Continuous Collaborations

A Case Study on the Development of an Adaptive Cyber-Physical System

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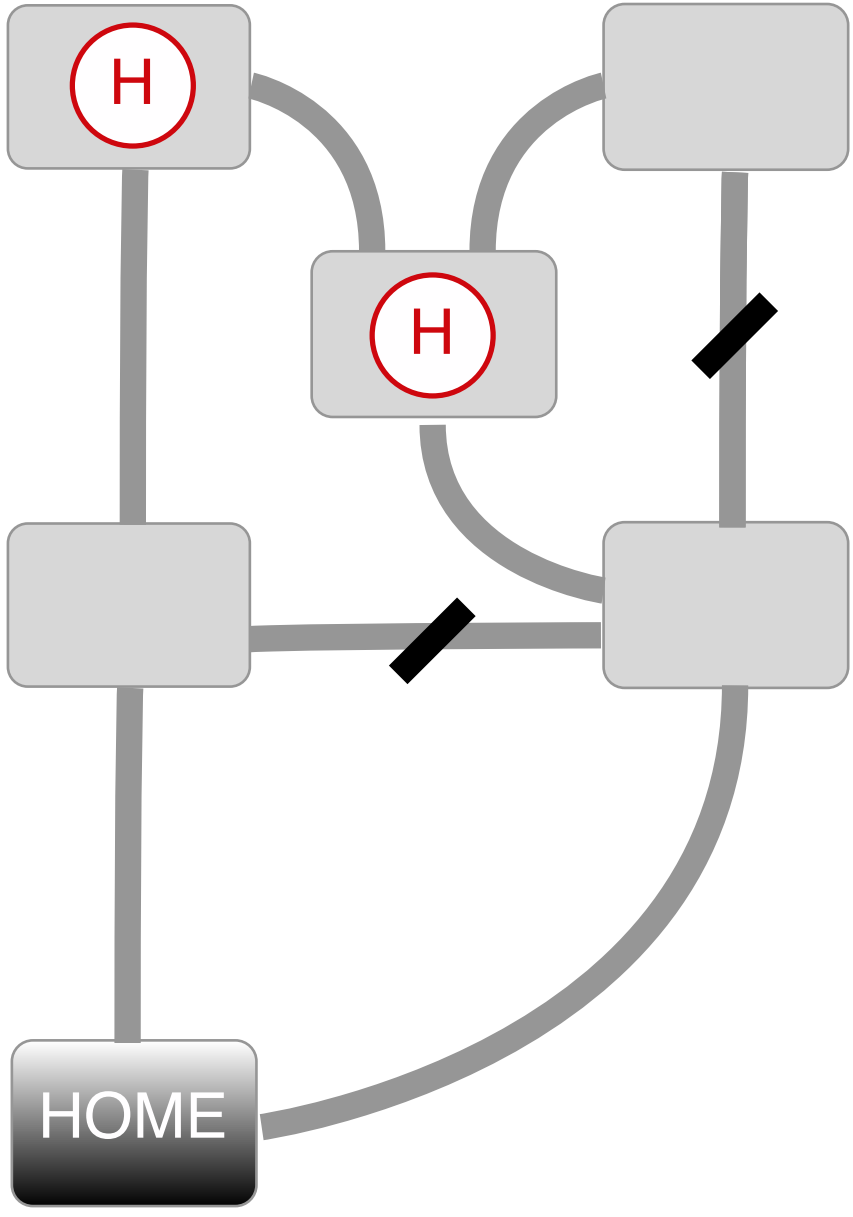
The Robot Rescue Force

Scenario

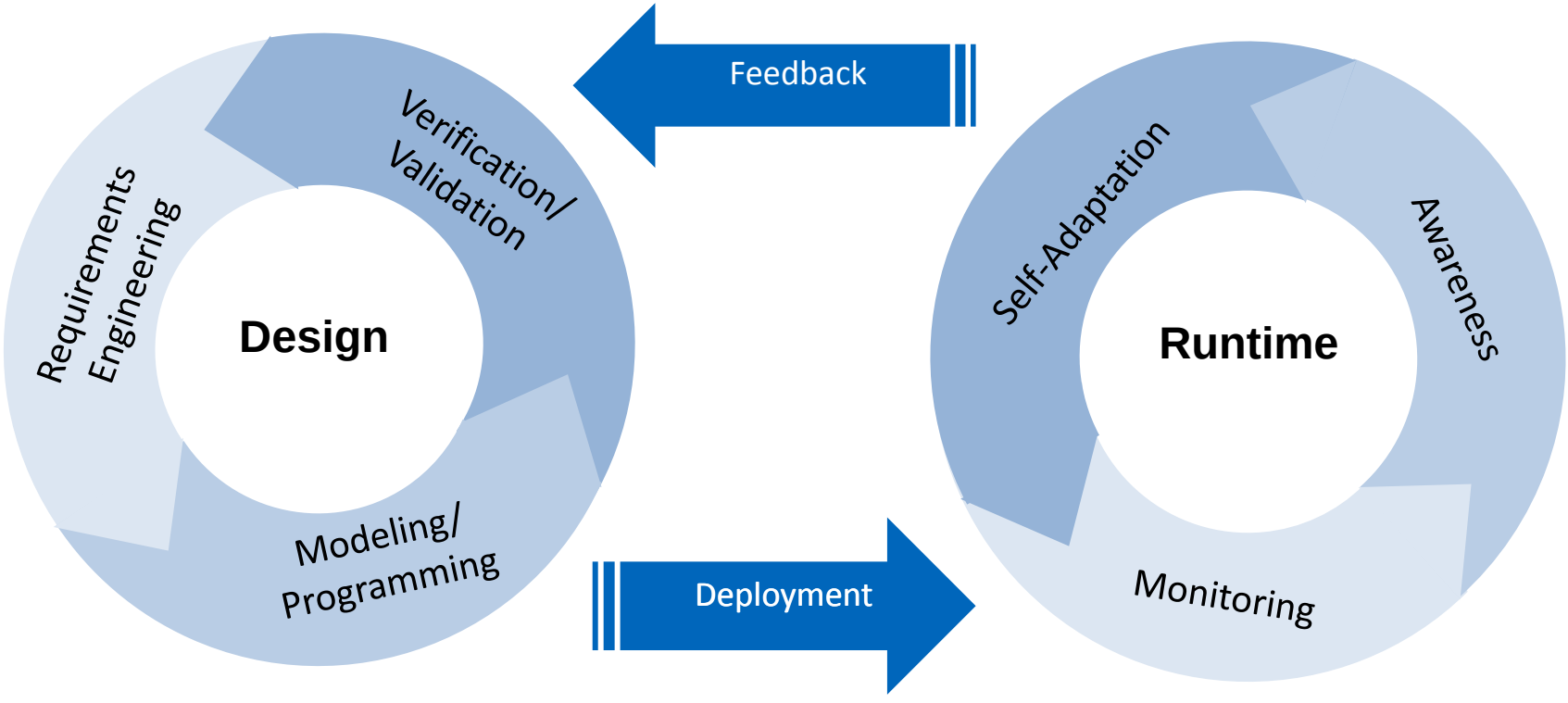
- industrial complex collapsed
- workers trapped
- lots of cheap robots

Task

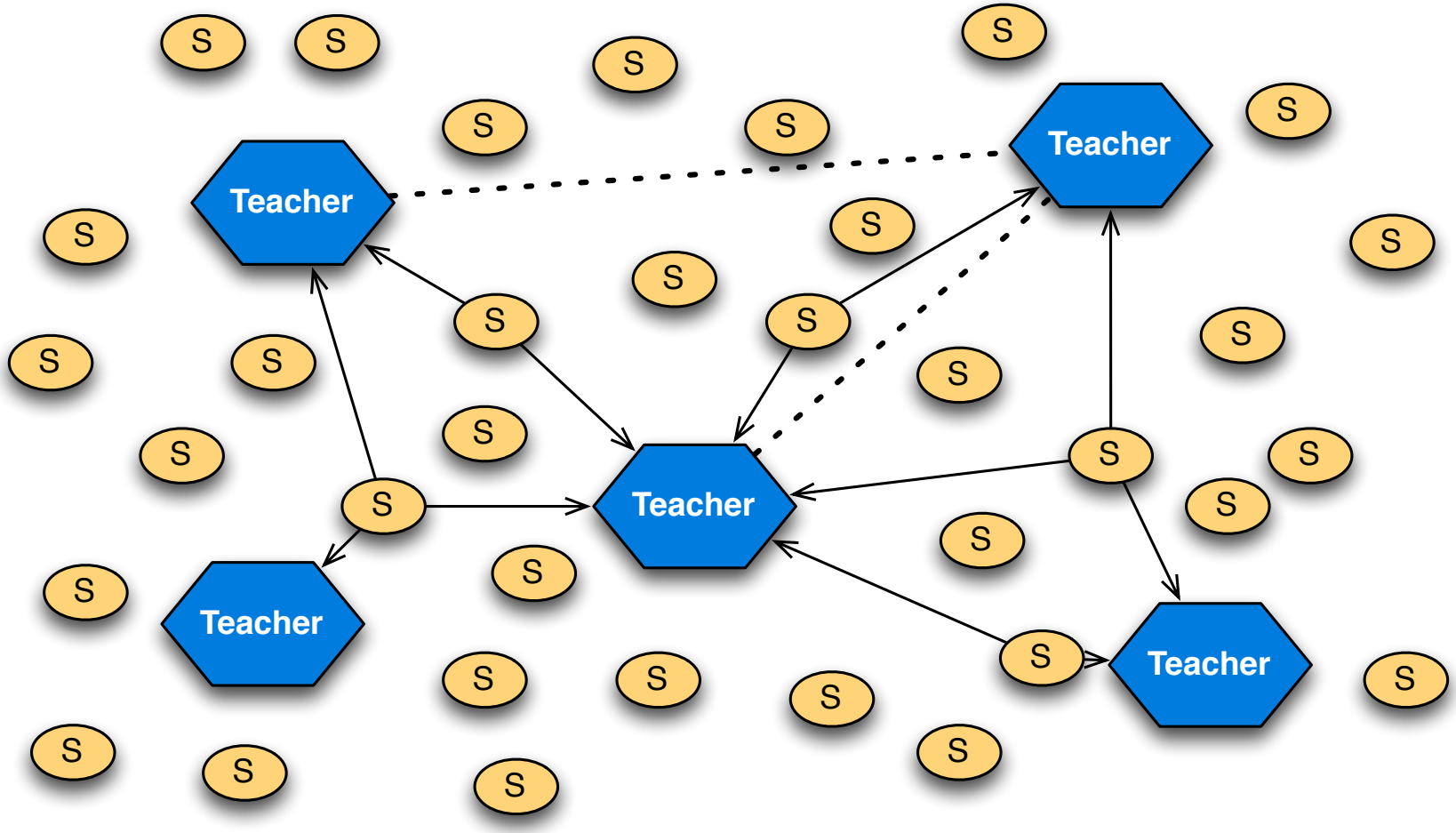
- find path to workers
- carry them to home base



Ensemble Development Life-Cycle (EDLC)



The Teacher/Student Structure



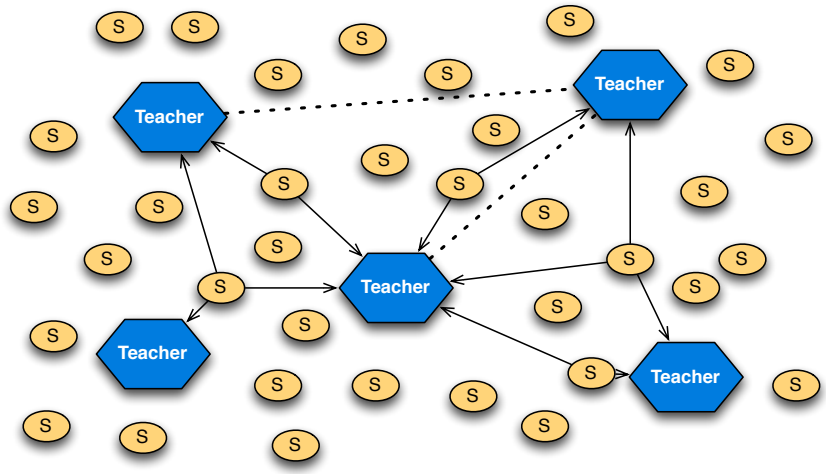
The Teacher/Student Structure

Teachers

- spread plans by teaching students nearby
- may improve plans via updating/learning
- may communicate

Students

- choose teacher according to trust and promised results
- execute taught plans and report results to teacher
- update trust relationships based on results



Continuous Collaboration

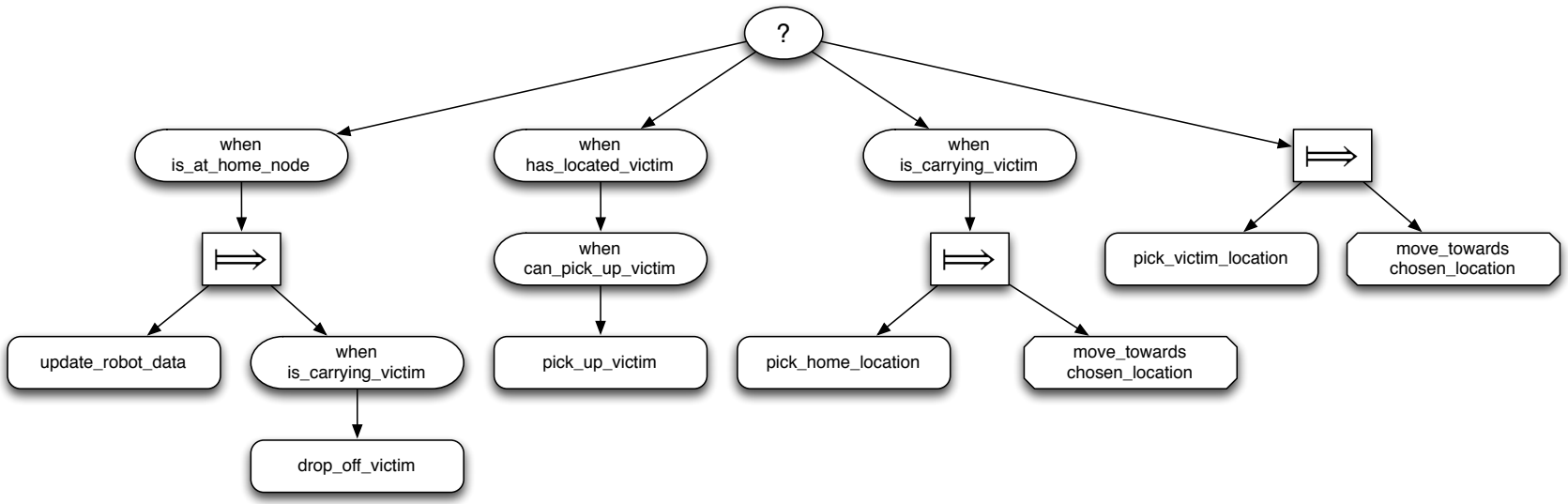
Continous Collaboration

- based on teacher/student structure
- develop and control a sCPS by adding/removing/altering only the teachers

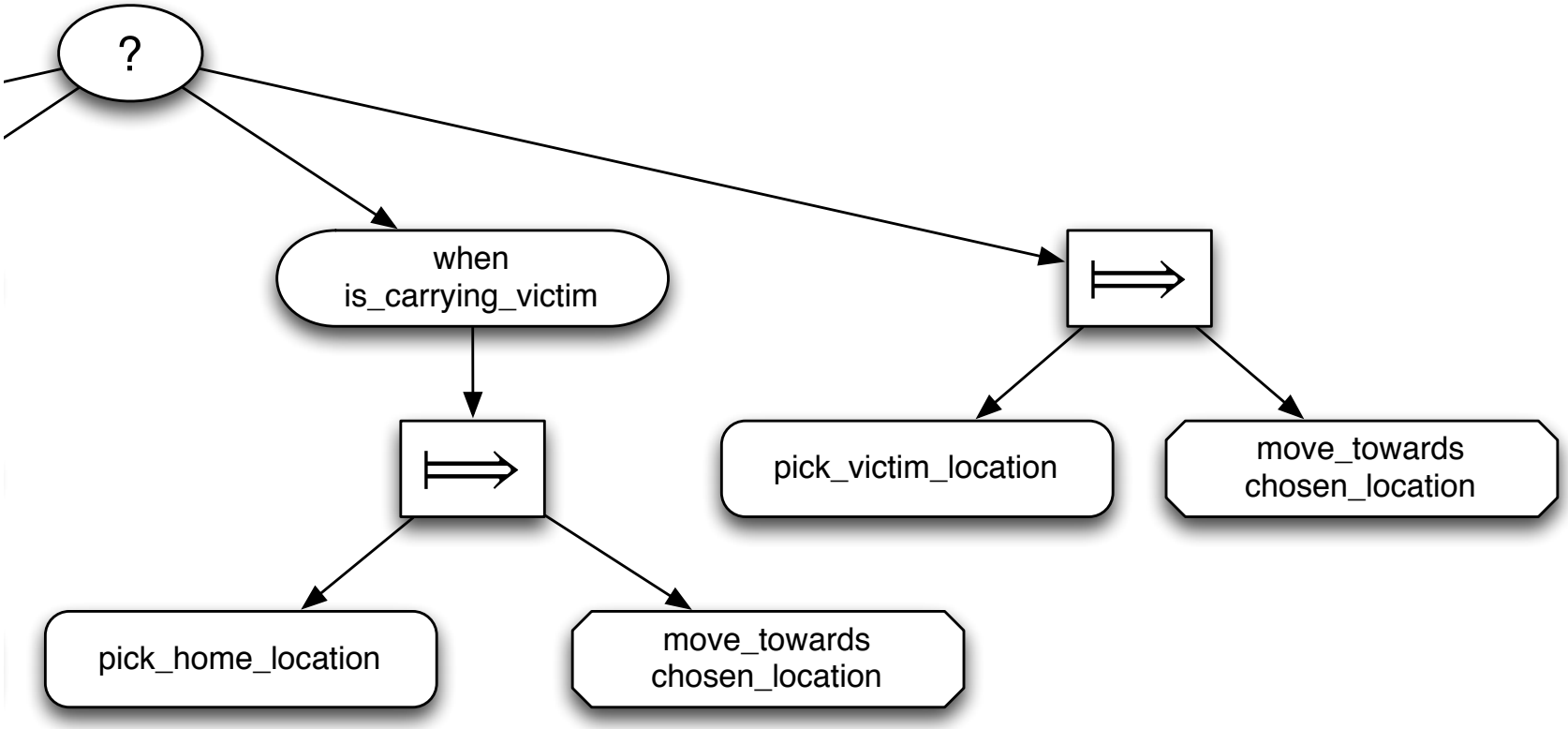
Prerequisites

- adaptive program specifications $\longrightarrow$ Extended Behavior Trees
- pervasive learning techniques $\longrightarrow$ Implicit Online Evolution

Extended Behavior Trees (XBTs)



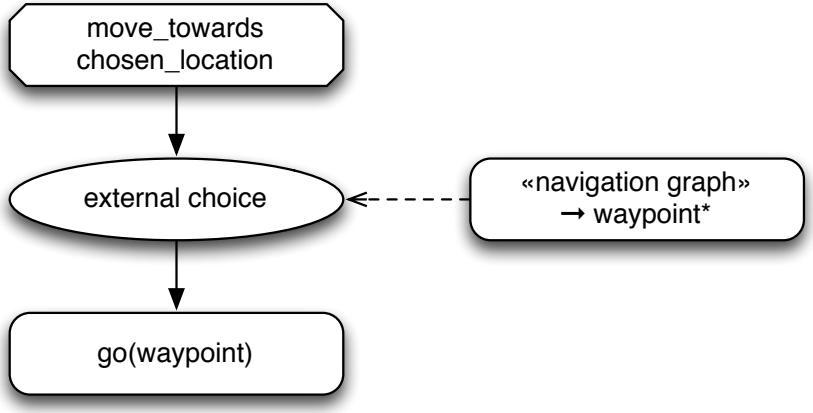
Extended Behavior Trees (XBTs)



Extended Behavior Trees (XBTs)

"move_towards_chosen_location"

- is called in the previous XBT
- uses "external choice" node
- execution depends on taught navigation graph



Implicit Online Evolution

Online Evolution

- solution candidates are plans
- plans of the population are executed while the evolutionary process is still going on
- results from execution are used for selection

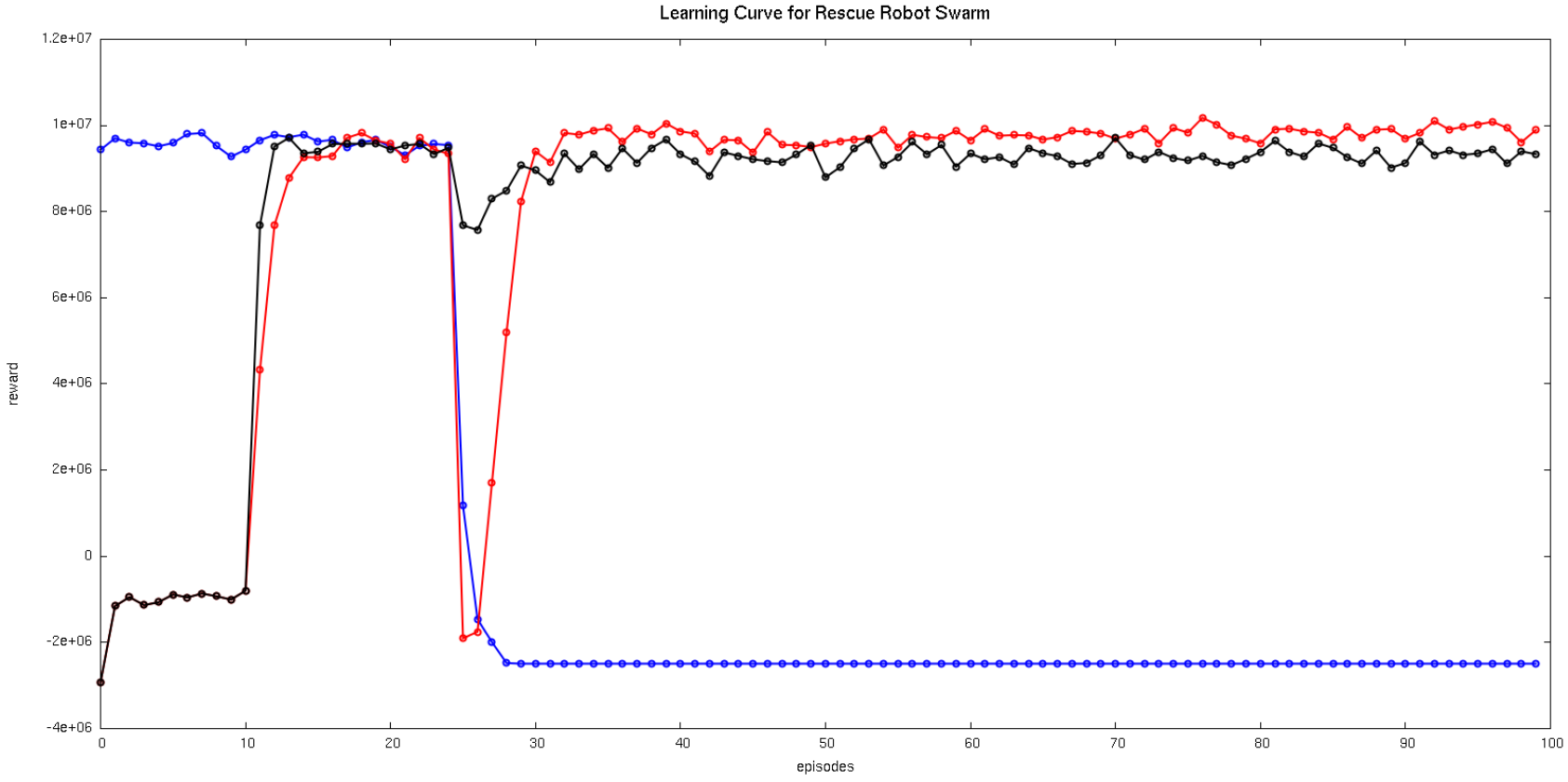
In the teacher/student case

- teachers maximize trust by spreading better plans
- students maximize results by trusting better plans

Results (1)

Single cathastrophe

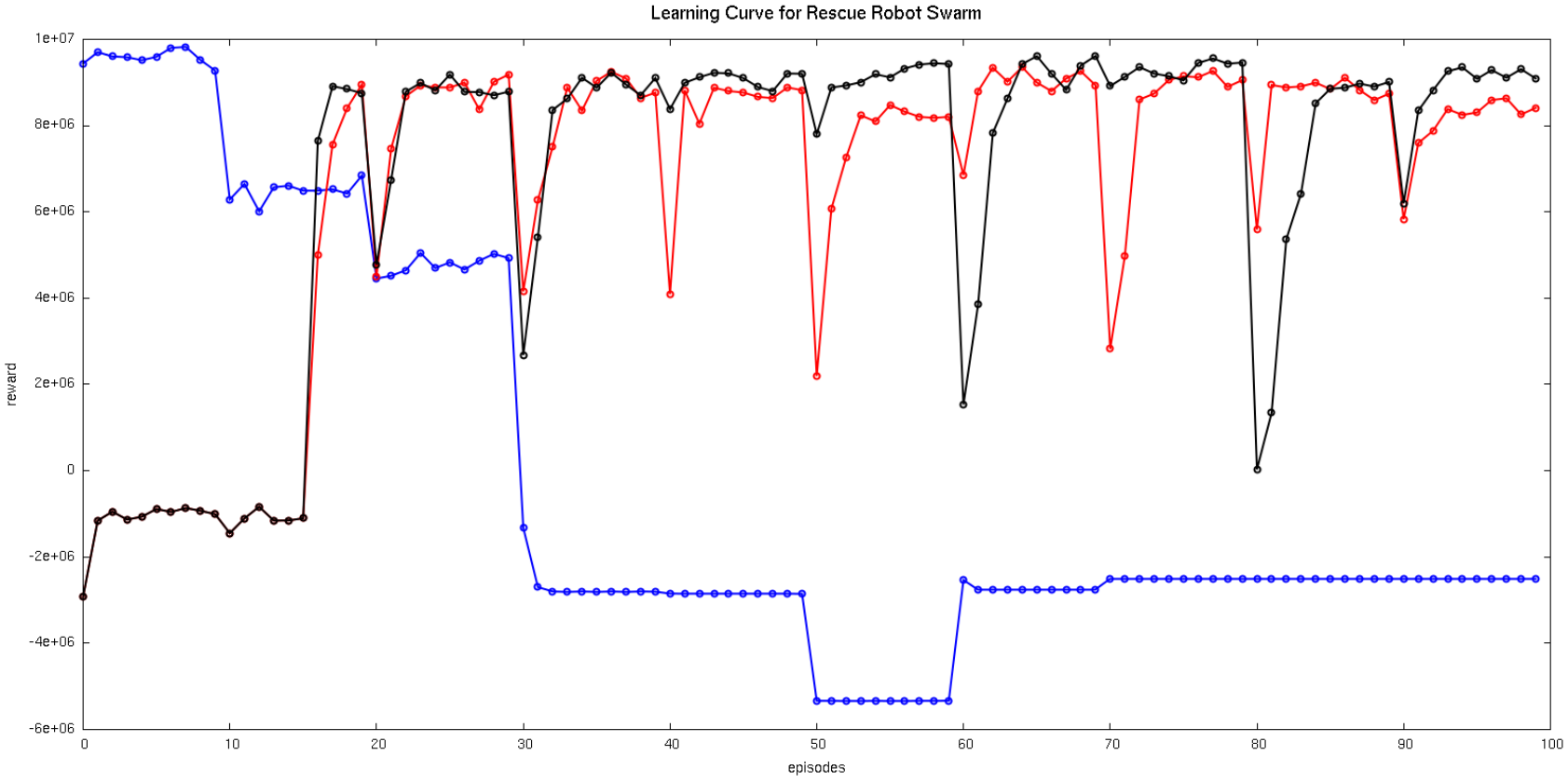
blue—original best plan, red/black—iteratively updated plans



Results (2)

It never stops cathastrophing...

blue—original best plan, red/black—iteratively updated plans



Continuous Collaboration (again)

For Feedback

- teachers may aggregate information from a lot of students
- trust relations show valuable teachers
- students form structures based on which teachers they trust

For Deployment:

- adding a new teacher makes the ensemble test its plans
- bad plans are disregarded with little harm
- teachers can be added/removed cheaply and dynamically

Thank You!