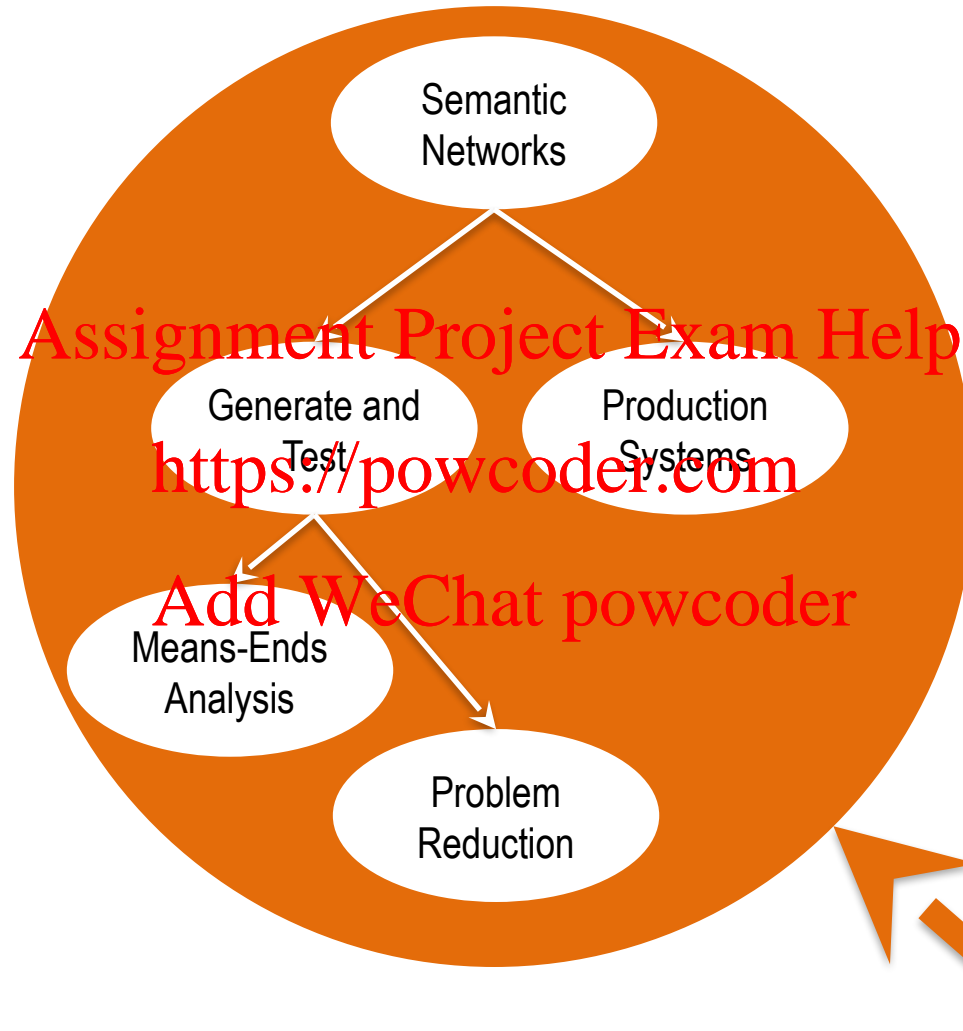


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Production  
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Systems

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# Fundamentals



# Lesson Preview

- Cognitive architectures
- Production systems
- Chunking

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It's the top of the 7<sup>th</sup> inning.  
There are runners on 2<sup>nd</sup> and  
3<sup>rd</sup> base. There are two outs.  
The batter, Martin Prado, has  
an average of .256 and bats  
fourth in the batting order. We  
are winning 3-2. I struck this  
batter out last time. My goal is  
to escape the inning.

What should the pitcher do?

o Pitch to the batter

o Intentionally walk the batter

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# Cognitive System

Metacognition

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Reasoning

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Learning

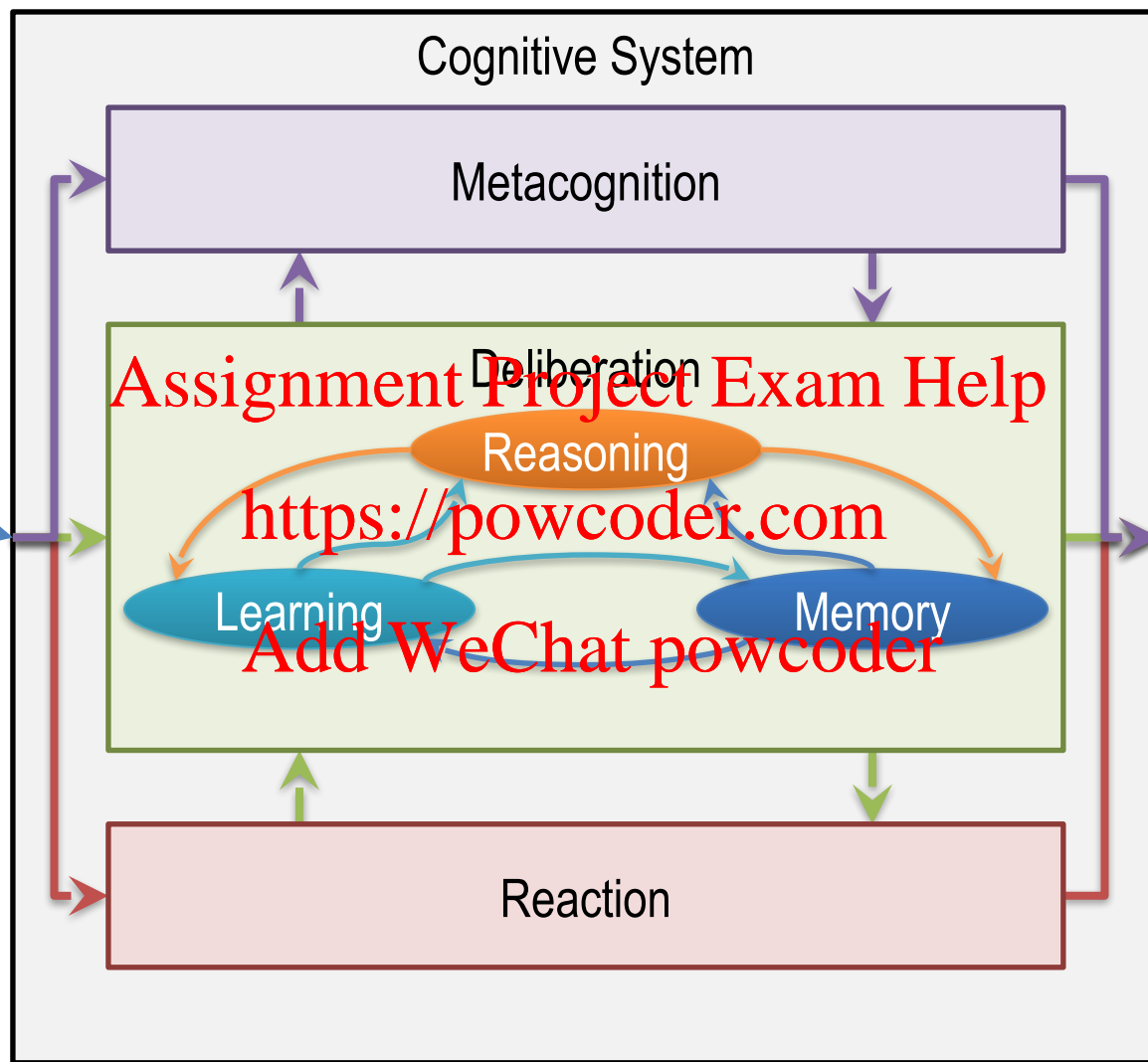
Memory

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Reaction

Input

Output



# Cognitive System

Metacognition

Assignment Project Exam Help

Deliberation

Reasoning

<https://powcoder.com>

Learning

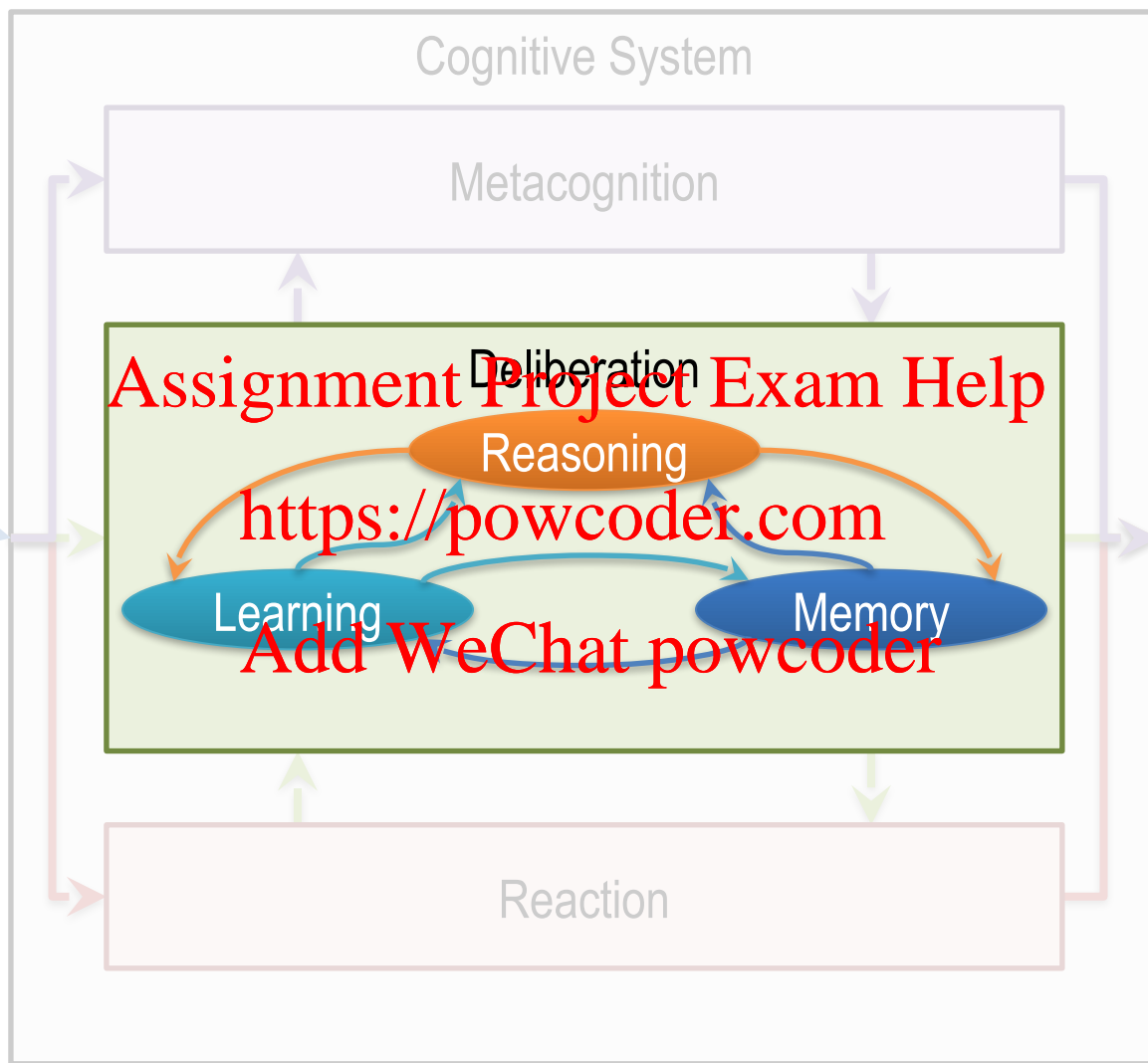
Memory

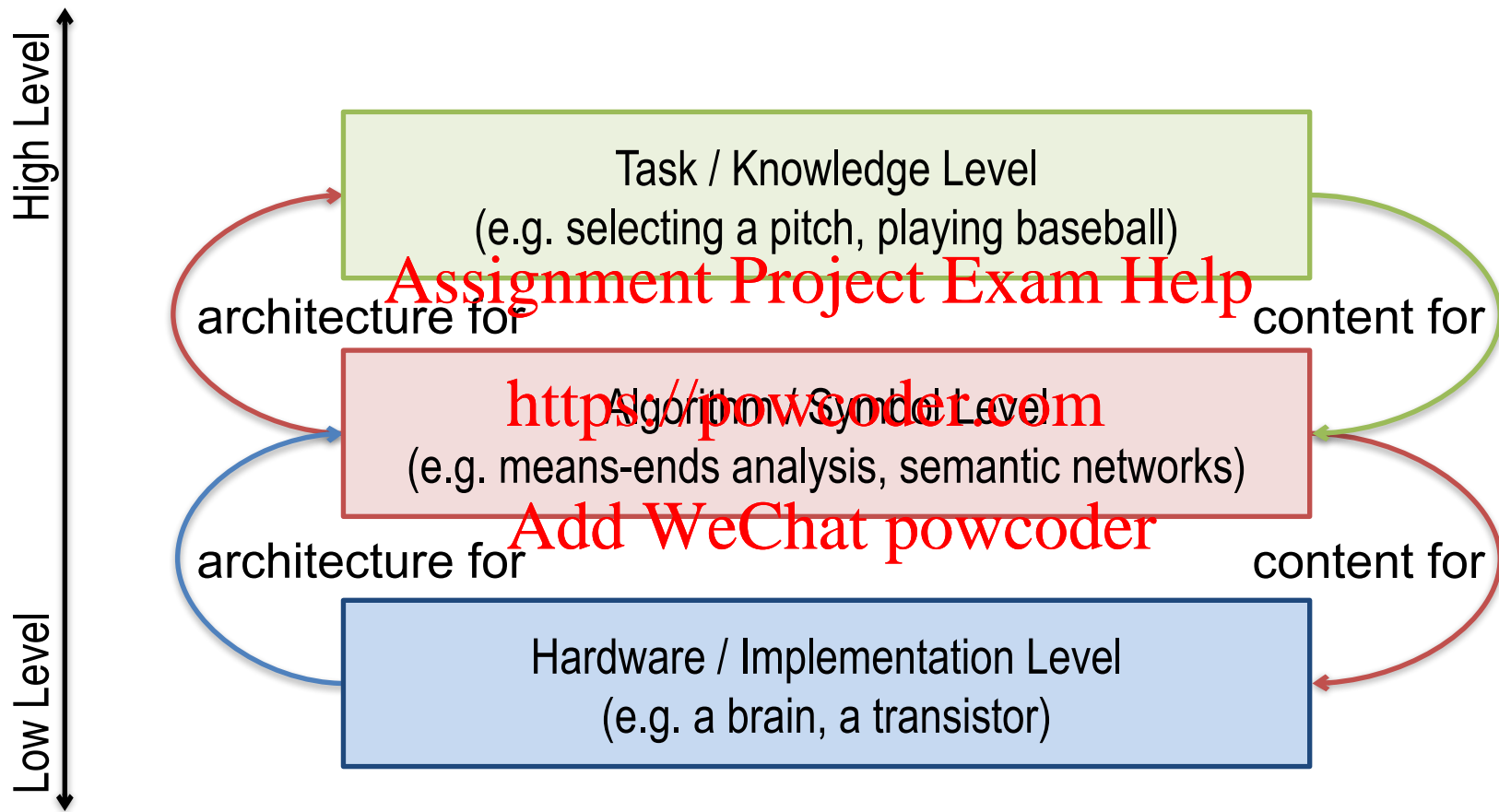
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Reaction

Input

Output





What are the layers of Watson?

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the physical computer

searching and decision-making

answering the inputted clue



# Assumptions of a Cognitive Architecture

- Goal-oriented
- Rich, complex environment
- Significant knowledge
- Symbols and abstractions
- Flexible and function of the environment
- Learning

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Architecture  
+  
Assignment Project Exam Help  
Content  
=  
<https://powcoder.com>  
= Chat  
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Function for cognitive architectures:  
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$f: P^* \rightarrow A$   
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**Add WeChat powder**  
Percepts  $\rightarrow$  Action

# Cognitive System

Metacognition

Assignment Project Exam Help

Deliberation

<https://powcoder.com>

Reasoning

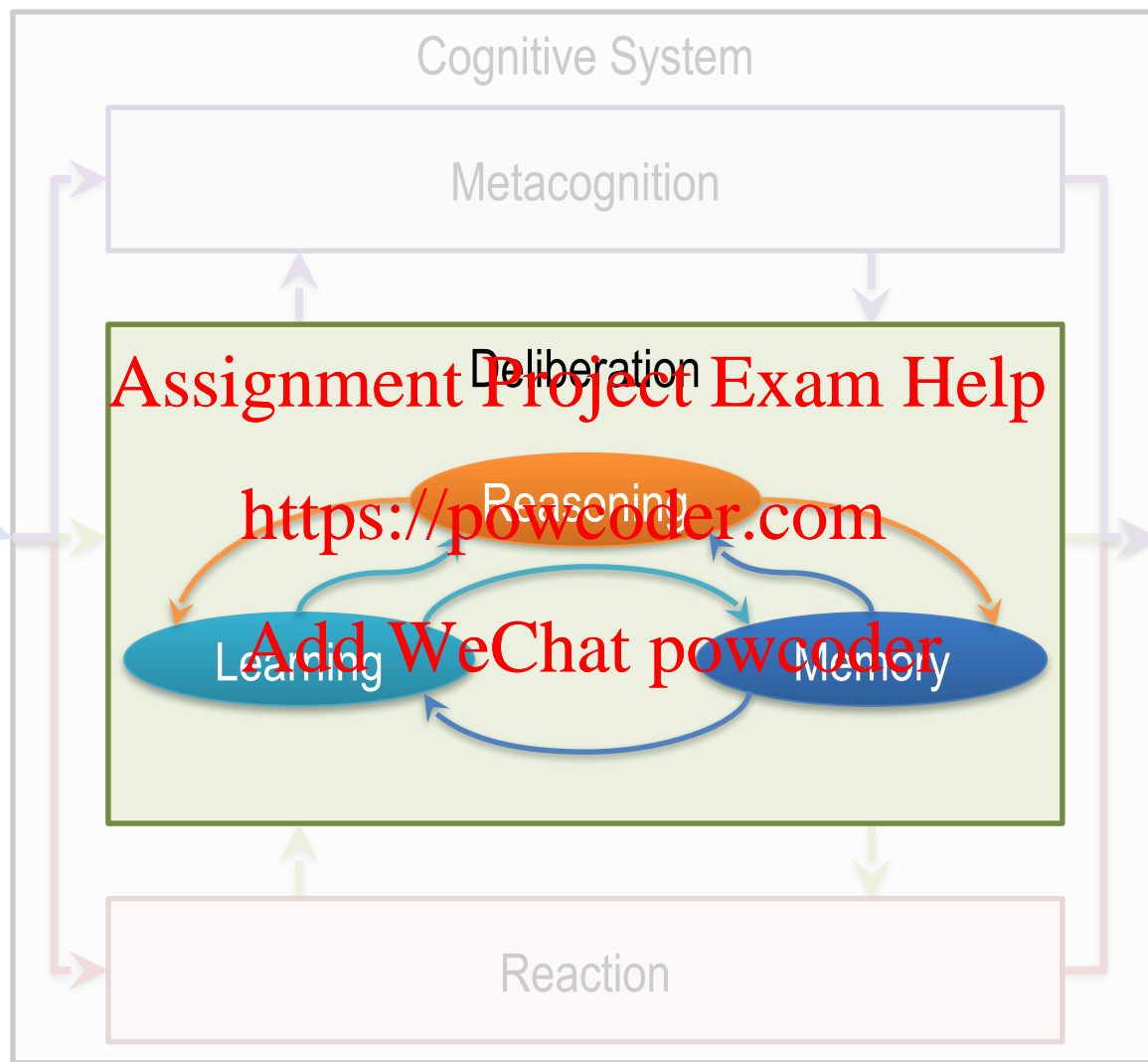
Learning

Memory

Reaction

Input

Output



# Cognitive System

Metacognition

SOAR

Procedural

Semantic

Episodic

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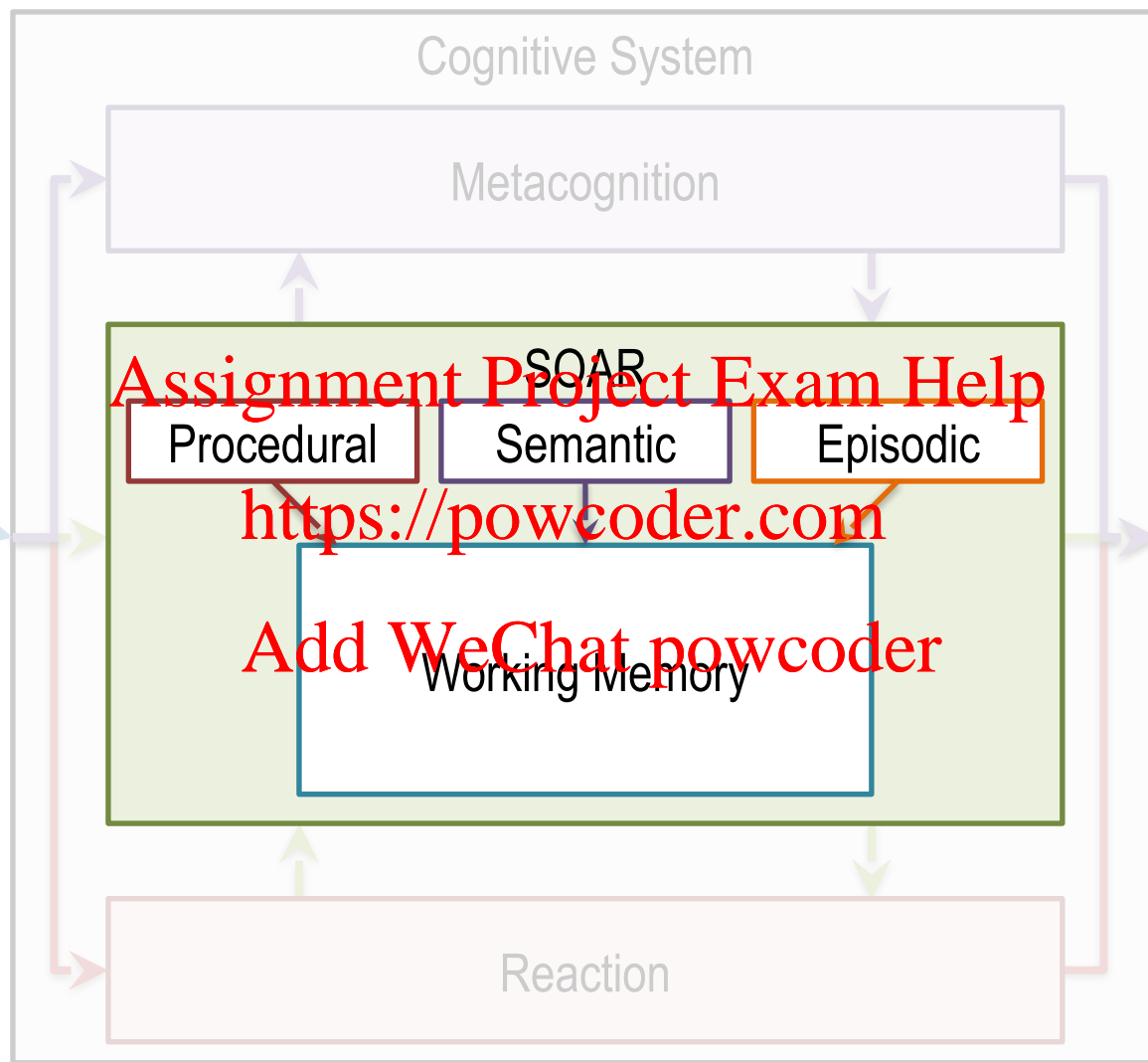
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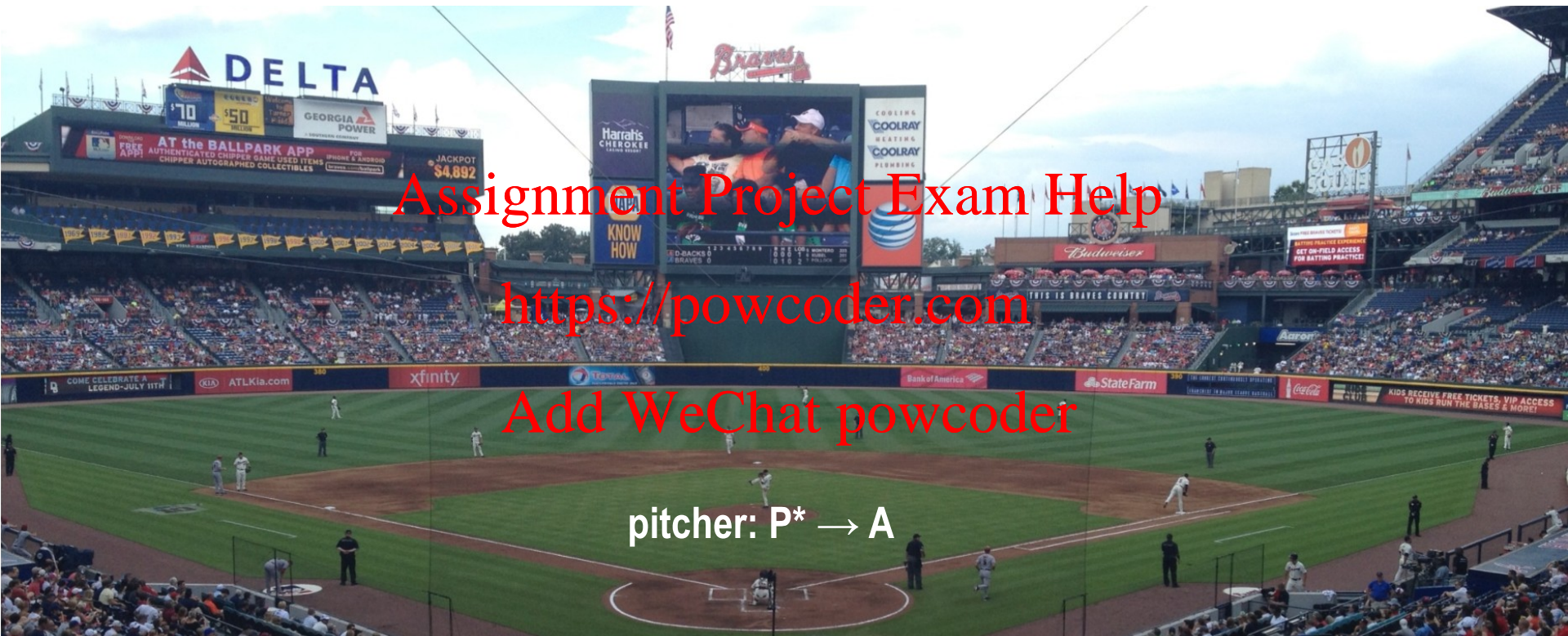
Working Memory

Reaction

Input

Output





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pitcher:  $P^* \rightarrow A$

It's the top of the 7<sup>th</sup> inning.  
There are runners on 2<sup>nd</sup> and  
3<sup>rd</sup> base. There are two outs.  
The batter, Martin Prado, has  
an average of .256 and bats  
fourth in the batting order. We  
are winning 3-2. I struck this  
batter out last time. My goal is  
to escape the inning.

What should the pitcher do?

o Pitch to the batter

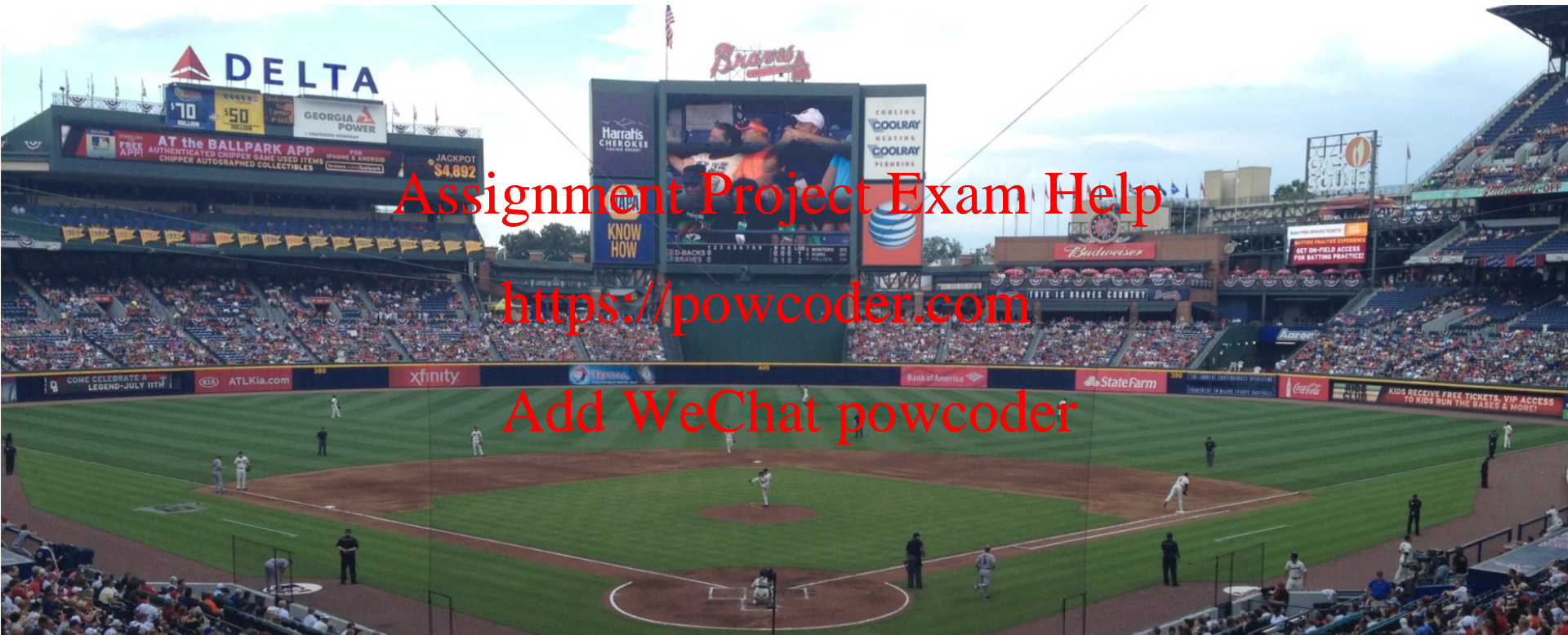
o Intentionally walk the batter

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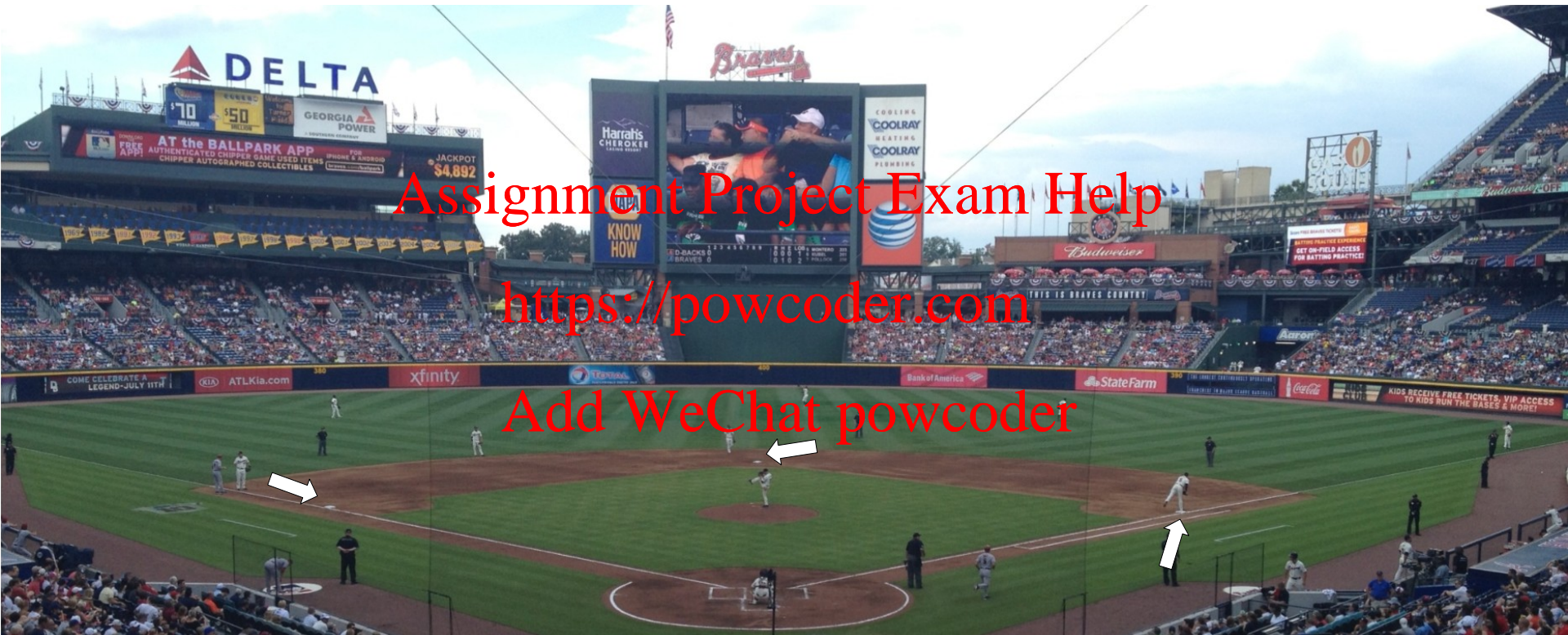


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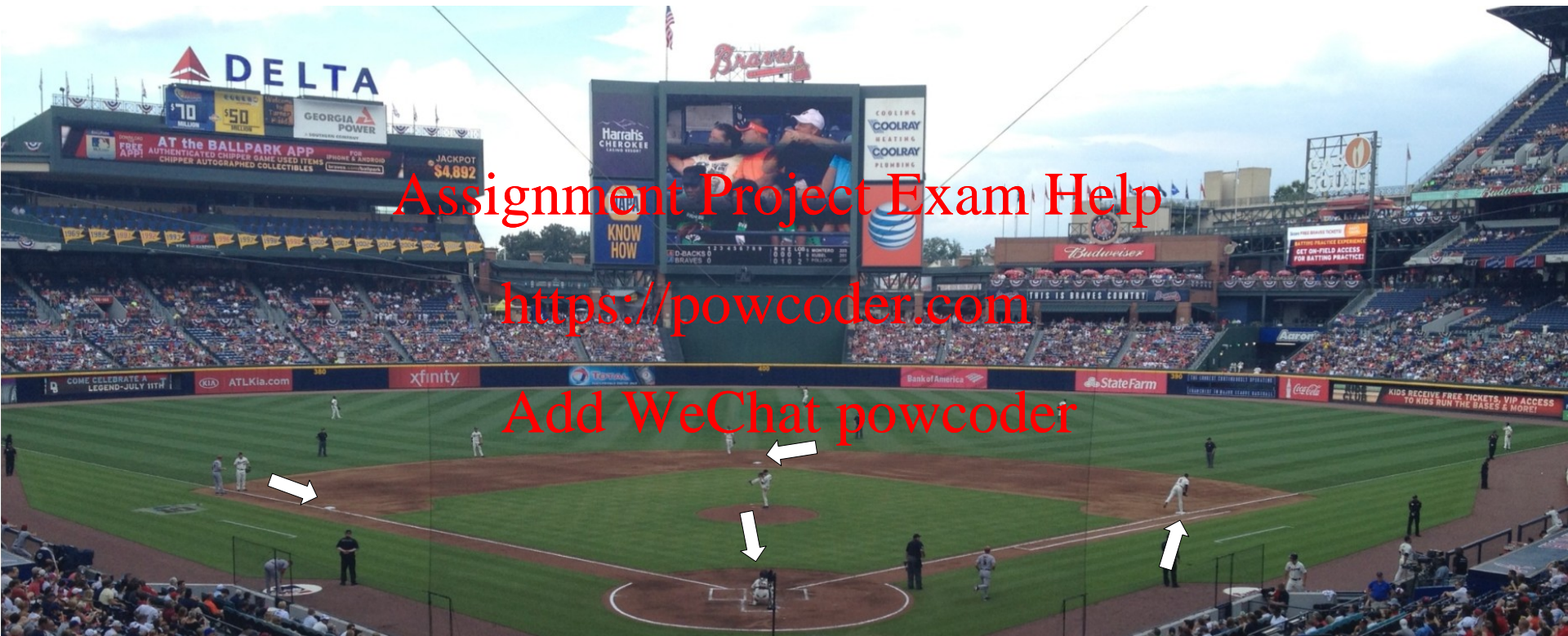




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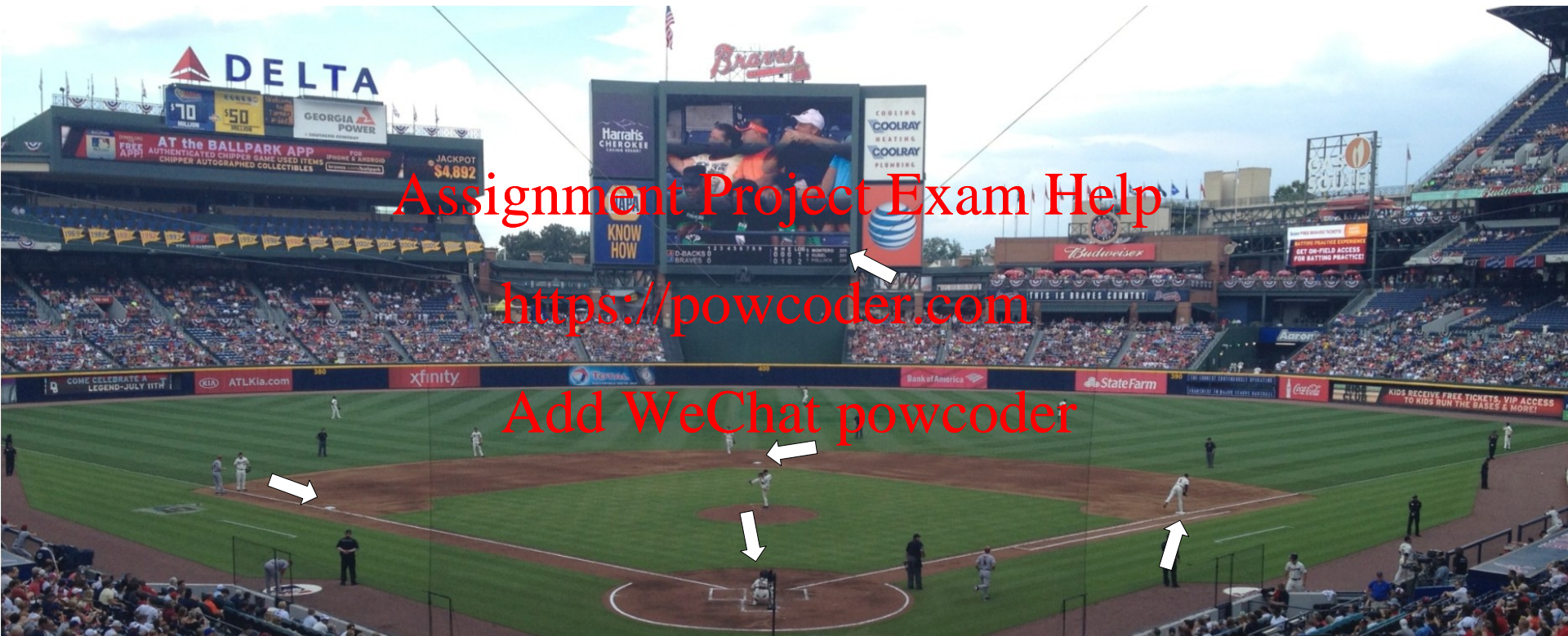
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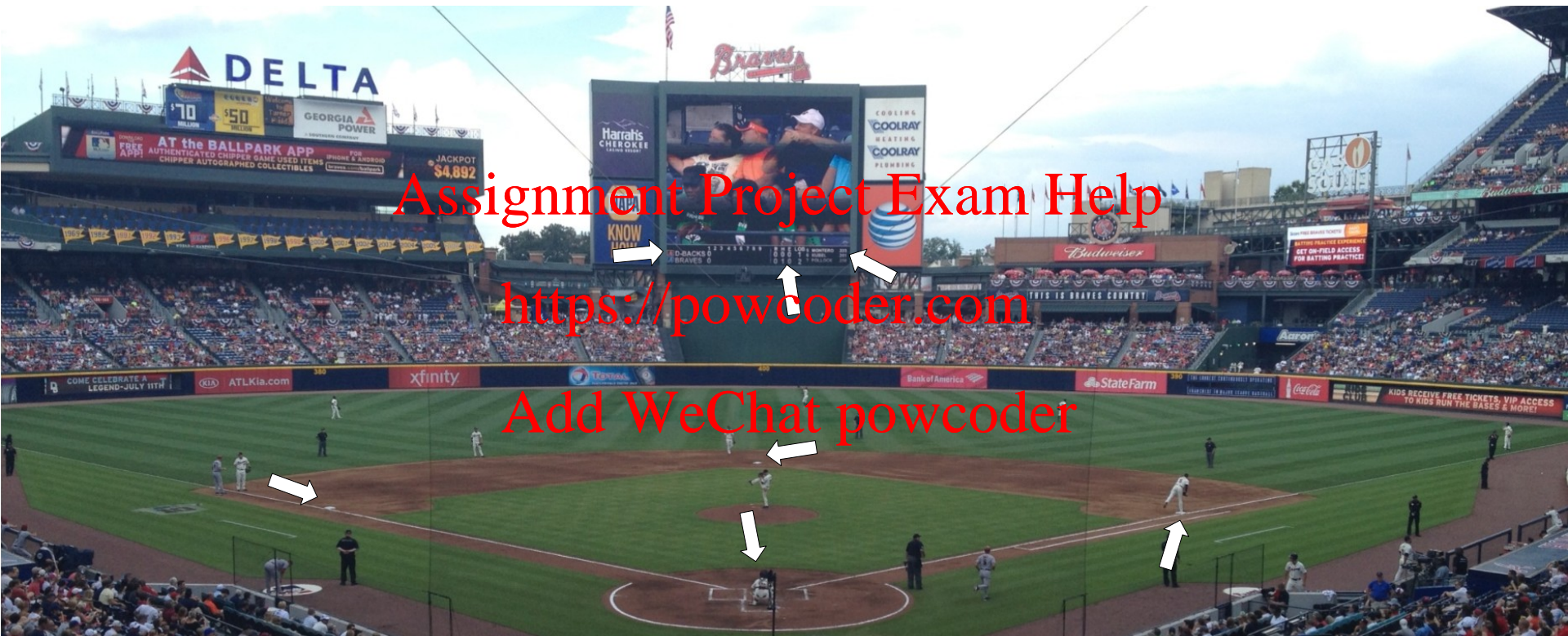




Assignment Project Exam Help

<https://powcoder.com>

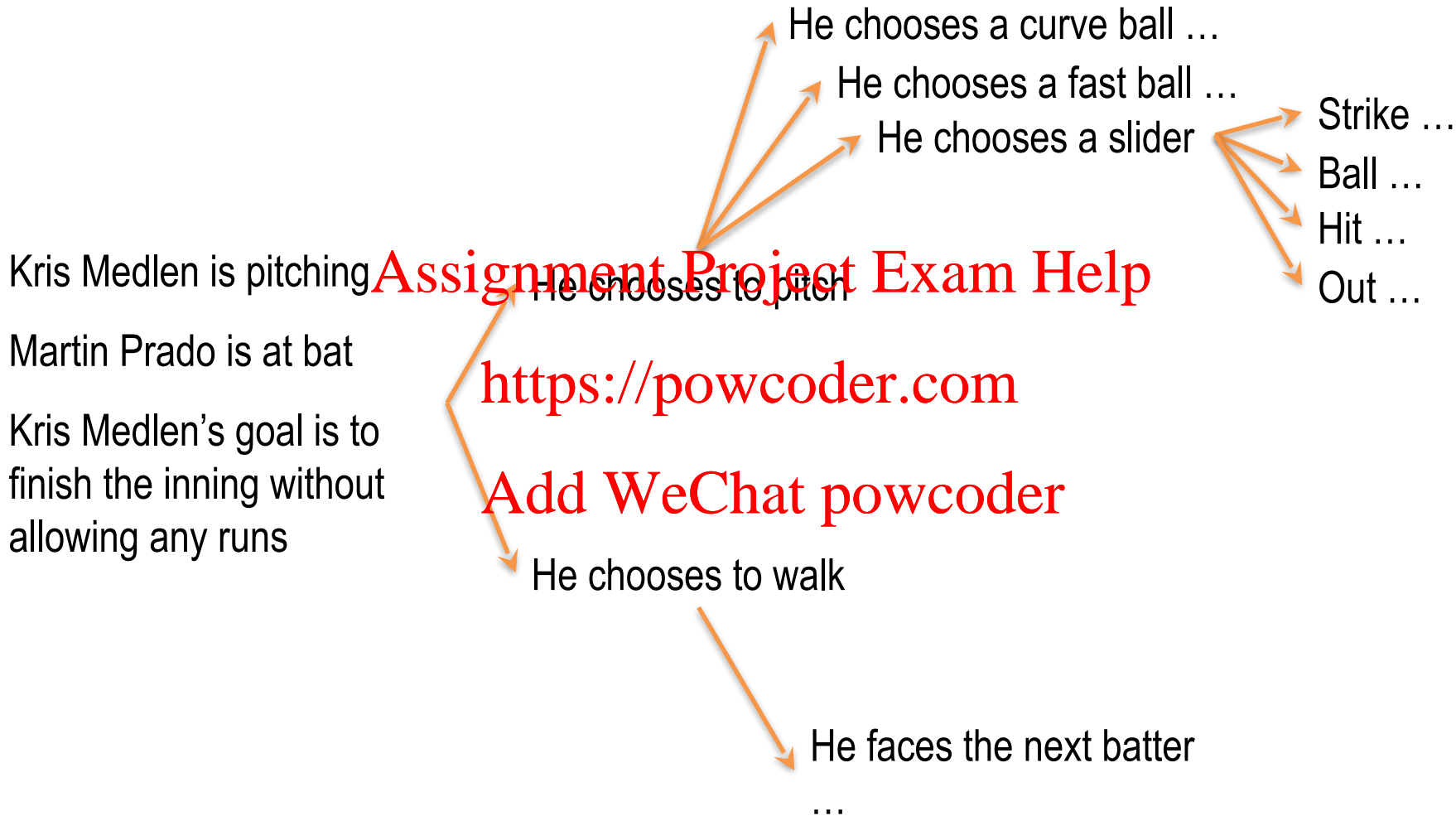
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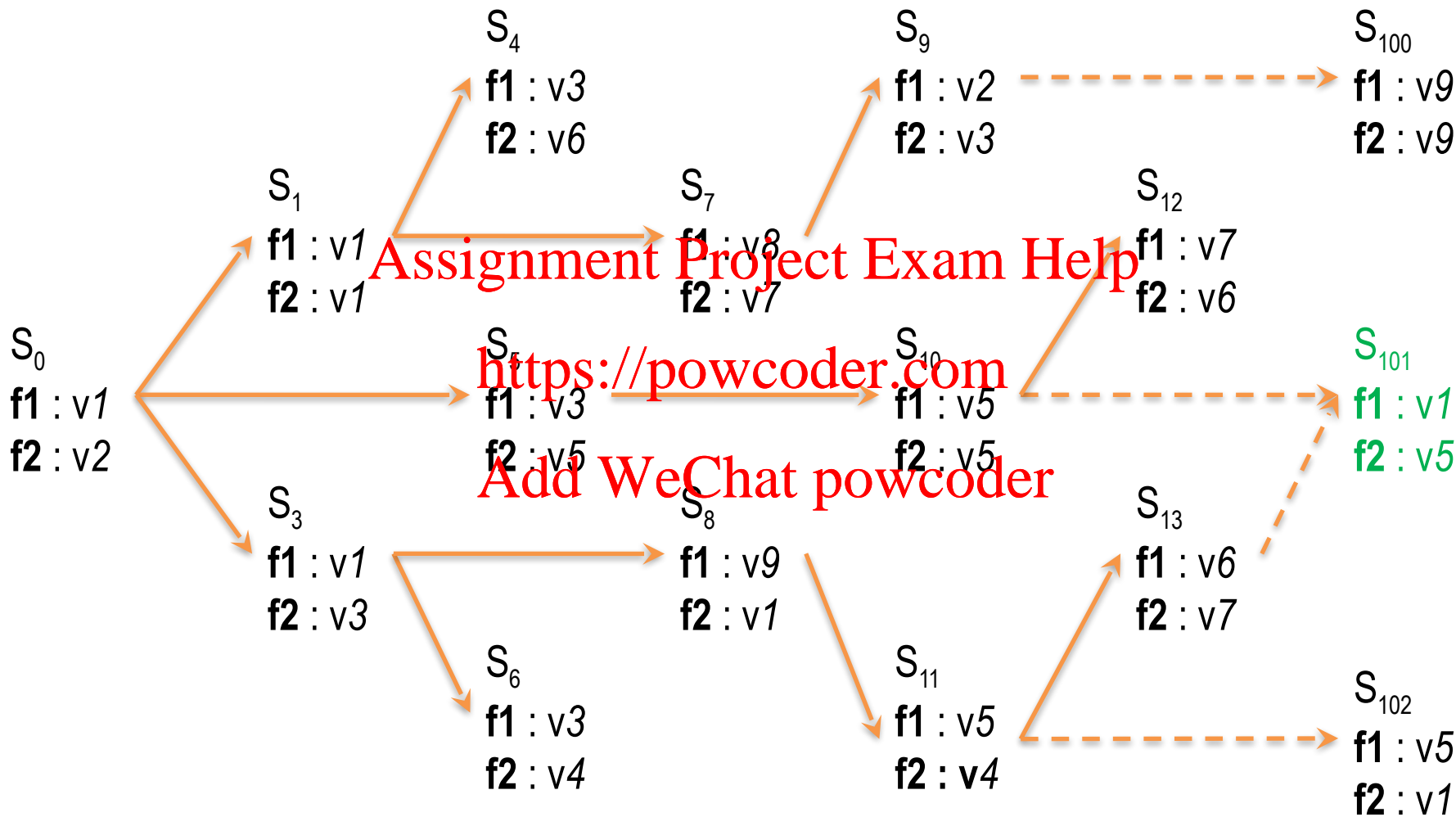


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It's the top of the 7<sup>th</sup> inning.  
There are runners on 2<sup>nd</sup> and  
3<sup>rd</sup> base. There are two outs.  
The batter, Martin Prado, has  
an average of .256 and bats  
fourth in the batting order. We  
are winning 3-2. I struck this  
batter out last time. My goal is  
to escape the inning.

**inning** : 7th  
**portion** : top  
**runners** : 2nd and 3rd  
**outs** : 2  
**batter** : Prado  
**average** : .287  
**bats** : right-handed  
**score** : 3-2  
**goal** : escape inning

# Cognitive System

Metacognition

Assignment Project Exam Help

Procedural

Semantic

Episodic

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Working Memory

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```
inning : 7th  
portion : top  
runners : 2nd and 3rd  
outs : 2  
batter : Prado  
average : .256  
bats : right-handed  
score : 3-2  
goal : escape inning
```

Reaction

Input

Output



```
inning : 7th
portion : top
runners : 2nd and 3rd
outs : 2
batter : Prado
average : .256
bats : right-handed
score : 3-2
goal : escape inning
```

(r1) If goal is to *Escape*, I perceive 2 outs, I perceive a runner on 2nd and I perceive no runner on 1st

then suggest goal intentionally walk batter (*Intentional Walk*)

(r2) If goal is to *Escape*, I perceive fewer than 2 outs, or I perceive a runner on 1st, or I perceive no runner on 2nd, or I perceive no runners

then suggest goal to get the batter out via pitching (*Pitch*)

(r3) If goal is *Intentional Walk*

then suggest intentional-walk operator

(r4) If goal is *Pitch* and I perceive a new batter who is left/right-handed

then add **batter not out**, **balls 0**, **strikes 0**, **bats left/right**

(r5) If the goal is *Pitch* and **batter not out**

then suggest throw-curve-ball operator

(r6) If the goal is *Pitch* and **batter not out** and **bats left-handed**

then suggest throw-fast-ball operator

(r7) If only one operator has been selected

then send operator to the motor system and add **pitch thrown** to state

```
inning : 7th
portion : top
runners : 2nd and 3rd
outs : 2
batter : Prado
average : .256
bats : right-handed
score : 3-2
goal : escape inning
```

## Assignment Project Exam Help

### What operator is selected?

- o intentional-walk
- o throw-curve-ball
- o throw-fast-ball
- o None, the system cannot decide.

(r1) If goal is to *Escape*, I perceive 2 outs, I perceive a runner on 2nd and I perceive no runner on 1st

then suggest goal intentionally walk batter (*Intentional Walk*)

(r2) If goal is to *Escape*, I perceive fewer than 2 outs, or I perceive a runner on 1st, or I perceive no runner on 2nd, or I perceive no runners

then suggest goal to get the batter out via pitching (*Pitch*)

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(r5) If the goal is *Pitch* and **batter not out**

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(r6) If the goal is *Pitch* and **batter not out** and **bats left-handed**

then suggest throw-fast-ball operator

(r7) If only one operator has been selected

then send operator to the motor system and add **pitch thrown** to state

```
inning : 7th
portion : top
runners : 1st, 2nd, 3rd
outs : 2
batter : Hill
average : .269
bats : right-handed
score : 3-2
goal : escape inning
```

## Assignment Project Exam Help

### What operator is selected?

- o intentional-walk
- o throw-curve-ball
- o throw-fast-ball
- o None, the system cannot decide.

(r1) If goal is to *Escape*, I perceive 2 outs, I perceive a runner on 2nd and I perceive no runner on 1st

then suggest goal intentionally walk batter (*Intentional Walk*)

(r2) If goal is to *Escape*, I perceive fewer than 2 outs, or I perceive a runner on 1st, or I perceive no runner on 2nd, or I perceive no runners

then suggest goal to get the batter out via pitching (*Pitch*)

(r3) If goal is *Intentional Walk*

then suggest intentional-walk operator

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(r4) If goal is *Pitch* and I perceive a new batter who is left/right-handed

then add **batter not out**, **balls 0**, **strikes 0**, **bats left/right**

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(r5) If the goal is *Pitch* and **batter not out**

then suggest throw-curve-ball operator

(r6) If the goal is *Pitch* and **batter not out** and **bats left-handed**

then suggest throw-fast-ball operator

(r7) If only one operator has been selected

then send operator to the motor system and add **pitch thrown** to state

```
inning : 7th
portion : top
runners : 1st, 2nd, 3rd
outs : 2
batter : Parra
average : .273
bats : left-handed
score : 3-2
goal : escape inning
```

## Assignment Project Exam Help

### What operator is selected?

- o intentional-walk
- o throw-curve-ball
- o throw-fast-ball
- o None, the system cannot decide.

(r1) If goal is to *Escape*, I perceive 2 outs, I perceive a runner on 2nd and I perceive no runner on 1st

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# Cognitive System

Metacognition

Assignment Project Exam Help

Procedural

Semantic

Episodic

<https://powcoder.com>

Working Memory

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```
inning : 7th  
portion : top  
runners : 1st, 2nd, 3rd  
outs : 2  
batter : Parra  
average : .273  
bats : left-handed  
score : 3-2  
goal : escape inning
```

Reaction

Input

Output

```
inning : 5th
portion : bottom
game : 131
weather : windy
runners : 1st, 3rd
outs : 1
batter : Pierzynski
average : .283
bats : left-handed
score : 1-4
goal : pitch
pitch : throw-fast-ball
result : homerun
```

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```
inning : 5th
portion : bottom
game : 131
weather : windy
runners : 1st, 3rd
outs : 1
batter : Pierzynski
average : .283
bats : left-handed
score : 1-4
goal : pitch
pitch : throw-fast-ball
result : homerun
```

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<https://powcoder.com> (r8) If two operators selected and one has an episode with **result**  
homerun

then prefer other operator

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“chunking”

```
inning : 7th
portion : top
runners : 1st, 2nd, 3rd
outs : 2
batter : Parra
average : .273
bats : left-handed
score : 3-2
goal : escape inning
```

## What operator is selected?

- o intentional-walk
- o throw-curve-ball
- o throw-fast-ball
- o None, the system cannot decide.

(r1) If goal is to *Escape*, I perceive 2 outs, I perceive a runner on 2nd and I perceive no runner on 1st

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(r4) If goal is *Pitch* and I perceive a new batter who is left/right-handed

then add **batter not out**, **bats 0**, **strikes 0**, **bats left/right**

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(r6) If the goal is *Pitch* and **batter not out** and **bats left-handed**

then suggest throw-fast-ball operator

(r7) If only one operator has been selected

then send operator to the motor system and add **pitch thrown** to state

(r8) If two operators selected and one has an episode with **result homerun**

then prefer other operator

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# **Assignment**

How would you use a production system to design an agent that could answer Raven's Progressive Matrices?

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## To recap...

- Cognitive architectures
- Production systems
- Action selection
- Chunking

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