Introduction to Cognitive Robotics

Module 7: Cognitive Architectures

Lecture 6: The CRAM cognitive architecture: operation

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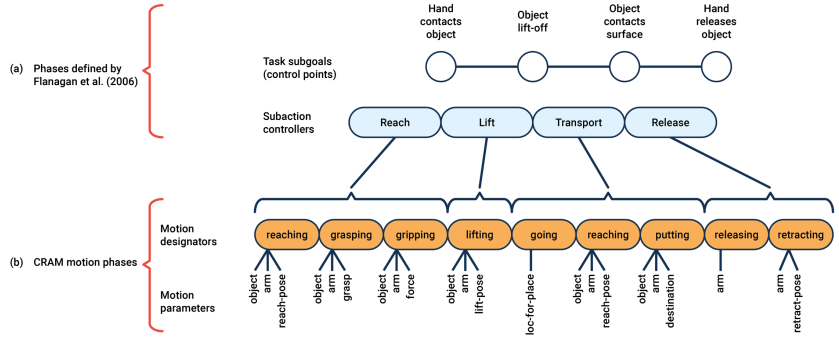
Walk through the execution of a generalized action plan



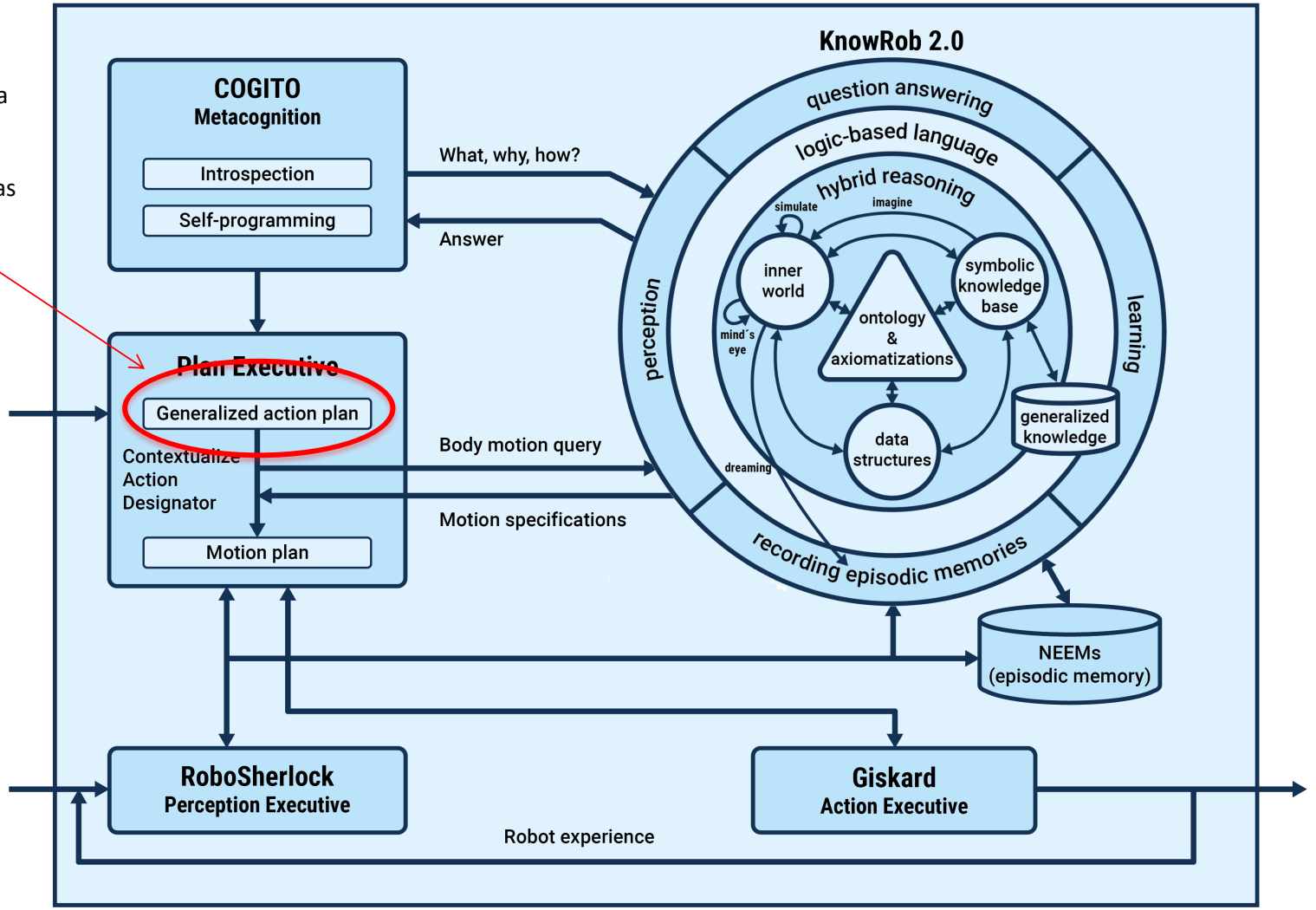
Generalized Action Plan

Motion Plan

The motion parameter values are provided by the generative model

3-step refinement process:
contextualization
Identify the values of the parameters to the motion plan that maximize the likelihood that the associated body motions successfully accomplish the desired action

Recall:
The robot agent is equipped with a generalized action plan for each action category, which typically corresponds to action verbs such as fetch, place, pour, and cut.

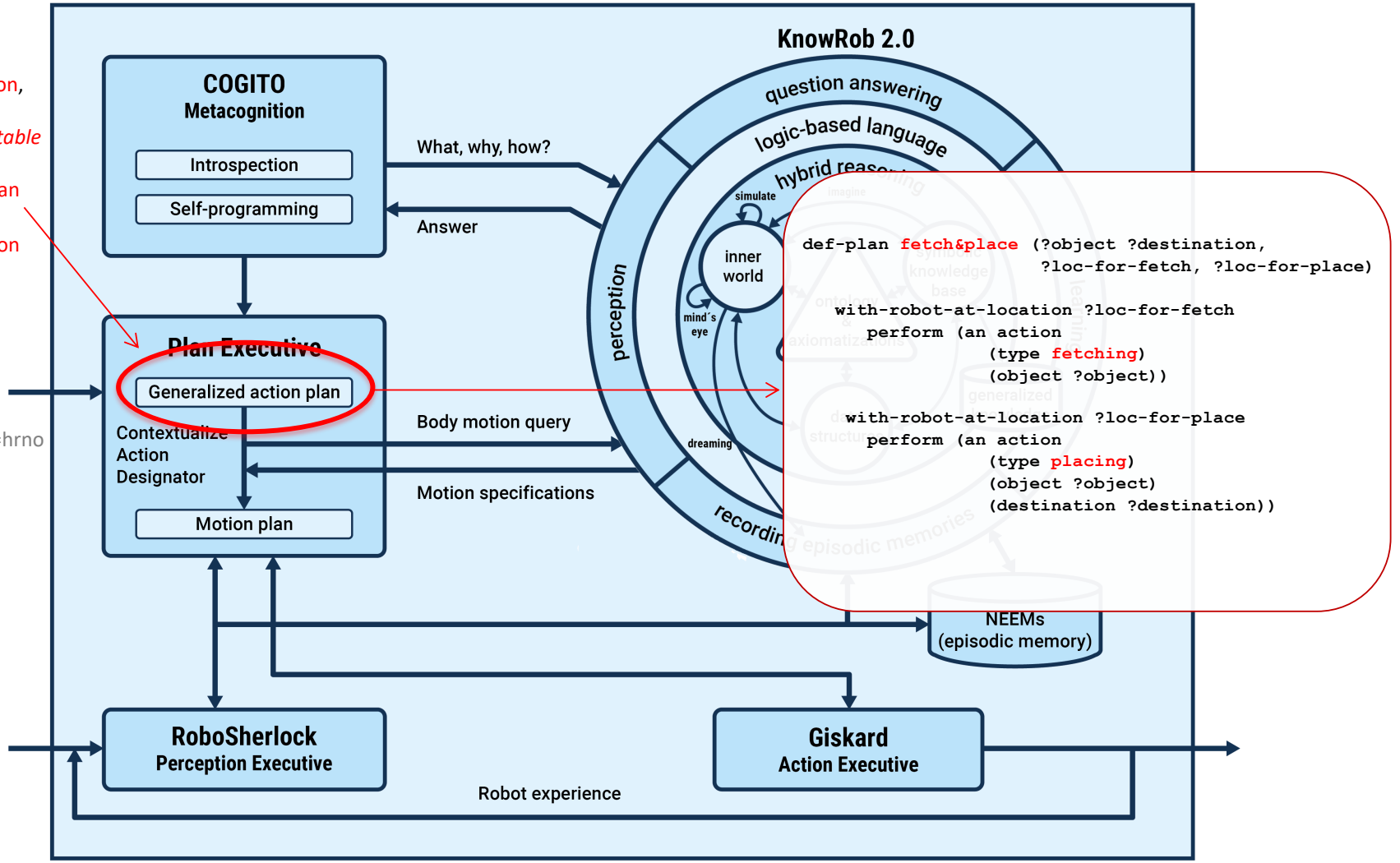


An action plan is invoked with
a request to perform
an underdetermined action description,

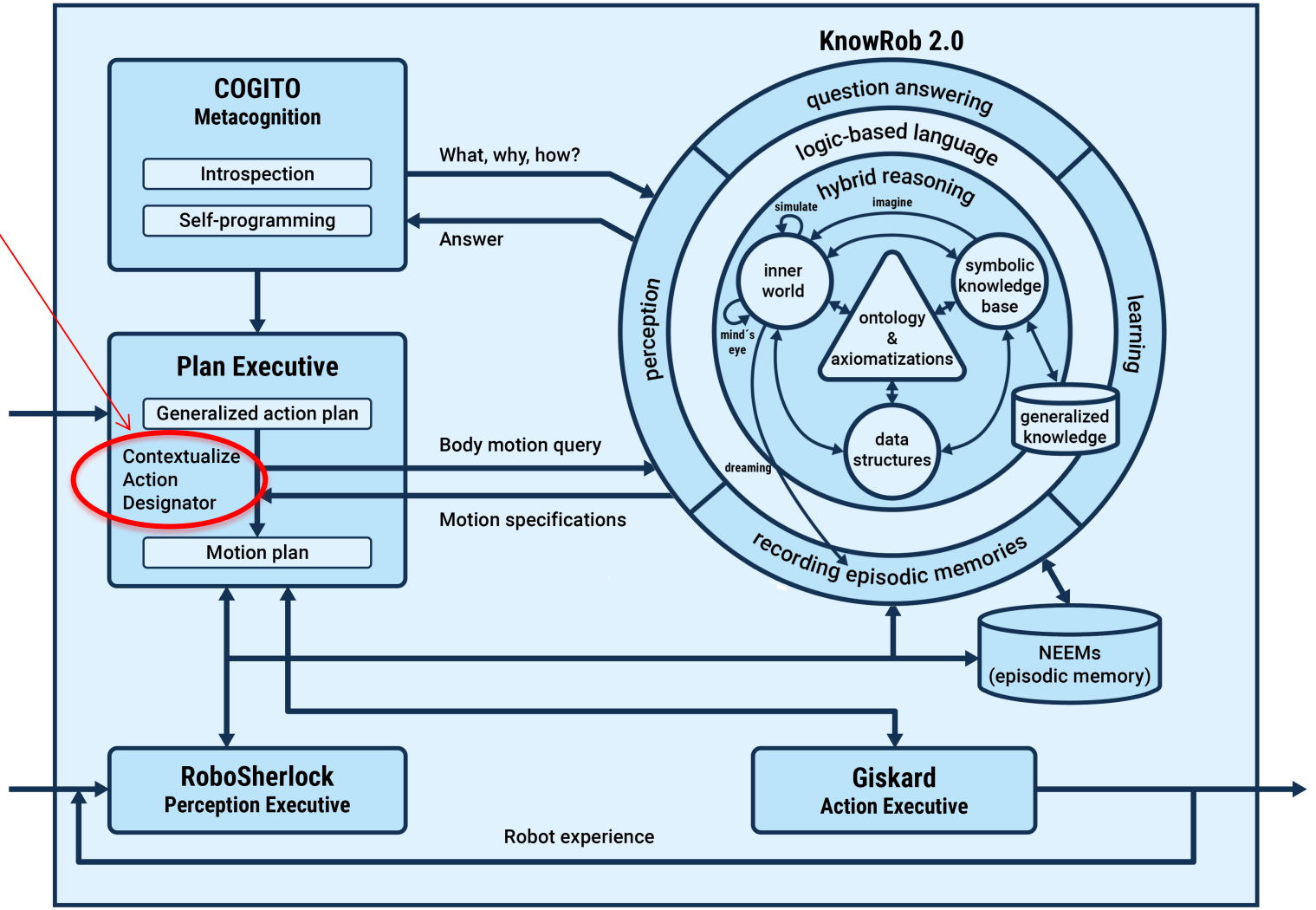
e.g. *fetch the cup and place it on the table*

by selecting the generalized action plan
for the action category
corresponding to the action description

(e.g. see the spoon challenge at
https://www.youtube.com/watch?v=hrnoY6J8ddE&feature=youtu.be)



The Plan Executive interprets the generalized action plan in process referred to as contextualization in three steps:

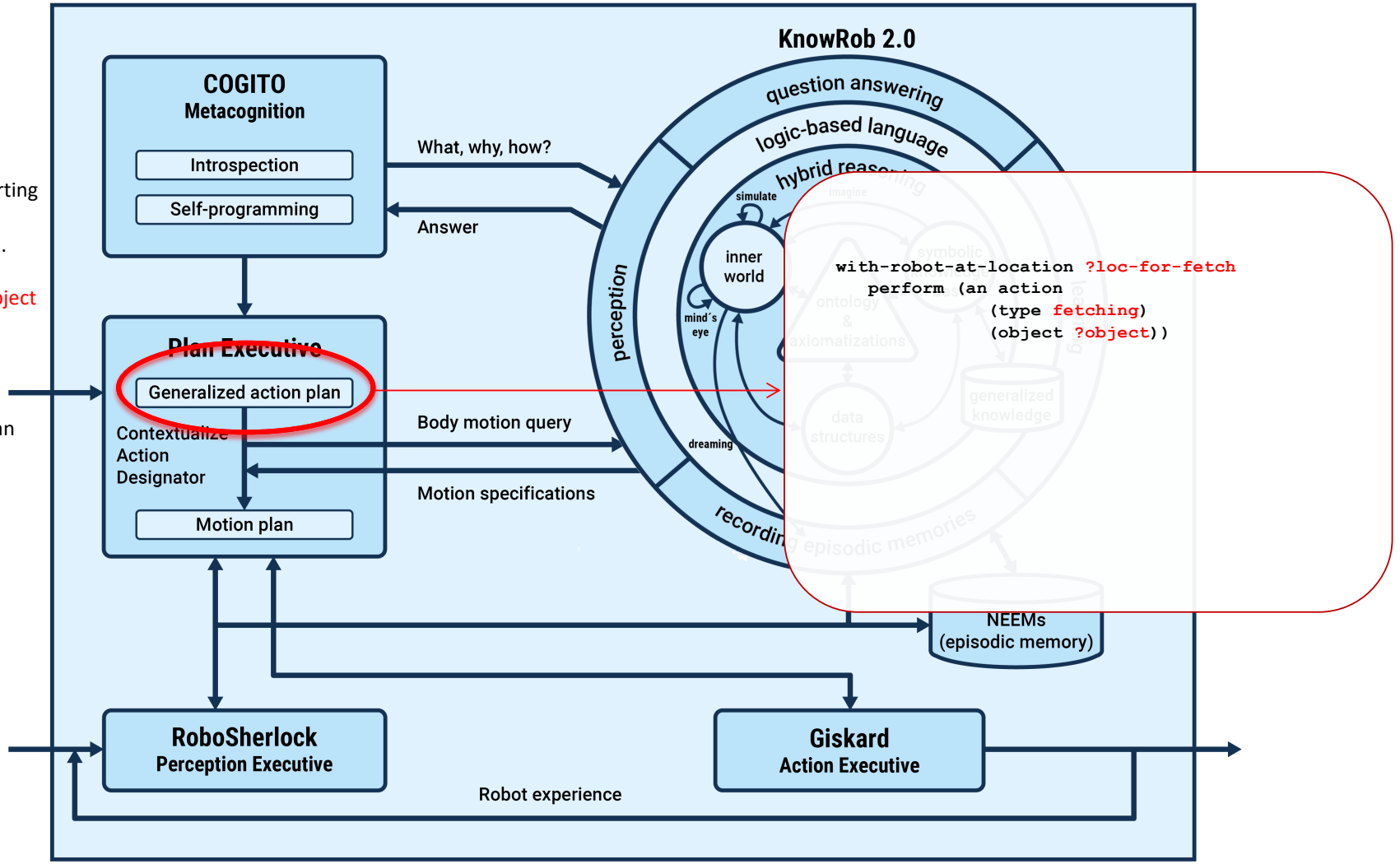


The Plan Executive interprets the generalized action plan in process referred to as contextualization in three steps:

1. Instantiate the selected generalized action plan by inserting the arguments required for the specific action to be performed.

- For example, the type of the object to be manipulated or the destination location.

- These arguments are typically designators of some kind, e.g. an action, object, or location designator.



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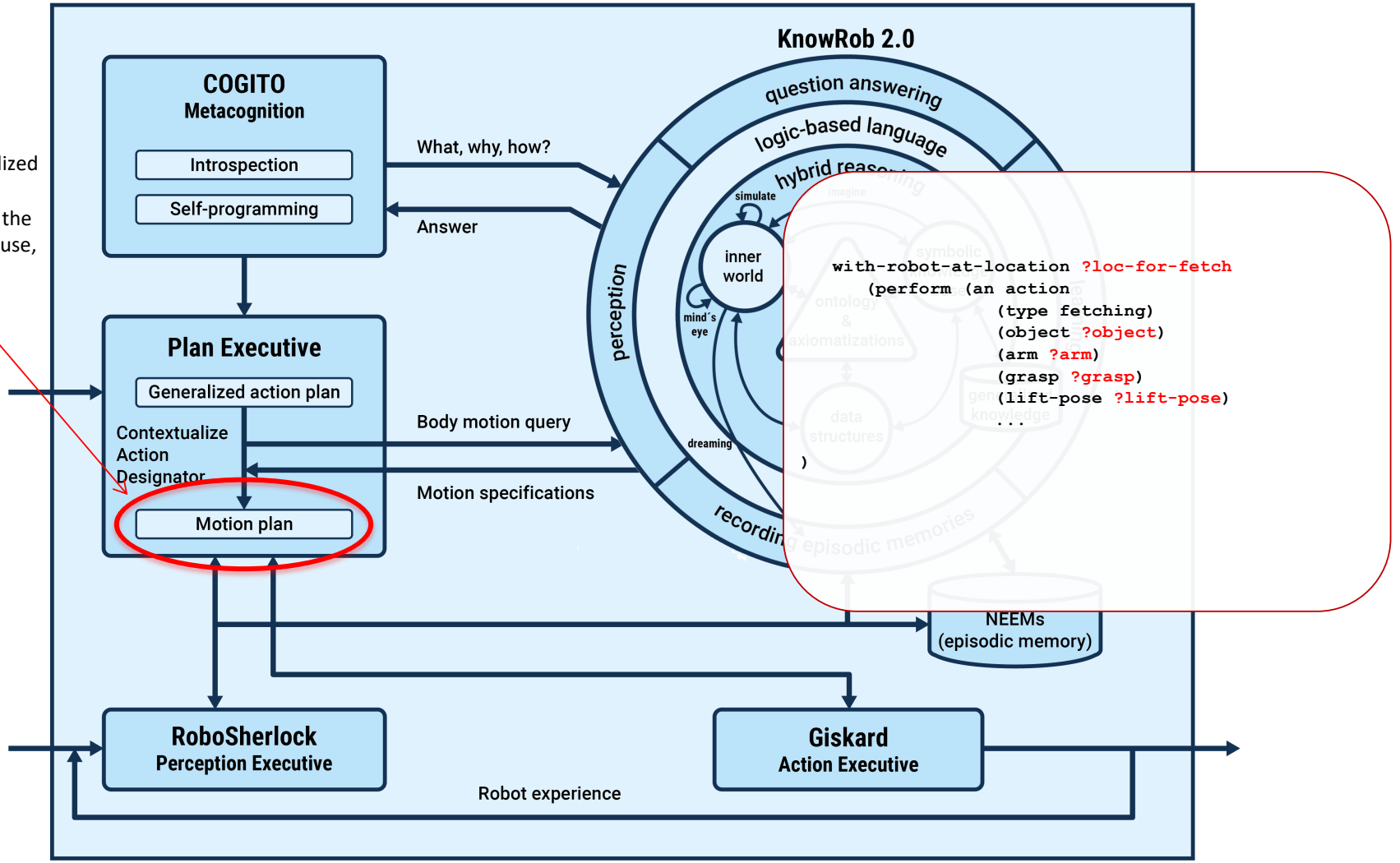
2. Extend the instantiated generalized action plan by adding the parameters needed to execute the motion plan, e.g. which arm to use, what grasp pose to use.



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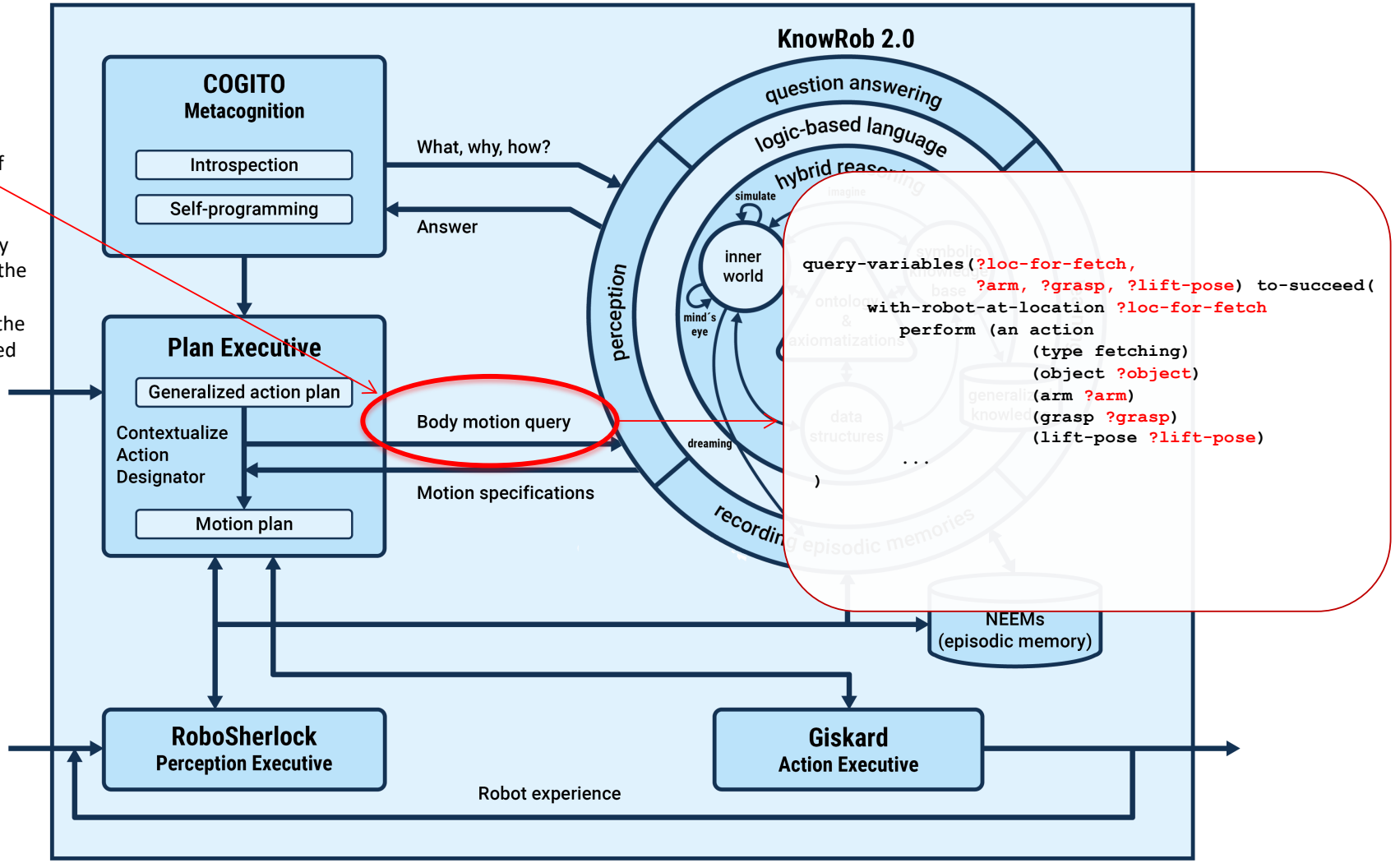
3. Create a query for the values of these parameters

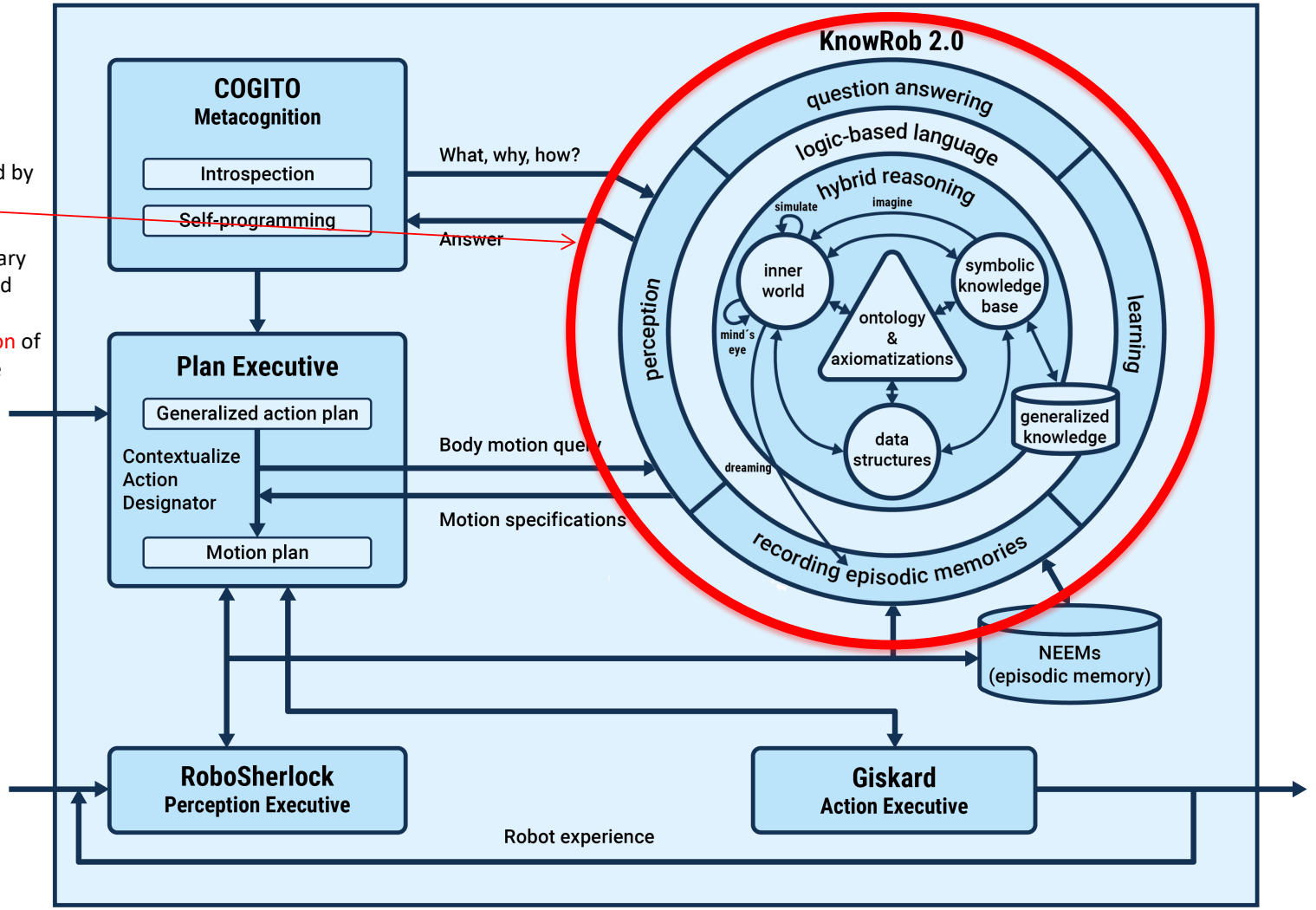
   (that would produce robot body motions to achieve the goal of the underdetermined action description and, equivalently, the associated instantiated extended generalized action plan).



The Plan Executive interprets the generalized action plan in process referred to as contextualization in three steps:

The contextualization is accomplished by KnowRob2.0.

The motion parameter values necessary to carry out the action are determined using a **generative model** effectively sampling a joint distribution of the motion parameter values and the associated outcome.



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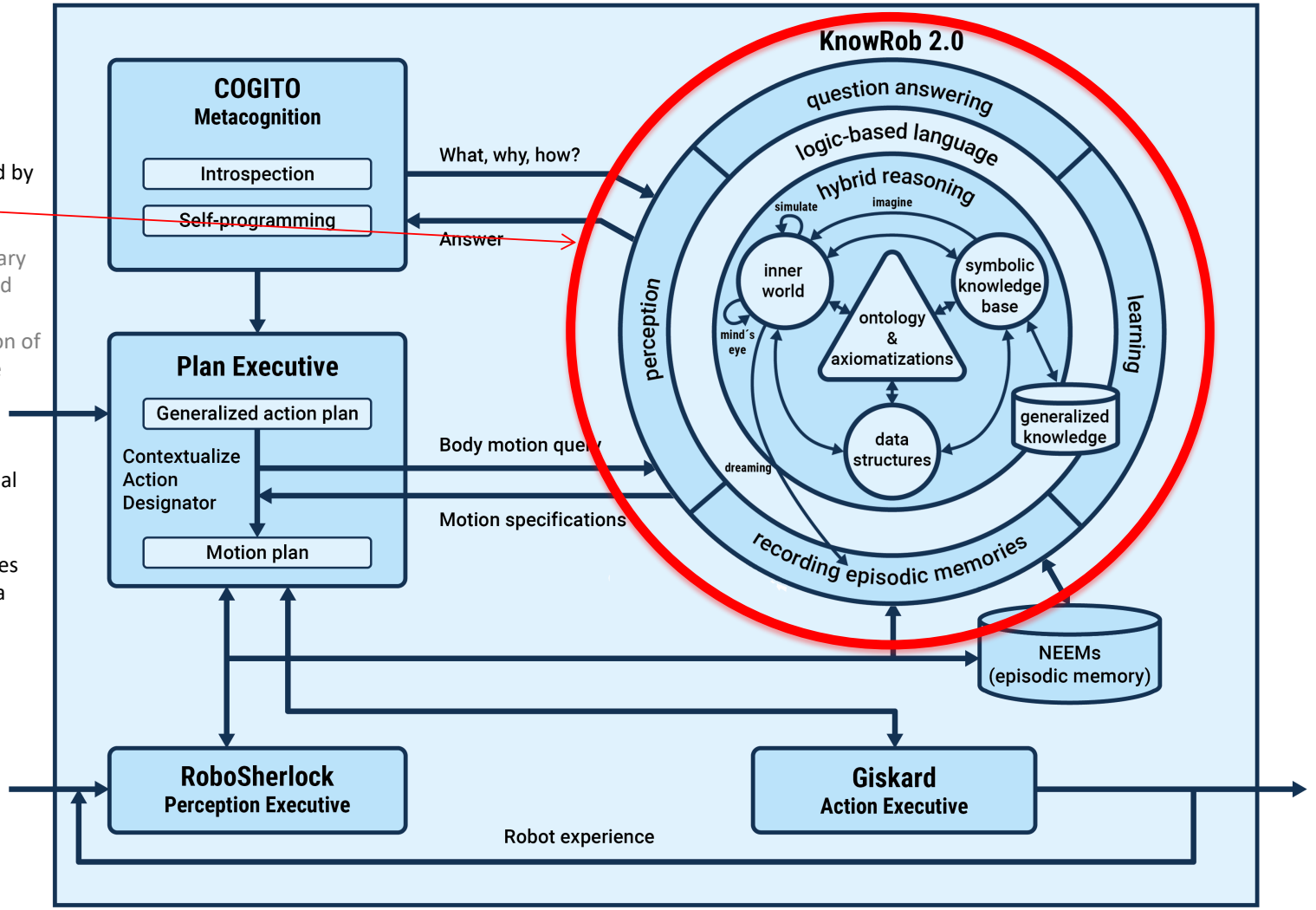
The motion parameter values necessary to carry out the action are determined using a generative model effectively sampling a joint distribution of the motion parameter values and the associated outcome.

It uses knowledge and reasoning, exploiting the constraints of contextual knowledge and current perceptual information, and prospection, to maximize the likelihood that the values identified are most likely to result in a successful action.



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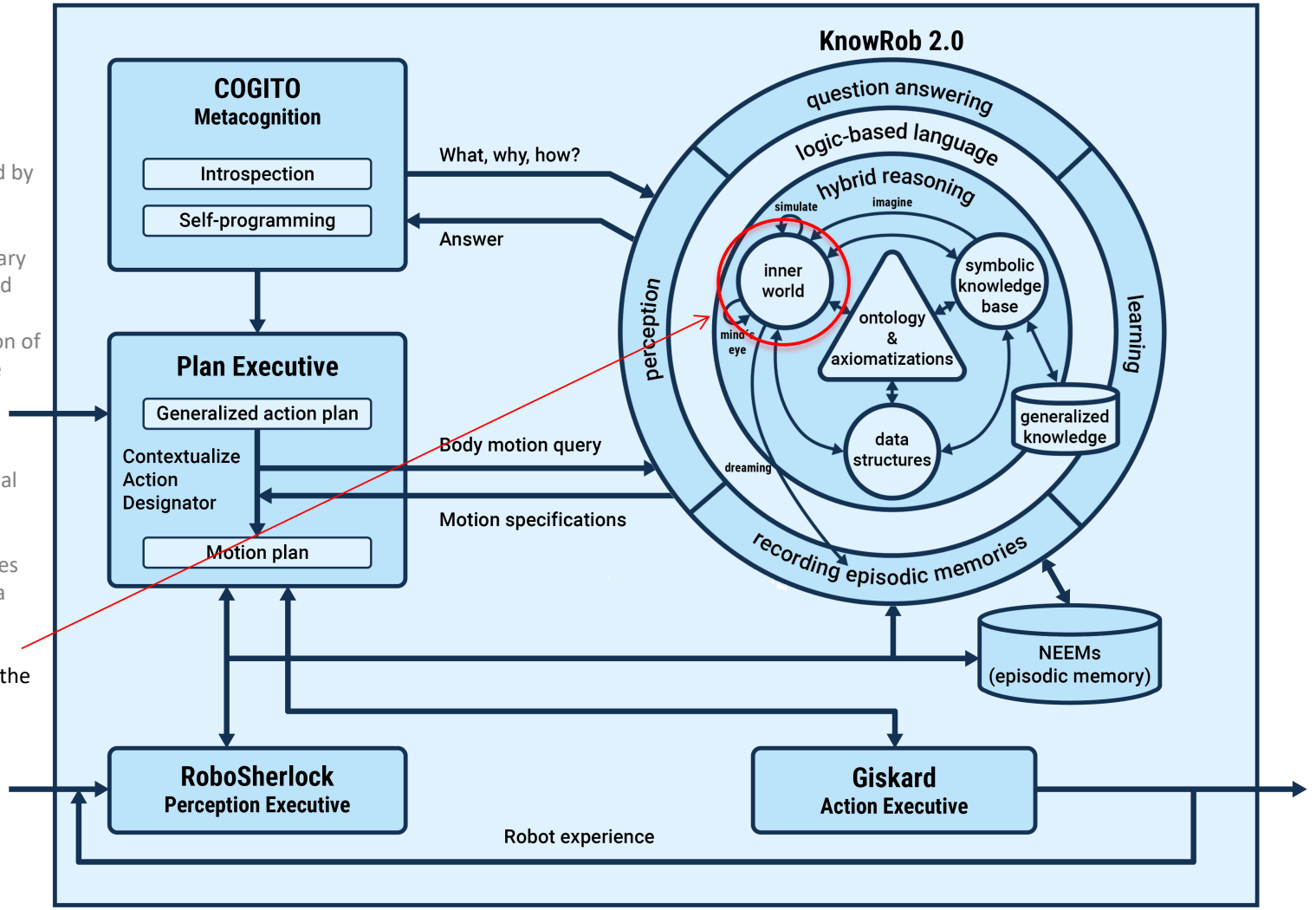

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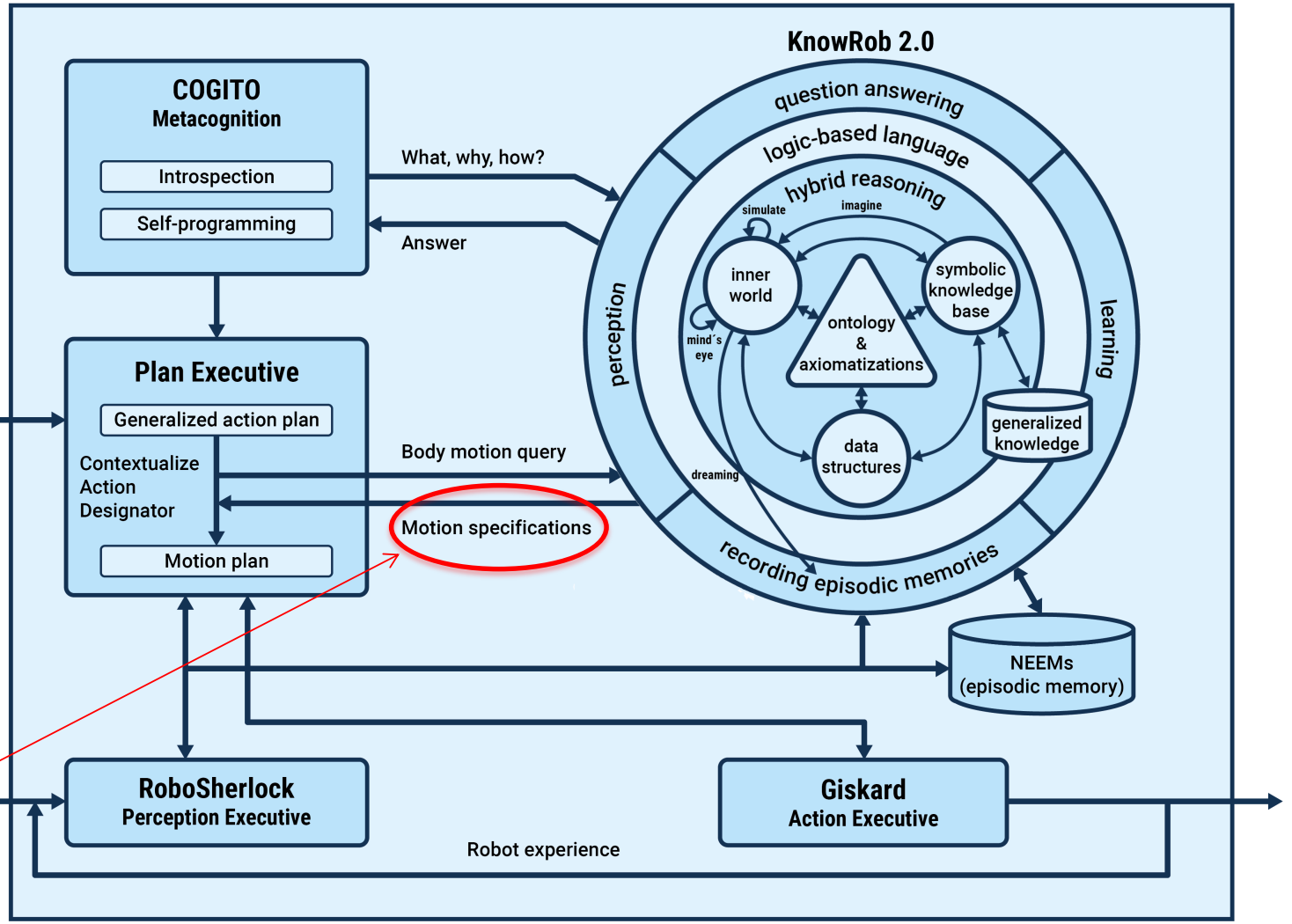
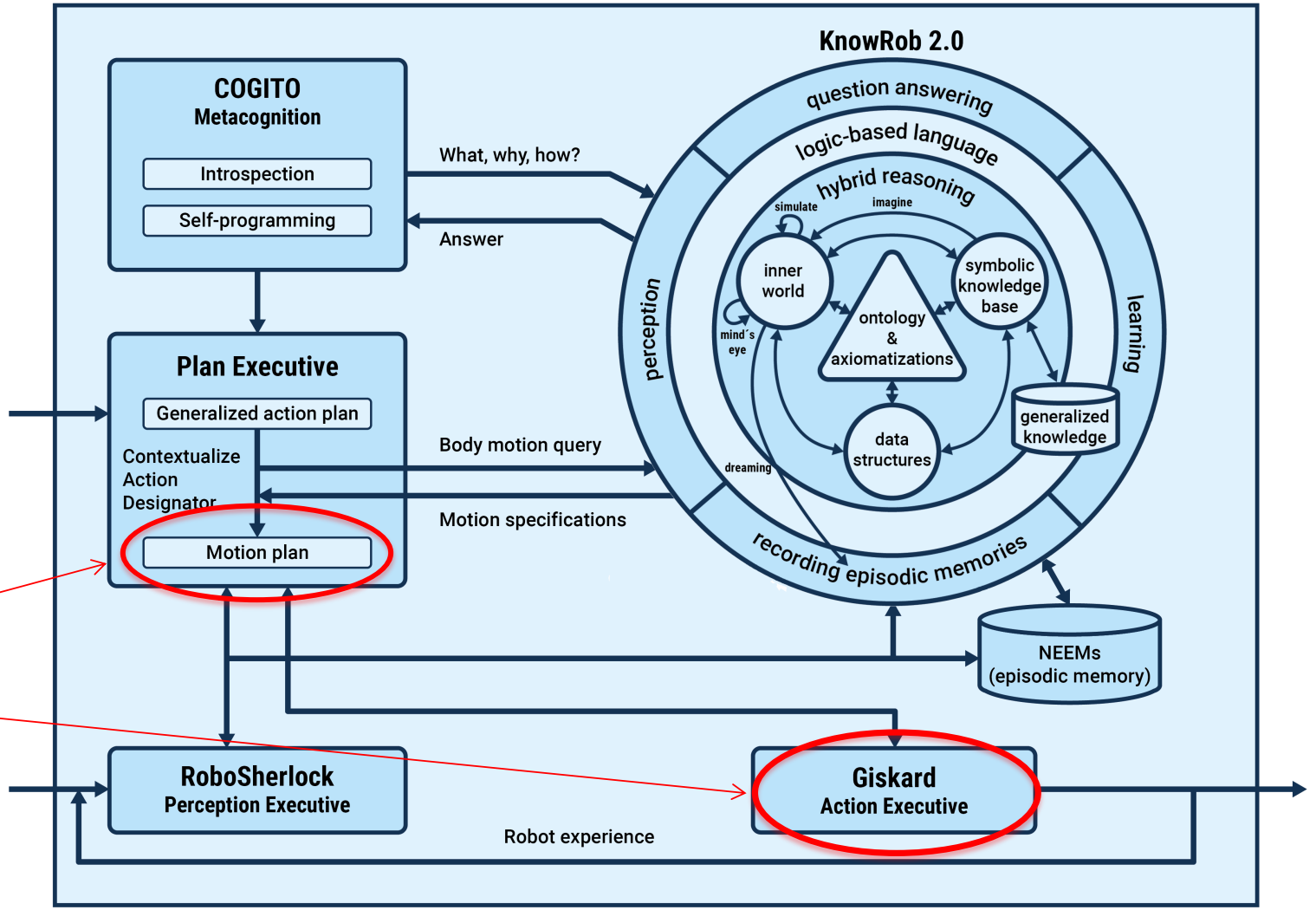
The motion parameter values are returned to the Plan Executive





The motion plan
is then executed by
the Action Executive

Recommended Reading

M. Beetz, L. Mösenlechner, and M. Tenorth. CRAM – A Cognitive Robot Abstract Machine for Everyday Manipulation in Human Environments. In IEEE/RSJ International Conference on Intelligent Robots and Systems, pages 1012–1017, Taipei, Taiwan, October 2010.

M. Beetz, D. Beßler, A. Haidu, M. Pomarlan, A. Kaan Bozcuoglu, G. Bartels, "KnowRob 2.0 – A 2nd Generation Knowledge Processing Framework for Cognition-enabled Robotic Agents", In International Conference on Robotics and Automation (ICRA), Brisbane, Australia, 2018.

Recommended Videos

G. Kazhoyan. Tutorial on CRAM (Cognitive Robot Abstract Machine). https://youtu.be/0uJN-jRb7J4