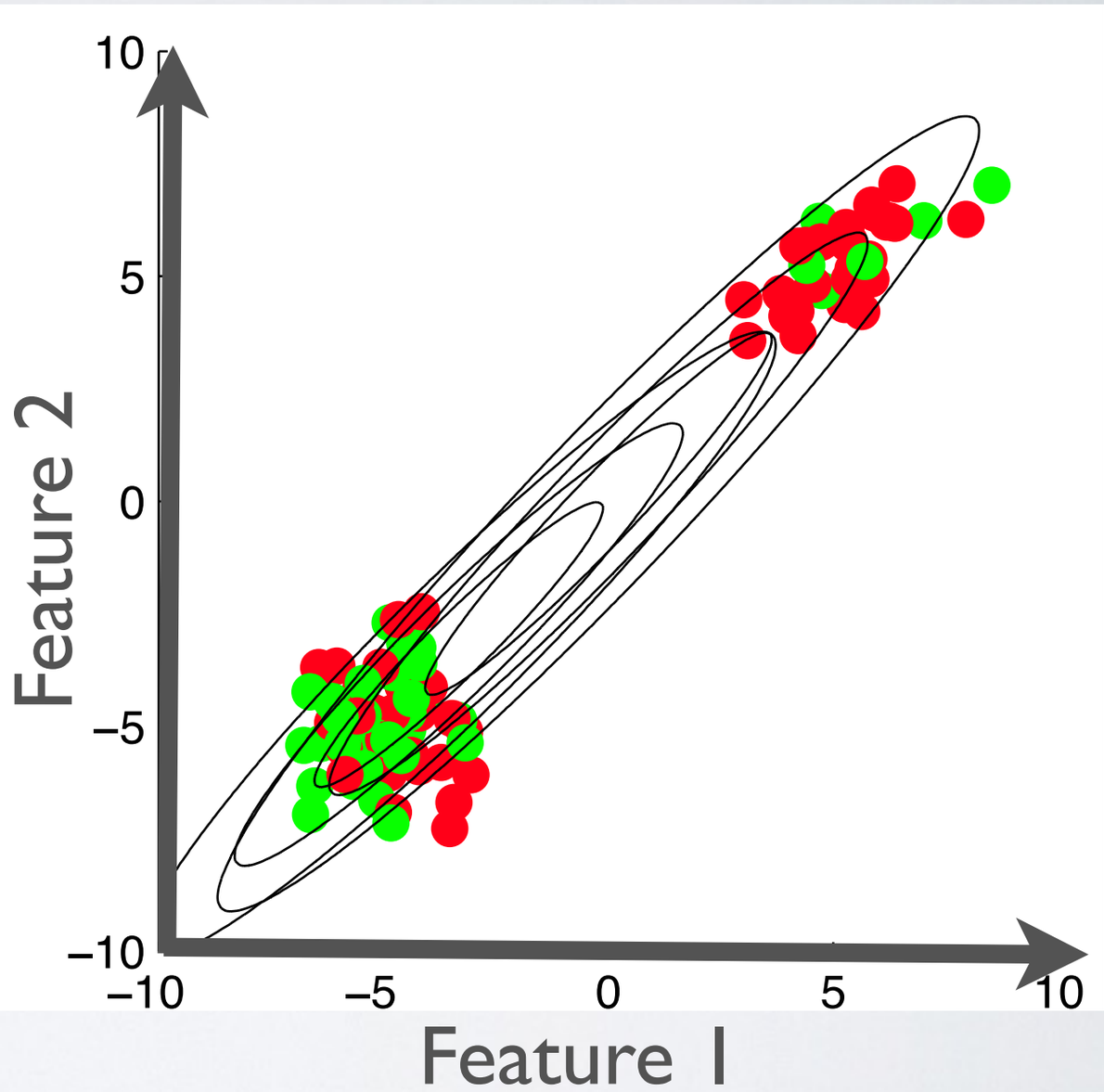

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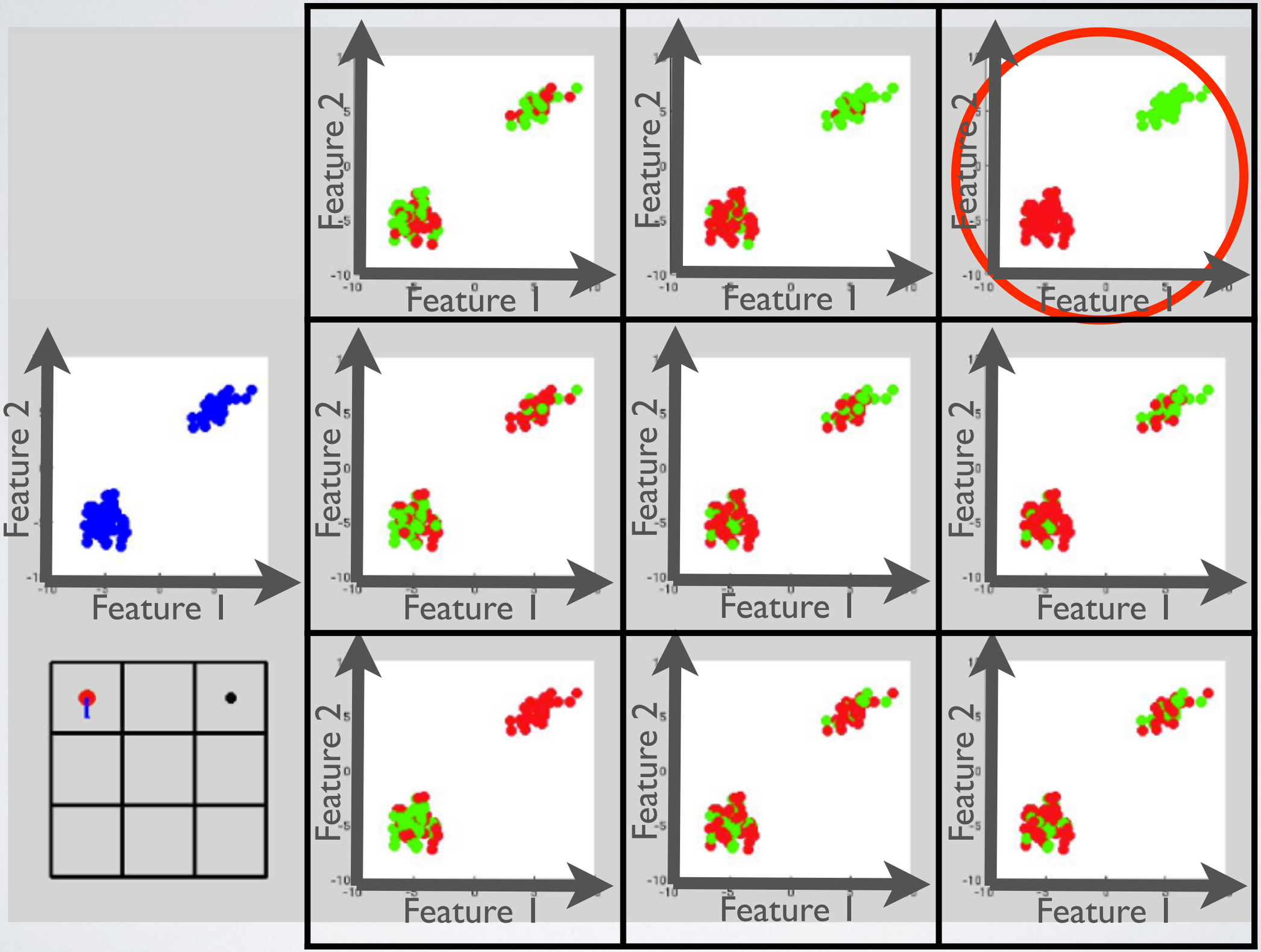

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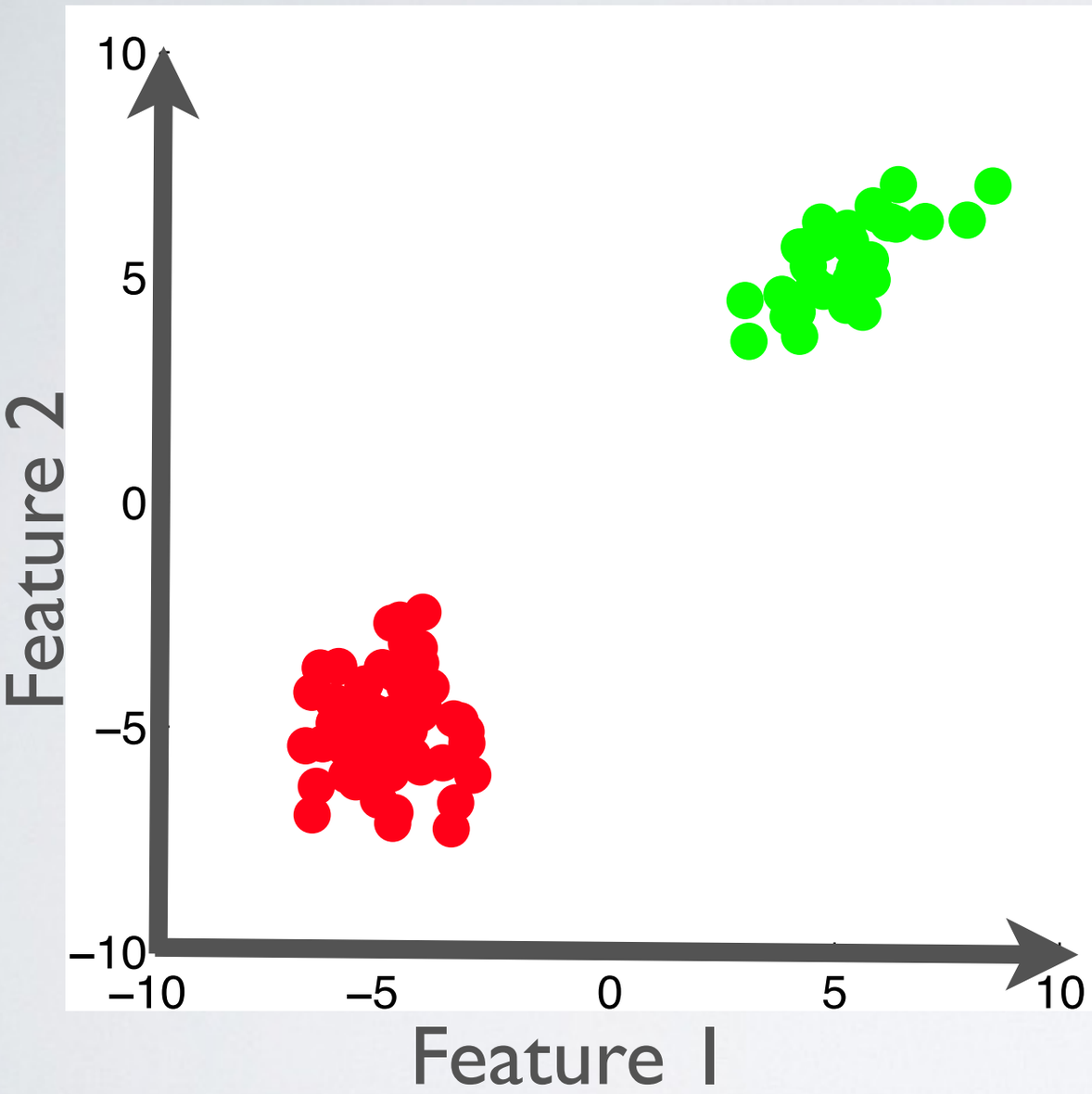

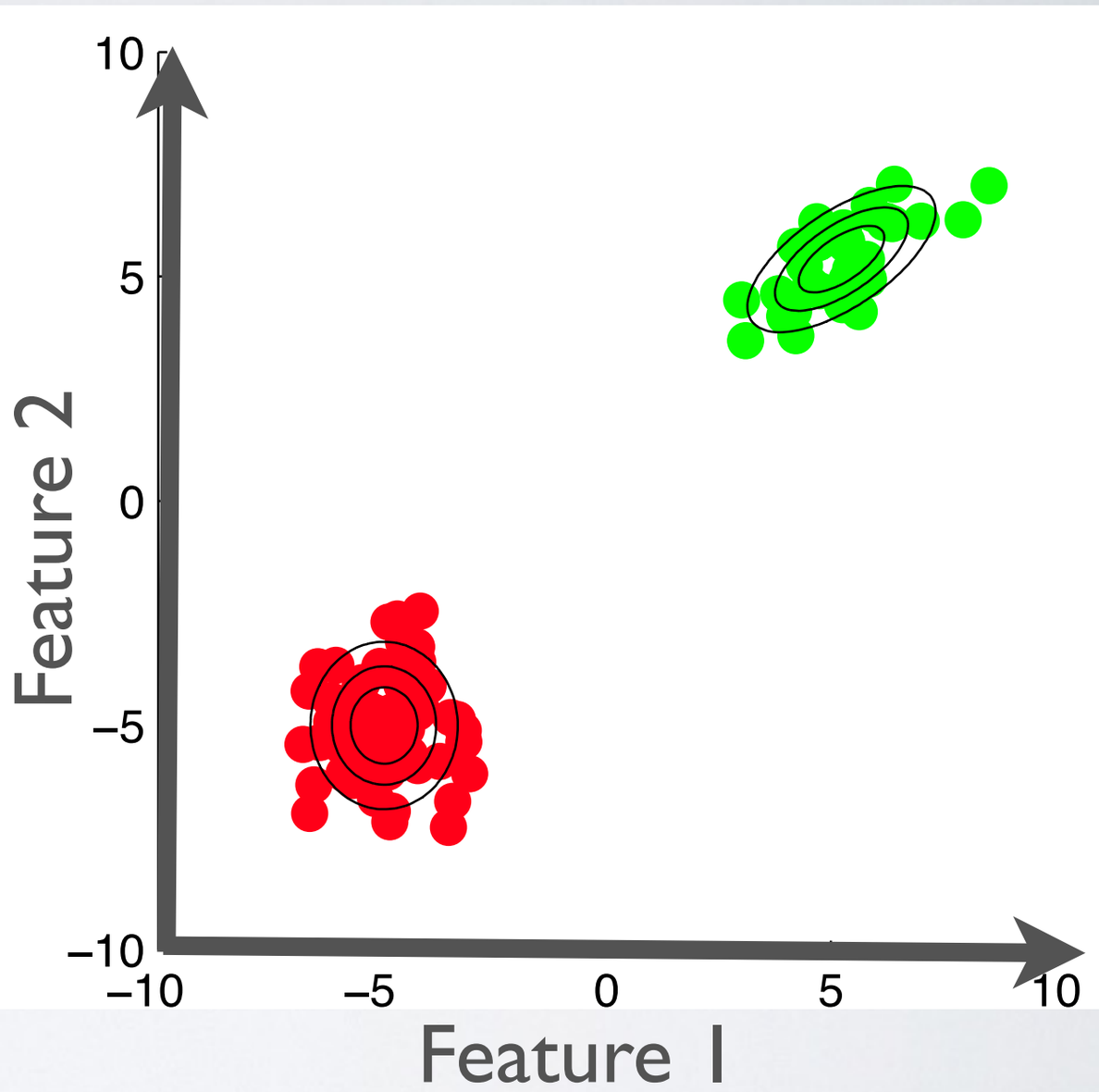

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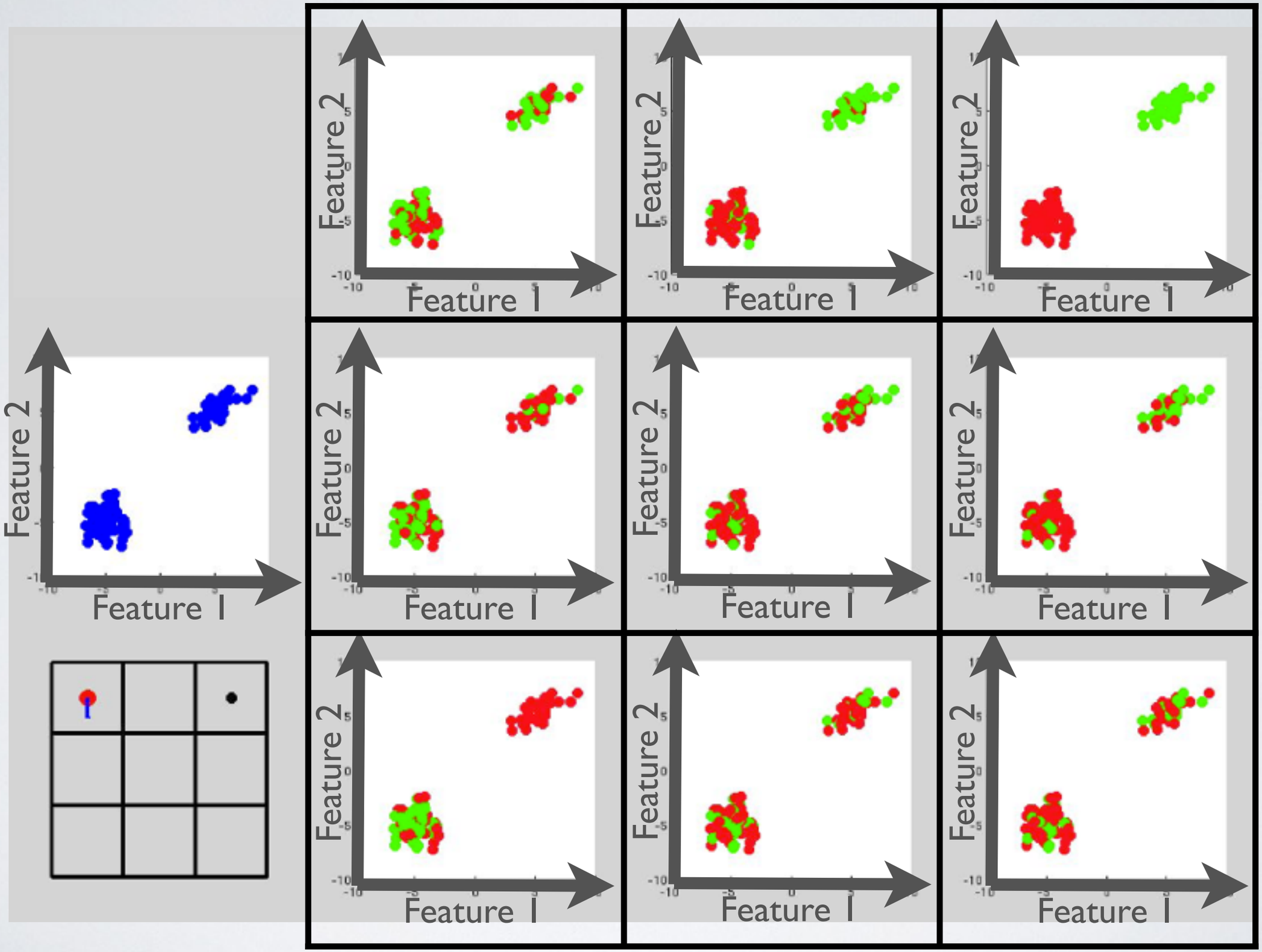

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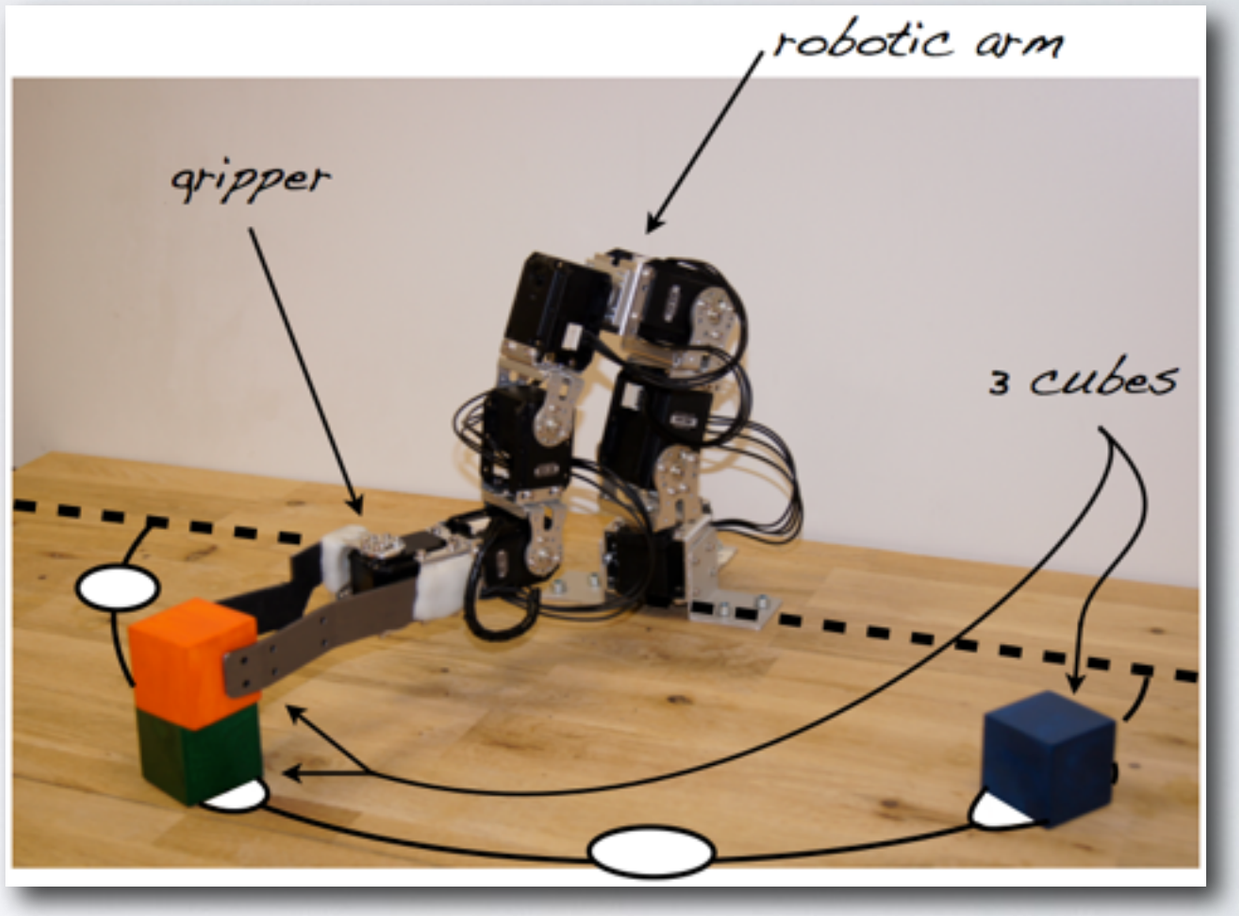
4. Results

MDP : 624 states, 4 actions (left,right,grasp,release)

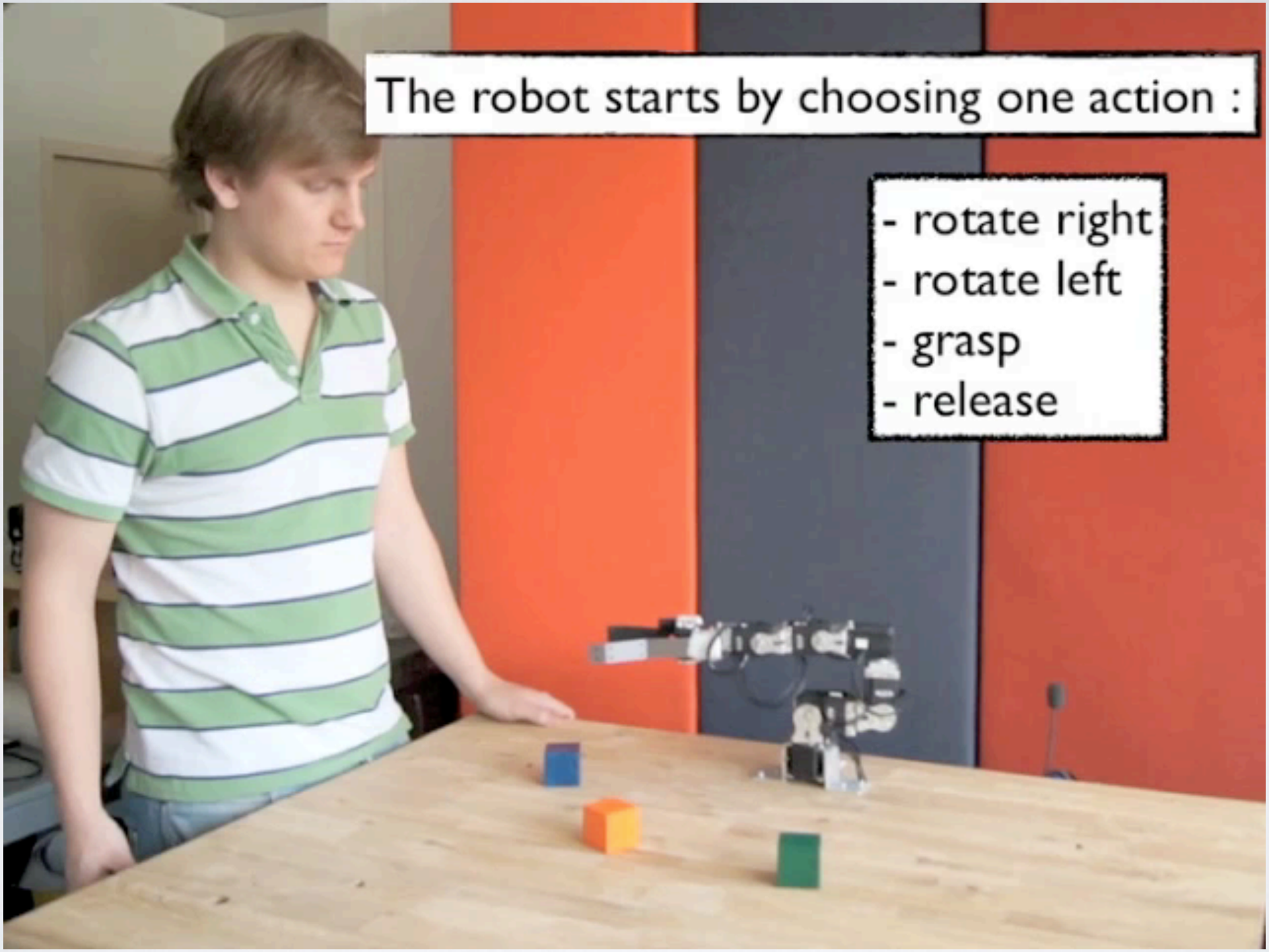
Task hypothesis :
Reach one of the 624 possible configuration



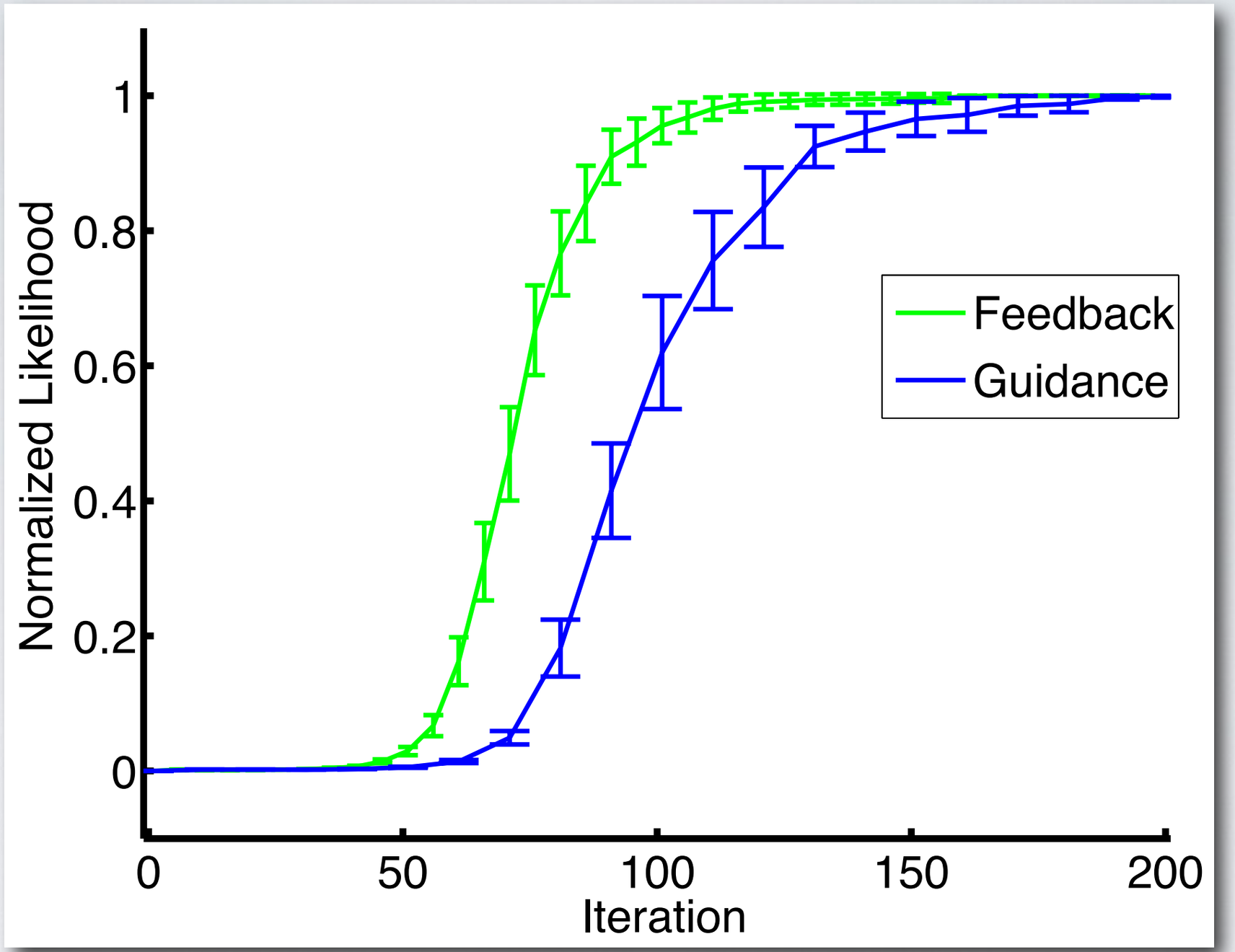
Feedback signals :
Spoken words mapped to a 20 dimensional feature space

Noise :
1- Words never spoken the same way
2- Teachers make mistakes

4. Results


The robot starts by choosing one action :
- rotate right
- rotate left
- grasp
- release

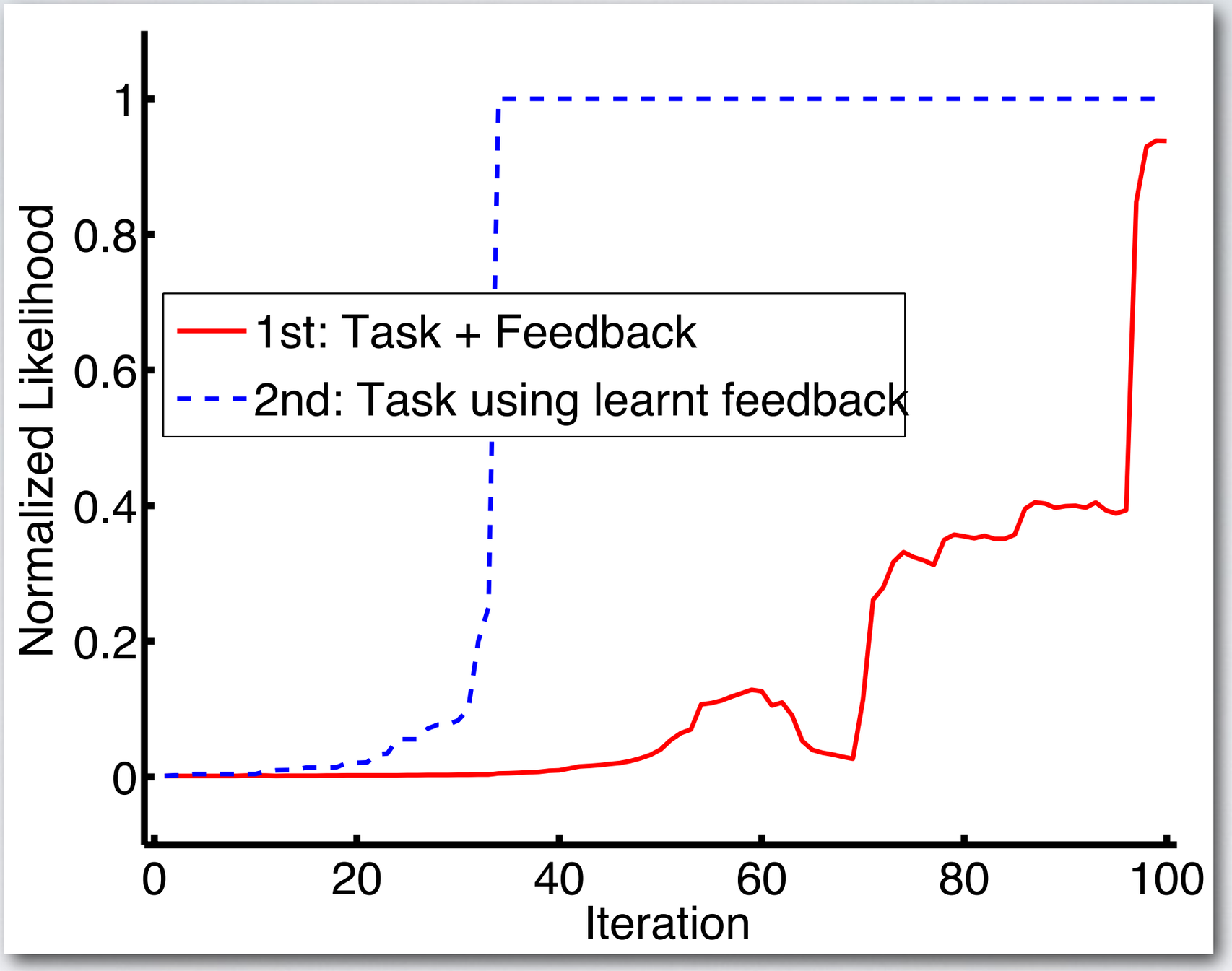
4. Results



Using ε-greedy with ε = 0.1

4. Results

Reuse acquired knowledge



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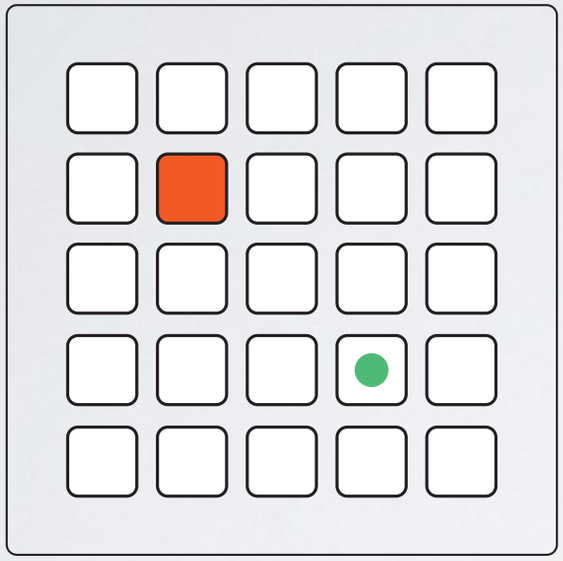
4. Results

We applied this algorithm to a BCI control task.

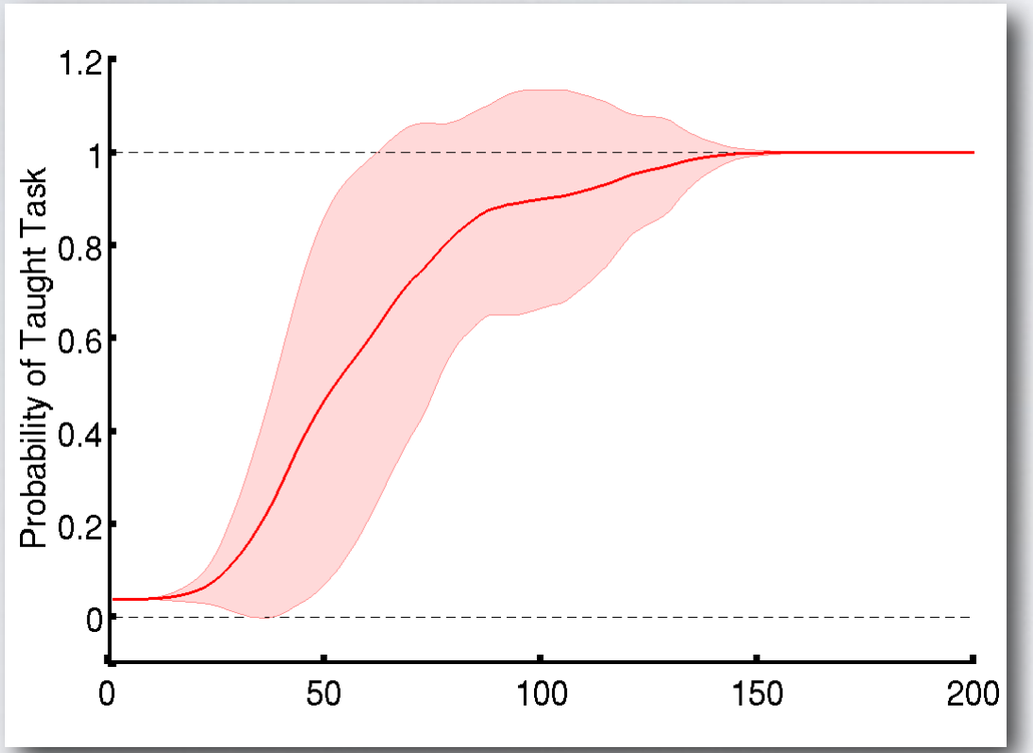
with Iñaki Itturrate and Luis Montesano, Universidad de Zaragoza, Spain

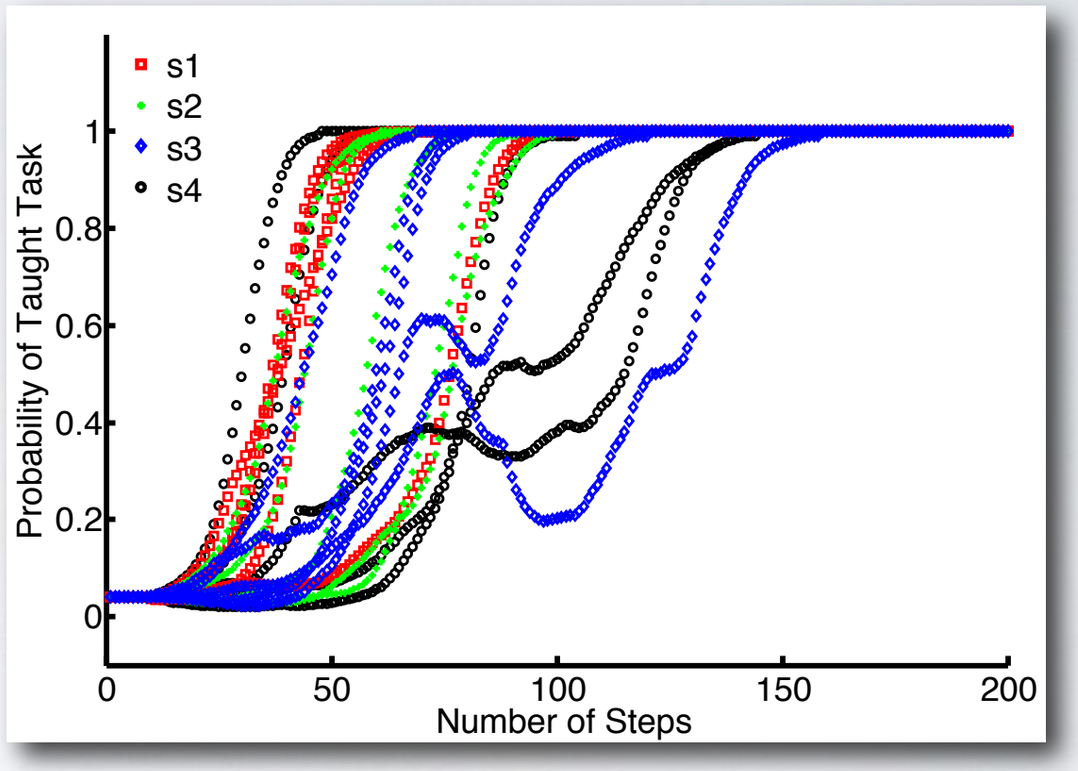


- 34 features, high amount of noise
- 25 possible tasks (5x5 grid world)

4. Results

Online experiments





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Proposed algorithm:

- Learn a task from unlabeled and noisy instructions.
- Reuse acquired knowledge.

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Of interest:

- Standard classification technics.
- Signal expressed as feature vector in R^N (can encode facial expression, gesture, speech, EEG ...).

5. Conclusion

Proposed algorithm:

- Learn a task from unlabeled and noisy instructions.
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Limitation:

- Synchronous and repetitive
- Users and robots should share the same meaning model

Thank you for your attention

Questions ?

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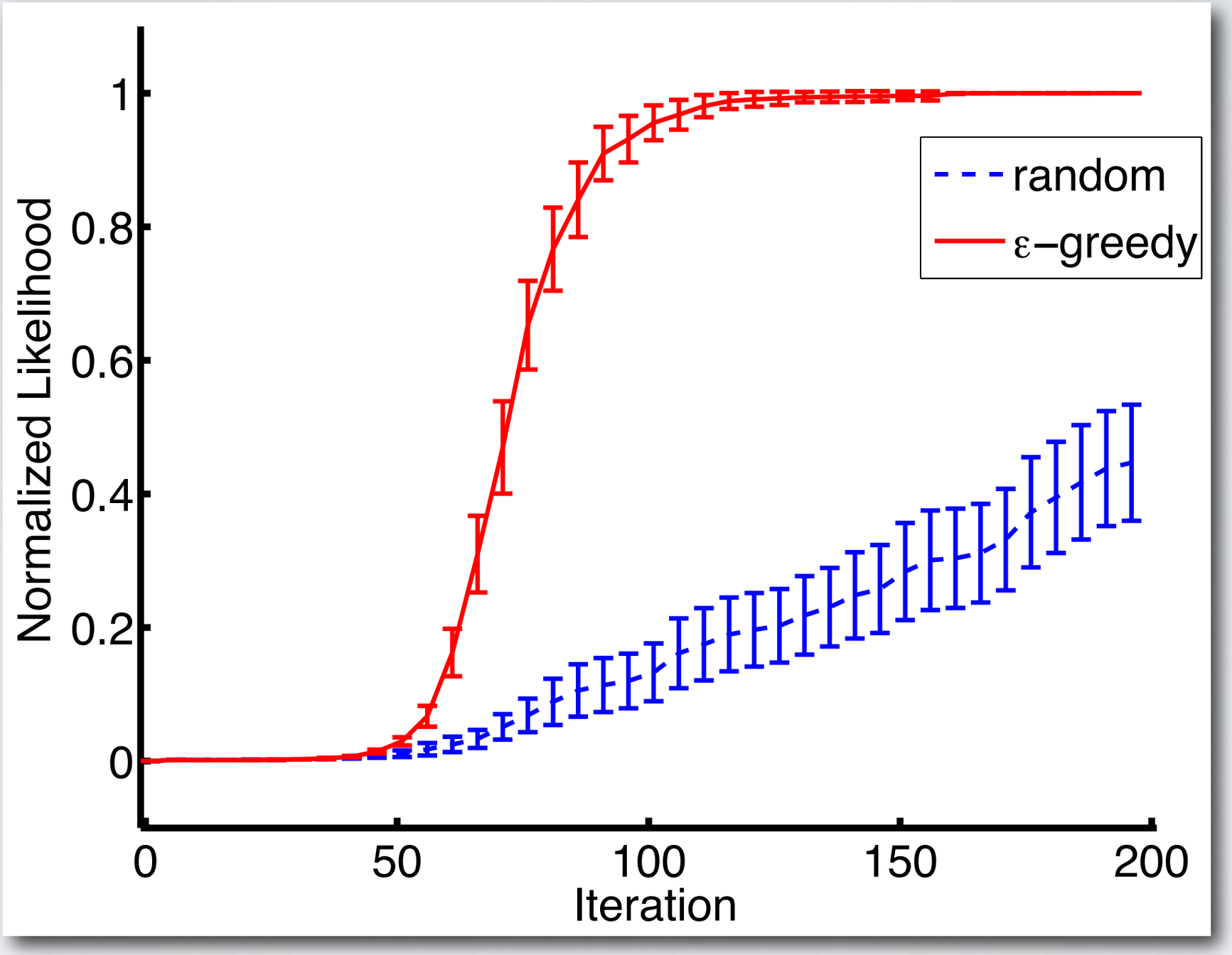

Can the robot act in order to improve the learning time?