New Paradigm of Context based Programming-Learning of Intelligent Agents

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Outlines

- Approaches and tendencies in programming of robots and other intelligent agents
- The idea of usage of context in programming of robot
- Requirements to basic language for programming based on context
- CBLR (Context Based Language for Robots)
- Architecture of programming-learning based control system

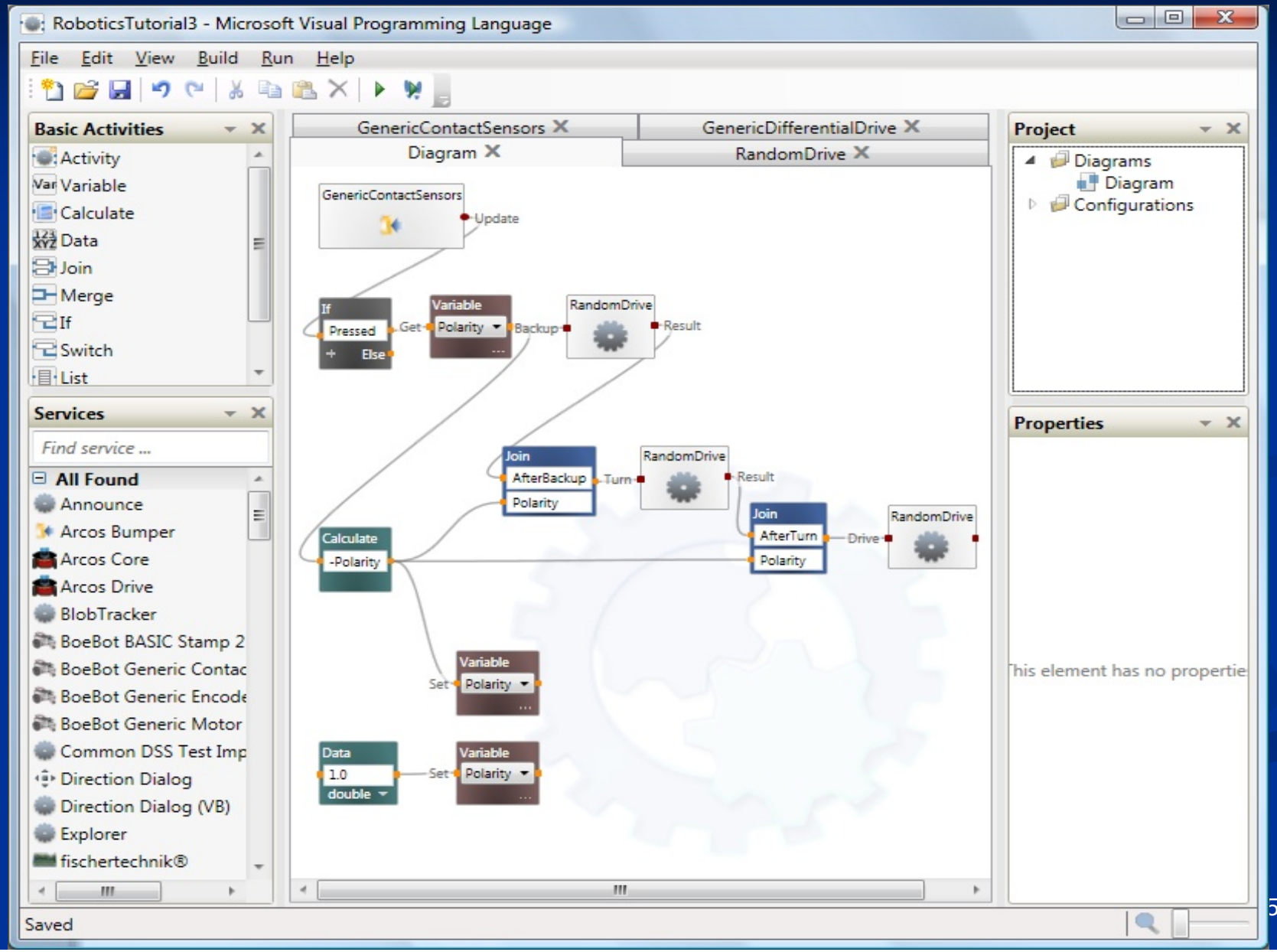
Existing approaches for programming of robots

- Algorithmic programming (traditional)
  - E.g., languages AML, AL
- Declarative programming
  - Based on description of model of world and tasks
- Visual programming
  - E.g., LEGO Mind Storm NXT, MS Robotics Developer Studio
- Probabilistic programming (for mobile robots)
  - Based on programming of behavior in unknown dynamic environment

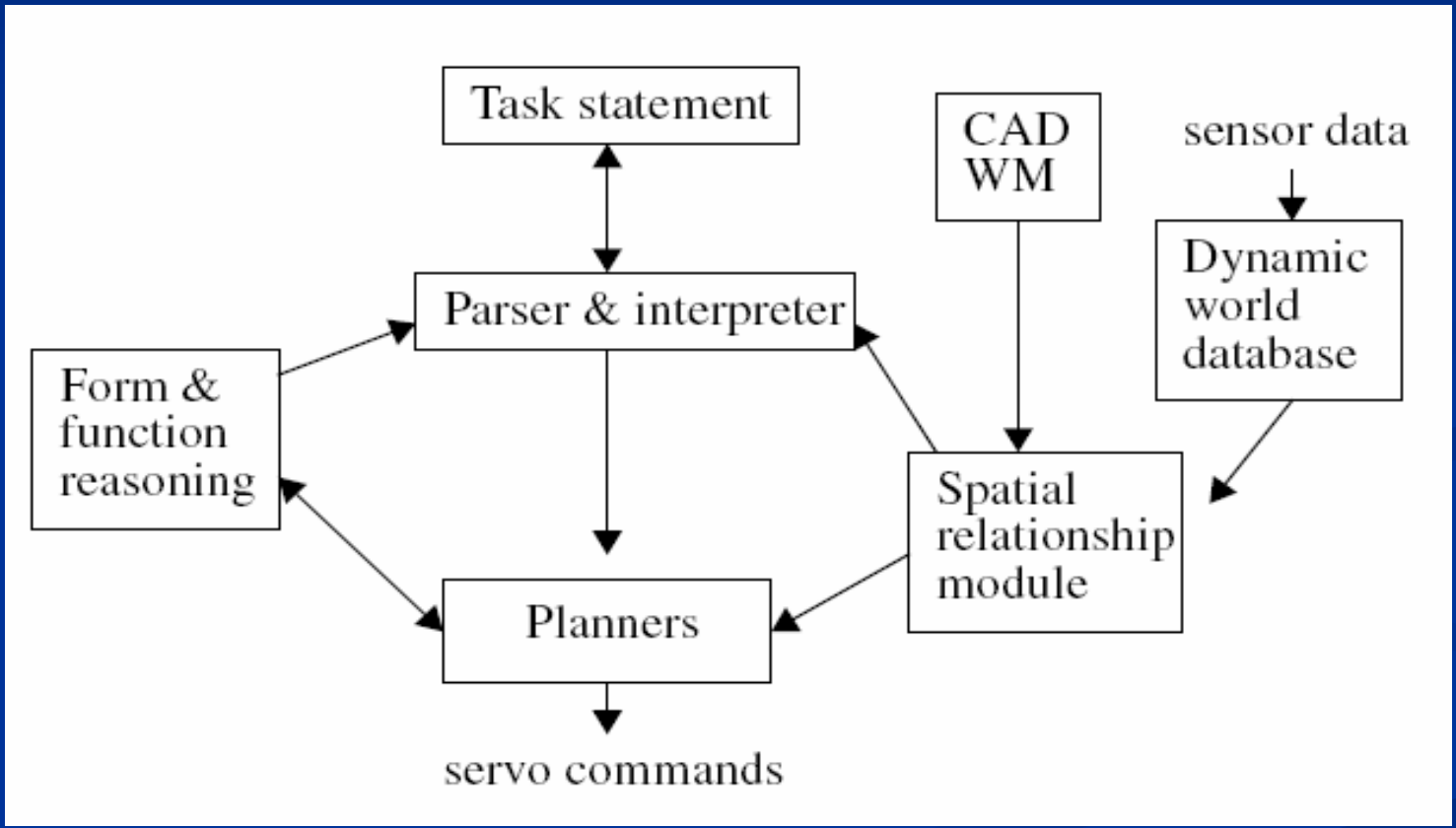
Environments for programming

- Robot programming language (traditional)
- Off-line programming environment (e.g. Igrip, CimStation, RobCad, MS Robotics Developer Studio)
  - Based on simulation of robot and using simulation language instead programming language
- Task-level programming environment (e.g., Ralph, Stanford Smart Robotic Workcell, Aramis, XPROB)
  - Based on description of goals without defining every movement in details:
  - Task specification
  - World model
  - Robot program synthesis

MS Robotics Developer Studio



Ralph structure

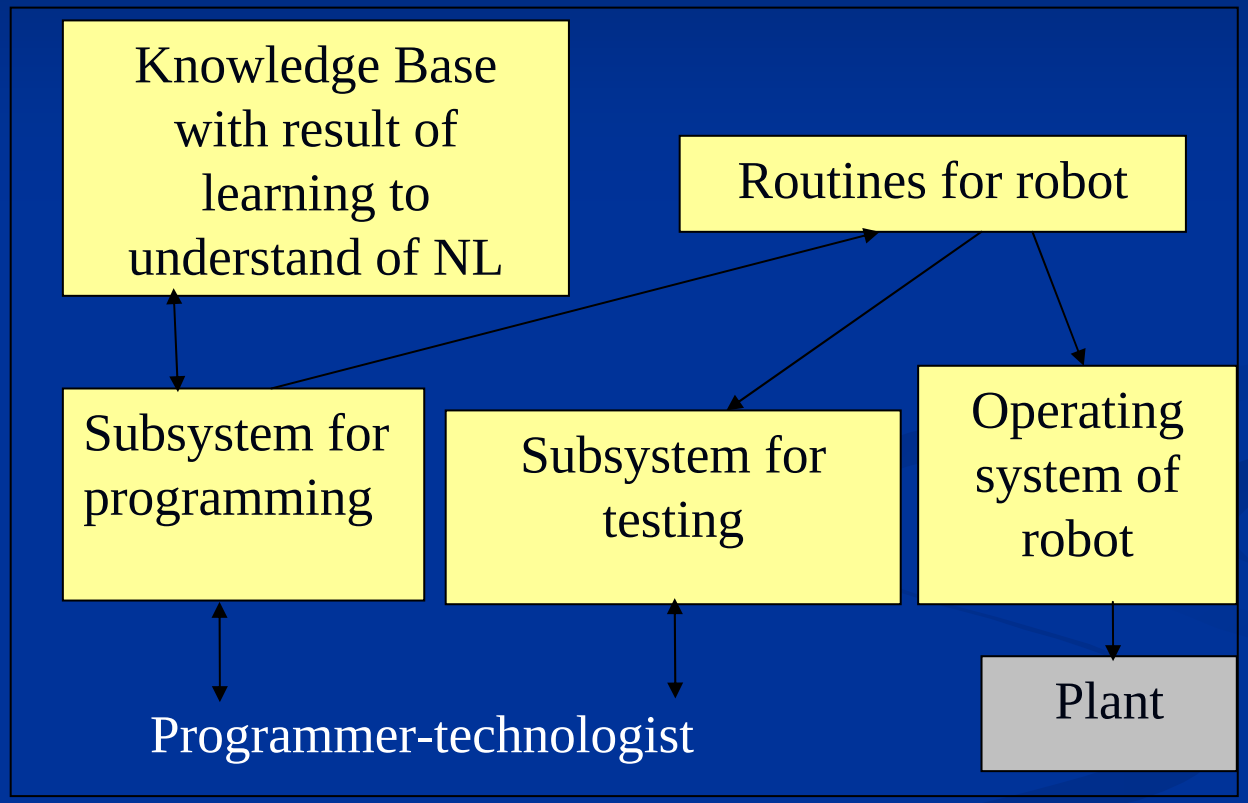


Features of context based programming

- We suppose that this is kind of task-level programming environment
- Operators are very simple with 1 or 0 parameters to set of value of corresponding context variable
- Delayed action. i. e. any action can be started just when all context variables needed for it have got value
- These features are similar to natural language (NL) and planning of human behavior as execution of commands received from NL based dialog
- This approach is combination of algorithms and events based programming

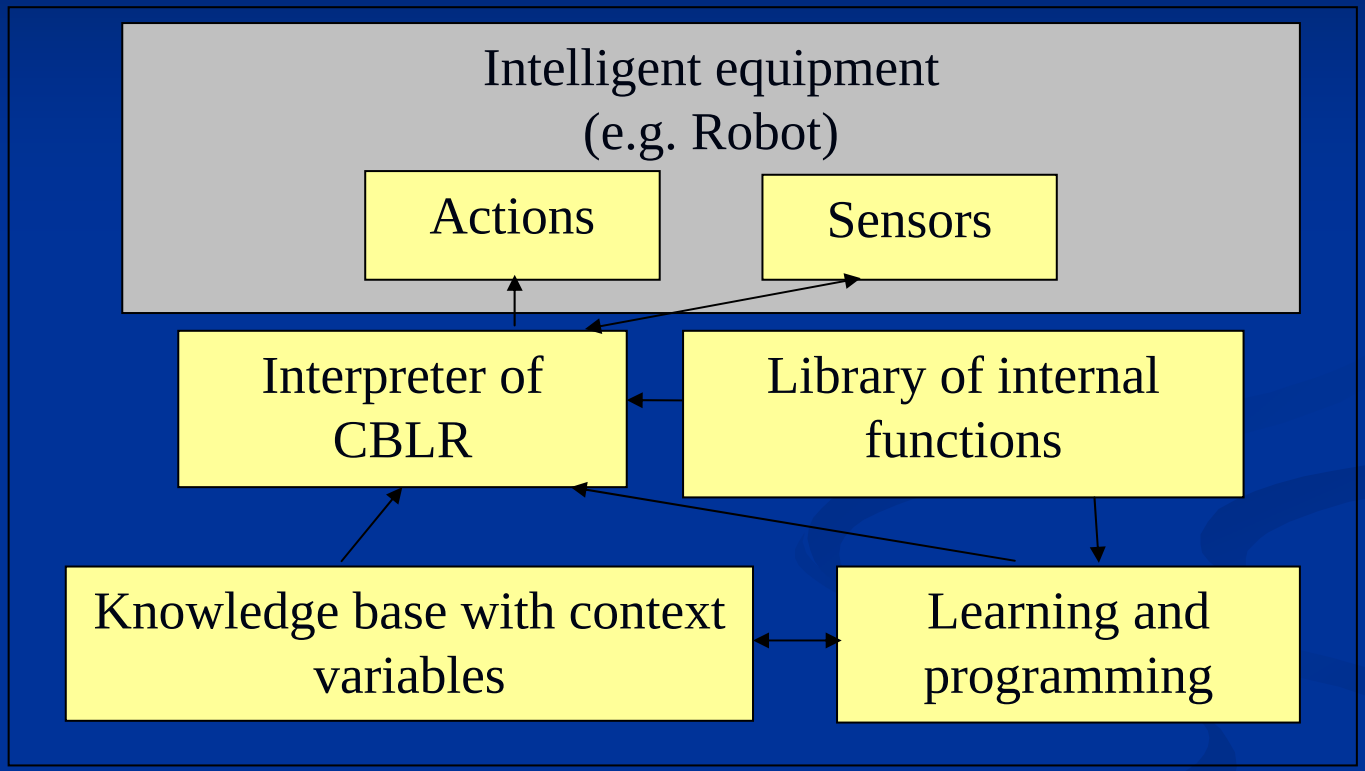
Architecture of software for transport robot

Gavrilov A.V. *Dialog system for preparing of programs for robot.* Automatyka, Vol.99, Glivice, Poland, 1988, p.173-180 (in Russian)

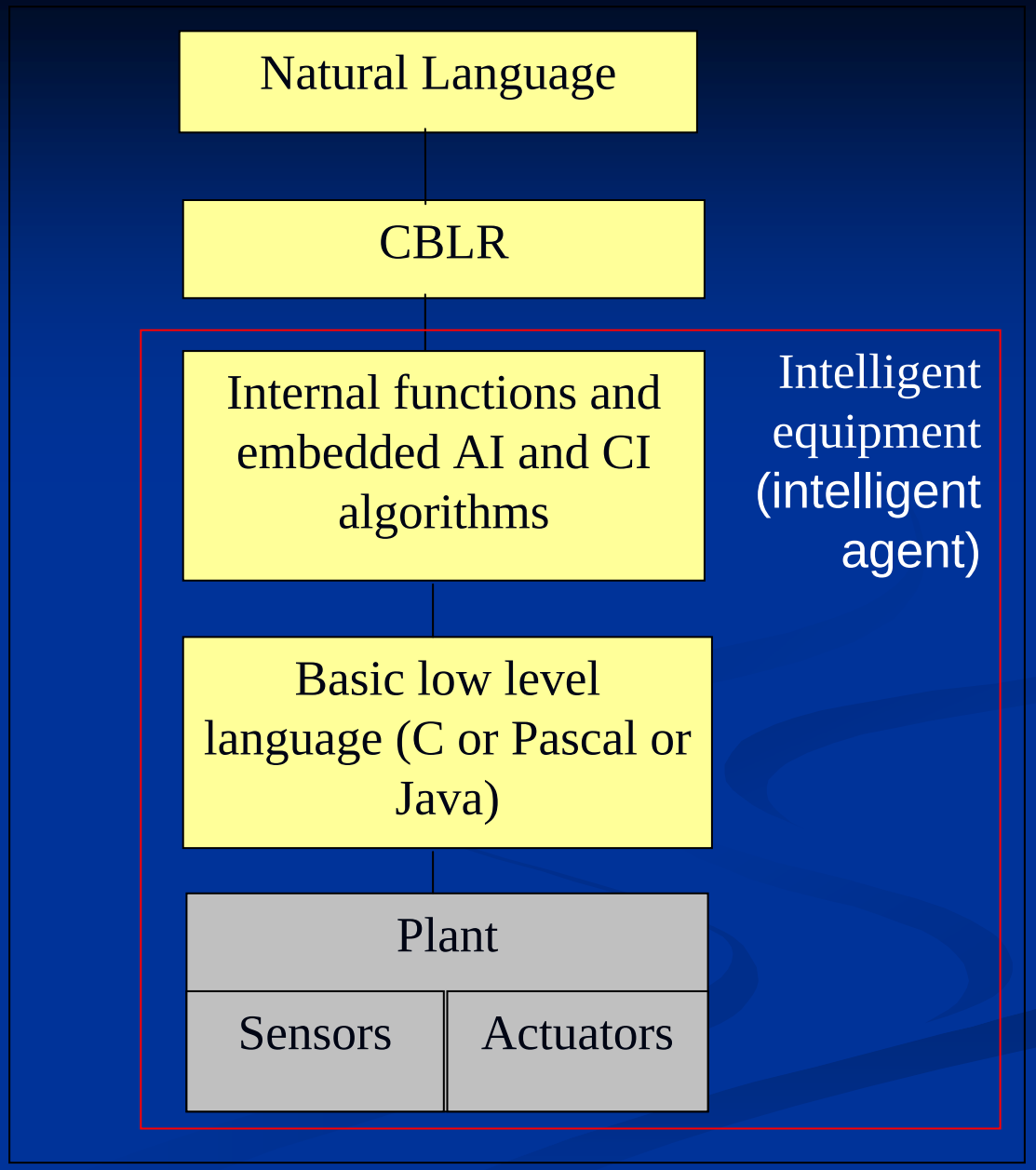


Was developing for automated manufacturing of capacitors

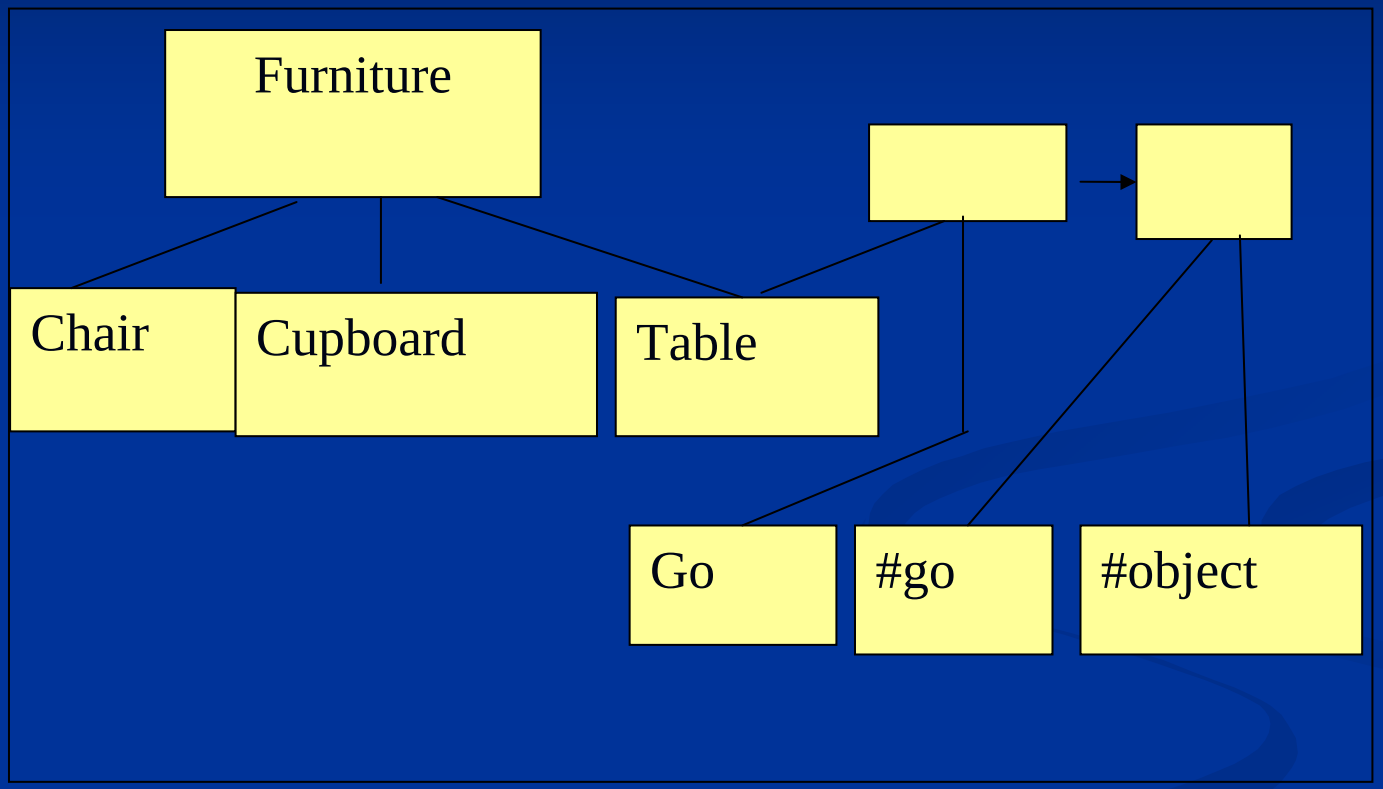
General paradigm of learning/programming of intelligent equipment. Components



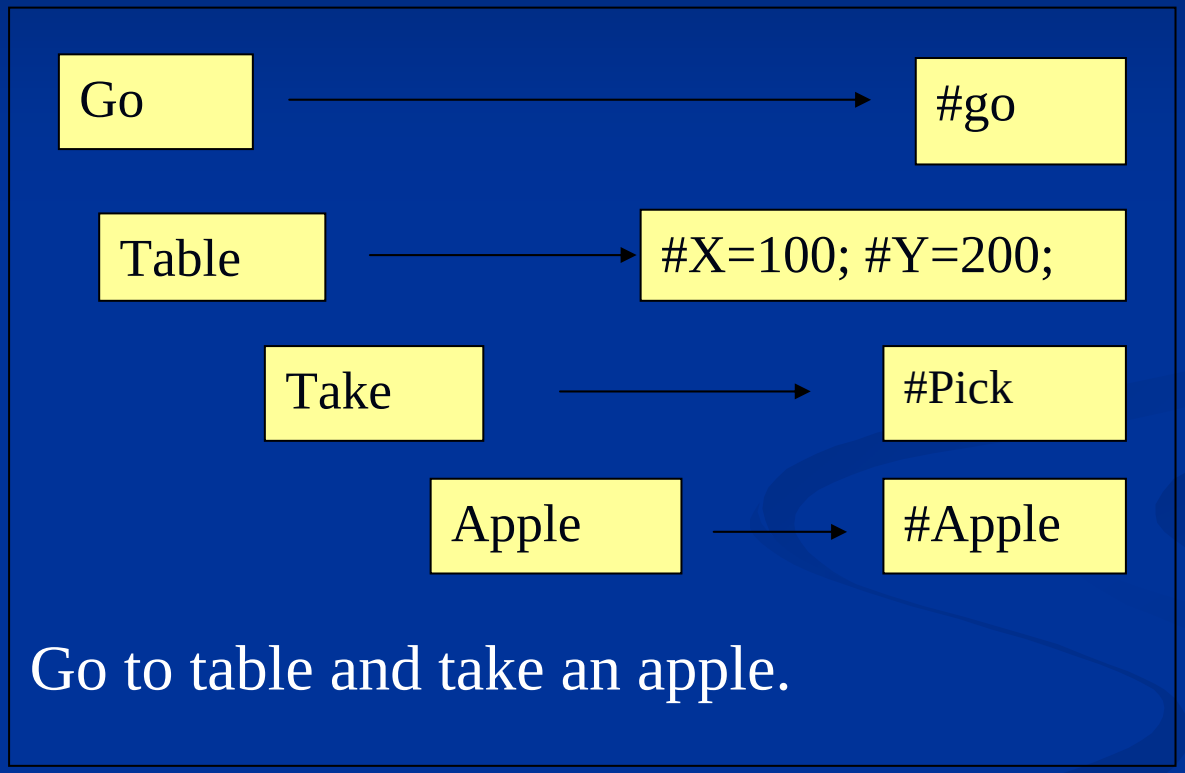
Levels of languages



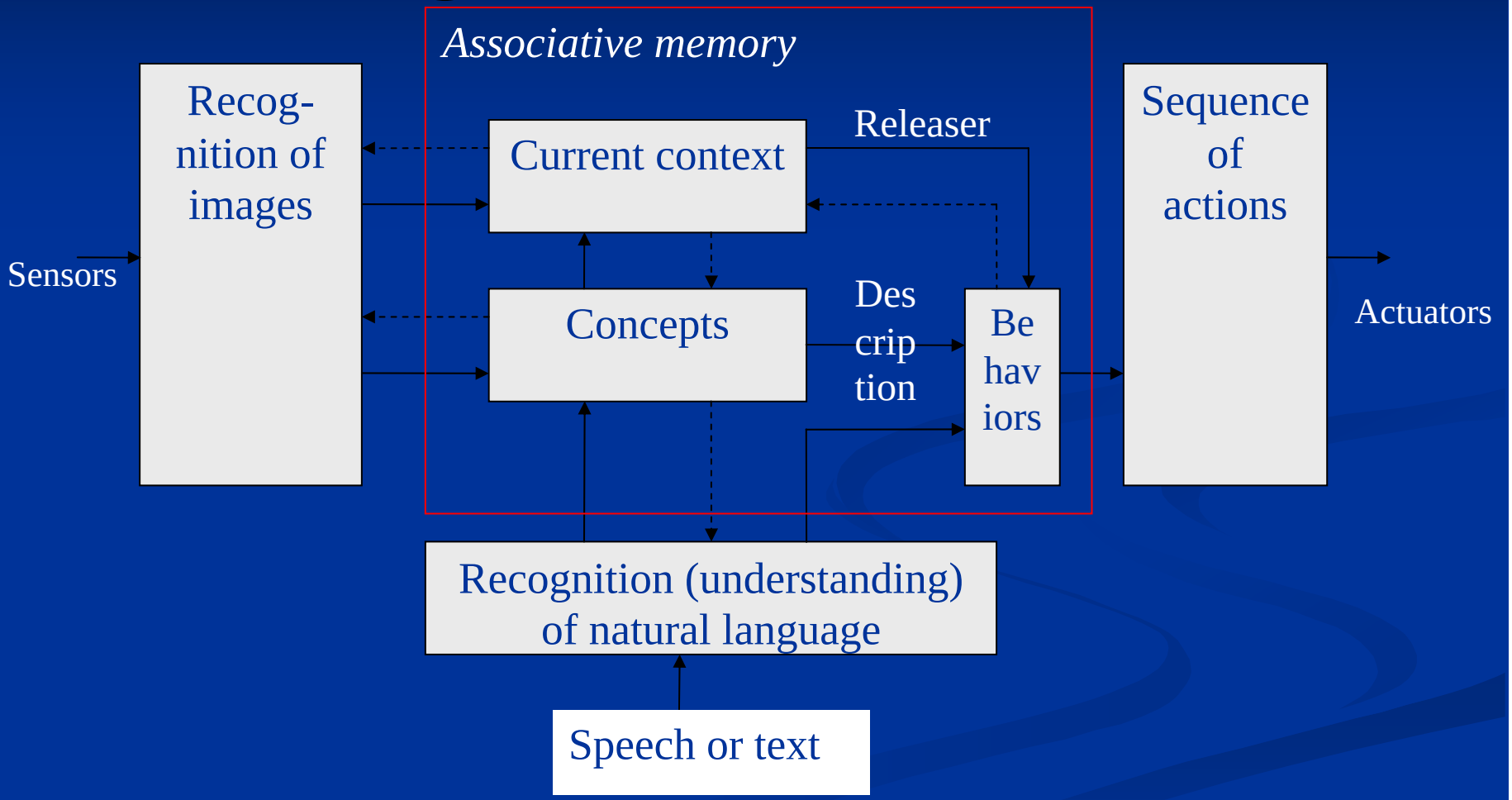
Fragment of knowledge base with association between collocation (“go”, “table”) and set of two context variables (#go, #object)



An example of translation of sentence in natural language to CBLR



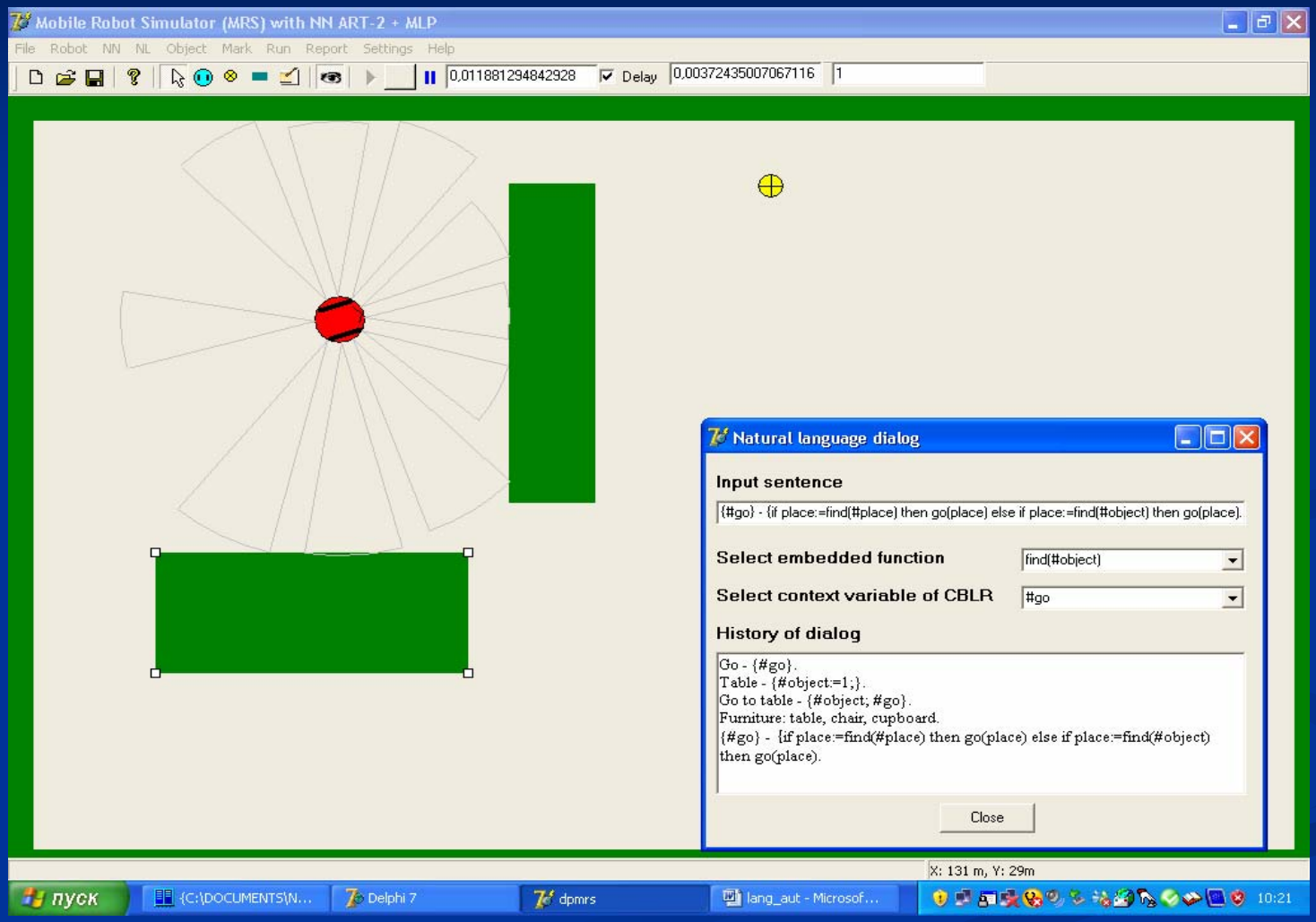
Architecture of programming-learning based control system



Examples of context primitives

Name of context primitive	Possible value	How this parameter influence on execution of motion primitive
Object	Name of object	May be used in action “say”
Internal state	Good, Bad, Normal	May cause motion to or from *Object*
Direction	Left, Right, Forward, Back	May cause corresponding turn depending on *Internal state*
Person	Name of person	May be used in action “say”
Obstacle distance	Far, Middle, Close	May be used in “act”
Obstacle type	Static, Dynamic	May be used in “act”
Speed	Low, Normal, High	May be used in “act”

Screenshot of software for simulation of mobile robot with dialog in natural language and CBLR (on going)



Conclusions

- In this report an approach for programming-learning of robots and other intelligent agents was proposed based on dialog by natural language and widely using context
- Advantages of this approach is opportunity to describe tasks, behavior, movements, world in natural language as learning of robot/equipment
- Result of learning-programming is description of behaviors releasing by recognized concepts of context
- Now this approach is implementing for mobile robots oriented for navigation tasks in our simulation system MRS

Thanks!

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