PMM

THINKING ENGINE

for command centre and personal support systems

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http://www.proto-mind.com
PMM Thinking Engine automatically collects and systemizes information, learns required behaviour and accumulates experience through a set of relevant manuals, instructions and books or just being corrected on fly during running dialogues.

Proto-Mind Machine Thinking Engine is a fully operational model of the human intellect. Being educated, PMM helps with decision making by rapid processing of an uncertain data like sets of English language messages.

PMM accepts mixed text-video-audio data as input and generates a corresponding text-audio data as an output. Knowledge for output generation is being created automatically when PMM processes its interconnected input data streams.
APPLICATIONS

“Today, command centers require hundreds of staff members to support a relatively small number of key decision makers. The Personalized Assistant that Learns (PAL) program is developing machine learning technologies to make information understanding and decision-making more effective and efficient for military users. The program is creating robust software assistants that can help users perform a wide variety of tasks while adapting to the environment and the user’s goals without programming assistance or technical intervention. PAL technologies will reduce the need for large command staffs, thereby enabling smaller, more mobile, less vulnerable command centers.”

DARPA PAL web site

“The problem is to grasp in innumerable special cases the actual situation which is covered by the mists of uncertainty to appraise the facts correctly and to guess the unknown elements to reach a decision quickly and then carry it out forcefully and relentlessly.”

Helmut von Moltke

PMM Thinking Engine is the most efficient in the following domains related to the command centre and personal support systems:

- **Smart agents** that scan the current common operating picture for any contingency that is likely to require further attention by staff.
- **Knowledge management systems** that autonomously integrate new information into existing information repositories, preserving and validating the information quality with respect to its age and reliability using relational databases.
- **Image analysis** performed by artificial intelligence systems, freeing human resources for vital human intelligence functions.
- Artificial intelligence systems that incorporate **human-level common-sense knowledge**, planning and reasoning abilities, permitting fully autonomous tactical decision-making by unmanned weapons systems within complex mission environments.
- **Psychological support** - human memory is not perfect, and soldier’s ability to react properly in uncertain situations is sometimes even worse - soldier may panic in extreme situations taking wrong and dangerous decisions. PMM thinking engine can help him by giving him **cold-minded advices** and general psychological support.

**PMM Military Assistant** (MA) is the first English-speaking artificial intelligent agent for military use which automatically learns. It uses PMM Thinking Engine to provide information support in order to help with decision making and communicating. MA uses **free English** to deliver and perceive information:

- MA works like a kind of information system which can be asked in English and can be expanded or modified with new data in free English as well without any limitations.
- MA can schedule time-related or situation-related events. MA will inform about necessary actions on these events.
- MA can work as a “secretary” processing the incoming messages and estimating the message importance on the request or delivering them at proper times.
The main PMM algorithm for information processing is of a neural network type which makes PMM reactions look like human ones - through the resemblance of current and all known discourses.

PMM works in three modes:
- **Listening** when it accumulates knowledge and current discourse,
- **Answering** when it generates the output using the acquired knowledge,
- **Mixed** when two modes above follow each other during dialogues.

**Mixed** mode allows PMM to gain experience during a normal functioning (e.g. learning on the fly). **Mixed** mode corresponds to human dialogues when dialogue partners exchange messages which are relevant to the current discourse. And the main PMM ability is to efficiently participate in such dialogues through generating discourse-dependent messages.

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### Relevant Publications

HOW PMM THINKING ENGINE WORKS

Our method: Creating the broad discourse connections
Being given any natural language message, PMM connects it with the messages-predecessors. After that these messages are used as templates of some kind for future dialogues. PMM accepts all input messages and resolves possible contradictions in a human-like manner. PMM's answers become stable and ready for practical use when the necessary volume of experience is gained.

* * * * *

Background: The model of brain neural network
Theoretical basis of PMM Thinking Engine is a result of scientific research in the field of neural network models.

* * * * *

Usage: Getting knowledge through reading and conversing
PMM Thinking Engine accepts English language requests and gives corresponding English language responses. Mixed English and formal language requests and responses are also supported. In order to create PMM knowledge base we simply ask it to read a specific manual for application domain and provide some training on basic user cases.

* * * * *

Hardware: Variety of configurations
There is a variety of hardware which can support PMM Thinking Engine. All hardware configurations include multi-core processor and 2 GB memory at least. Detail specification of hardware configuration depends on customer’s requirements.

* * * * *
EXAMPLES OF INTELLECTUAL BEHAVIOR

Following examples of PMM functioning are divided onto two parts.

The first part contains PMM responses to the questions and corresponding situation descriptions relevant to some pseudo-combat environment. This environment was introduced to PMM through the manual which had the typical scenarios for possible combat situations. The manual has been read by PMM.

After that PMM had been questioned about the situations which are similar (but not the same!) to ones described in the manual.

The general structure of examples includes:
- original situation descriptions which comprise expected PMM reaction,
- description of the test situation and the relevant question or message to PMM,
- response of PMM.

Each test result is organized in the table:

<table>
<thead>
<tr>
<th>Description of the test situation and the relevant question to PMM (serves as a test request to PMM)</th>
<th>PMM response to the test request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original situation descriptions which comprise expected PMM reaction (excerpt from the manual which was read by PMM before the tests started)</td>
<td></td>
</tr>
</tbody>
</table>

A color legend is used to present and highlight the important details of each test:

- **Red** color highlights the phrases and/or their parts which were intentionally omitted in parts 1 and 2 to make the test situations different from the original ones.

- **Blue** and **green** colors show the difference of the corresponding phrases between original situation description in the part 1 and description in the part 2 (altered for testing).

- **Magenta** color indicates a changed sentence order (i.e. unchanged phrases have different positions in the original and test situation descriptions).

Square brackets enclose the internal PMM responses (PMM internal speech) which are not exposed normally.

The second part of examples shows the general PMM ability to think like human. Prior creating these examples PMM has read a plenty of novels which constituted the PMM’s knowledge database.
Pseudo-Combat Environment

THE SAME QUESTION - TWO DIFFERENT CONTEXTS – TWO DIFFERENT ANSWERS

<table>
<thead>
<tr>
<th>FIRST REQUEST</th>
<th>PMM ASWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down the road the vehicles came to a <strong>jerky</strong> halt</td>
<td>Bots see a checkpoint</td>
</tr>
<tr>
<td>Campbell couldn't see <strong>clearly</strong> what the <em>reason</em> was through the Camel's</td>
<td>[ Came Marchand's voice from the back seat ]</td>
</tr>
<tr>
<td>windshield</td>
<td>Looks like the local constabulary</td>
</tr>
<tr>
<td>What's going on?</td>
<td></td>
</tr>
</tbody>
</table>

...**Halfway** down the road the **lead** vehicles came to a **sudden** halt
Campbell couldn't see what the **problem** was through the Camel's **starred** windshield
Marchie? Tam?
What's going on?
Bots see a checkpoint
Came Marchand's voice from the back seat
Looks like the local constabulary...

<table>
<thead>
<tr>
<th>SECOND REQUEST</th>
<th>PMM ASWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daz swore under his breath</td>
<td>We've rerouted into infrared through the swarmbot net, Sarge</td>
</tr>
<tr>
<td>However the gunfire had become a <strong>monotonous din</strong> followed by echoes</td>
<td>[ The EM bands are all full of noise ]</td>
</tr>
<tr>
<td>Simultaneously Marchand <strong>muttered</strong> something in Campbell's headset</td>
<td>I think the insurgents are bombing the crap out of the city's communications grid</td>
</tr>
<tr>
<td>What's going on?</td>
<td>But our equipment is shielded</td>
</tr>
</tbody>
</table>

...Daz swore under his breath and at length
Just then however the gunfire that had become a **monotonous din**, **trailed off in** echoes
Simultaneously Marchand **spoke** in Campbell's **ear**
Hear me?
Marchie, we hear you
What's going on?
We've rerouted into infrared through the swarmbot net, Sarge...
The EM bands are all full of noise
I think the insurgents are bombing the crap out of the city's communications grid
But our equipment is shielded
Great I meant what's going on here, right now?
Why's the firing stopped?
Oh the strikebots put down the enemy bots, Sarge...
**LOGIC INFERENCE**

<table>
<thead>
<tr>
<th><strong>REQUEST</strong></th>
<th><strong>PMM ANSWER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Children were laughing as they chased tiny helicopter drones</td>
<td>[That's momentarily putting them too far from the ground to sniff out any nearby explosive devices]</td>
</tr>
<tr>
<td>These ones bounced in the air far from the children's reach</td>
<td>The drones are to be back and followed Camel</td>
</tr>
</tbody>
</table>
| Five meters ahead of the Camel, some children were laughing as they chased| From MANUAL
| two palm sized helicopter drones                                         | It would have been odd to see a Camel that didn't have one or two of them circling around it
| The drones were part of the Camel's standard kit                          | These ones bounced up into the air, out of the children's reach
| From MANUAL                                                               | That's momentarily putting them too far from the ground to sniff out any nearby explosive devices
| It would have been odd to see a Camel that didn't have one or two of them | The drones are to be back and followed Camel!                                                                                                 |
| circling around it                                                        |                                                                                                                                             |

**GENERAL QUESTIONS**

<table>
<thead>
<tr>
<th><strong>REQUEST</strong></th>
<th><strong>PMM ANSWER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sixty feet of empty lot surrounded the plant</td>
<td>An action that was relayed automatically to the operations situation display</td>
</tr>
<tr>
<td>They pulled in behind a screen of sun withered trees and everybody began</td>
<td></td>
</tr>
<tr>
<td>getting out of the vehicles</td>
<td></td>
</tr>
<tr>
<td>Why Campbell activated the strike bots in this situation?</td>
<td></td>
</tr>
</tbody>
</table>
| It was offset from the road by wire fencing and a row of grotesquely       | From MANUAL
| rusted oil tanks                                                          | An action that was relayed automatically to the operations situation display!
| A good sixty feet of empty lot spread out around the plant itself, which    | They rose up in whirs of dust                                                                                                                  |
| was two stories high and largely windowless                               |                                                                                                                                               |
| They pulled in behind a screen of sun withered trees and everybody began   |                                                                                                                                               |
| piling out of the vehicles                                                |                                                                                                                                               |
| Campbell activated the strikebots,                                         |                                                                                                                                               |
| An action that was relayed automatically to the operations situation      |                                                                                                                                               |
| display!                                                                   |                                                                                                                                               |
| They rose up in whirs of dust                                              |                                                                                                                                               |
**GENERAL QUESTIONS**

### REQUEST

Semaphore
This could be useful
We're going to need a brief course on this semaphore language
But now we know what we have to do to defend
So what we have to do to fight back?

### PMM ANSWER

[ but at least now we know what we have to do to fight back ]
We have to hijack Mastan Nouria's message and substitute our own!

Semaphore,
Said Ebun instantly
They all looked at her again
It's a gang thing, in the slums,
She explained
It started out as hand signals during silent raids, and evolved into this elaborate system that uses flags
All the slum kids learn it
Did you learn it?
She nodded
The major grinned
This could be useful
Major Monet, have you noted that?
Yes, I have,
Said a weary-sounding voice over the HMDs
We're going to need a crash course on this semaphore language
But at least now we know what we have to do to fight back
We have to hijack Mastan Nouria's message and substitute our own!

### REQUEST

The swarmbots had rolled and scuttled their way into positions where they could use their Doppler radar and terahertz sensors
Desai recorded a number of heartbeats inside the generator building,
Only six or seven in the main plant beyond
Where the plant personnel is hiding?

### PMM ANSWER

The plant personnel must be hidden somewhere deeper inside, out of reach of her sensing gear
[ It was a maze of metal in there, after all, so the radar didn't work at all well ]

The swarmbots had rolled and scuttled their way into positions where they could deploy their Doppler radar and terahertz sensors
She registered a number of heartbeats inside the generator building,
Only a half dozen or so in the main plant beyond
From MANUAL
The plant personnel must be hidden somewhere deeper inside, out of reach of her sensing gear!
It was a maze of metal in there, after all, so the radar didn't work at all well
## GENERAL QUESTIONS

<table>
<thead>
<tr>
<th>REQUEST</th>
<th>PMM ANSWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>The two trucks were cableless</td>
<td>Reinforcements should be arriving now!</td>
</tr>
<tr>
<td>Campbell looked more closely</td>
<td></td>
</tr>
<tr>
<td>Behind them was a set of multi wheeled platforms piled with cargo</td>
<td></td>
</tr>
<tr>
<td>Each <strong>scarabs</strong> was surmounted by a strike bot</td>
<td></td>
</tr>
<tr>
<td>Ops, where are <strong>those damn</strong> reinforcements?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>From MANUAL</td>
</tr>
<tr>
<td>Campbell looked more closely</td>
<td></td>
</tr>
<tr>
<td>The two trucks were cableless</td>
<td></td>
</tr>
<tr>
<td>Behind them was a herd of squat multi wheeled platforms piled with crates and equipment</td>
<td></td>
</tr>
<tr>
<td>These low slung cableless vehicles were aptly named scarabs</td>
<td></td>
</tr>
<tr>
<td>Each <strong>one</strong> was surmounted by a strike bot in sentry mode</td>
<td></td>
</tr>
<tr>
<td>Ops, where are <strong>our</strong> reinforcements?</td>
<td></td>
</tr>
<tr>
<td>Reinforcements should be arriving now!</td>
<td></td>
</tr>
<tr>
<td>said MA in his ear</td>
<td></td>
</tr>
<tr>
<td>Only the bots and automated vehicles got through!</td>
<td></td>
</tr>
</tbody>
</table>
In order to fill PMM memory in with some knowledge which is necessary for the experiment PMM Thinking Engine was requested to read and memorize a set of books, articles from a variety of domains, internet chats, messages, etc. After reading, PMM became able to generate proper (e.g., relevant to the given examples) responses using the linguistic knowledge gained during the reading period.

The following examples were created after PMM has read 60 books and texts of the mentioned types and analysed a set of simple visual images in the corresponding discourses. The first example below is the most complex one. It demonstrates the real thinking process in PMM: the PMM answer is an estimation of the gentleman who describes himself in the context part of the example. Also PMM gives advice on how to manage the situation. Neither the estimation nor the advice is mentioned in the Stevenson’s book; they are PMM’s opinions on the subject.

**CONTEXT** *(excerpt from St. Ives by Robert Louis Stevenson):*

*Why, my dear madam!*
*I only -*
*I began.*
*You shouldn't jest in serious matters, she interrupted.*
*On the whole, she entered into what I chose to tell her of our idyll with avidity, like a cat licking her whiskers over a dish of cream.*
*And, strange to say - and so expansive a passion is that of love!*
*That I derived a perhaps equal satisfaction from confiding in that breast of iron.*
*It made an immediate bond:*
*From that hour we seemed to be welded into a family-party.*
*And I had little difficulty in persuading her to join us and to preside over our tea-table.*
*Surely there was never so ill-matched a trio as Rowley, Louise and the viscount Anne!*
*But I am of the apostle's way, with a difference:*
*All things to all women!*
*When I cannot please a woman, hang me in my cravat!*

**PMM ANSWER:**
*I don't know to what denomination he joined*
*But we've got to get out of here. The only question that throws anything like a vague light on this mysterious matter is a report.*
The next example works with a direct question.

**CONTEXT:**
...it is not good to laugh on a poor man; everybody must respect others independently of their living level.

**QUESTION:** what do you think about respect?

**PMM ANSWER:** Be friendly, genial, convivial - what you will - if you desire nothing more than

Other example is short, it show that even a single request to the system get a coherent answer.

**QUESTION:** Hello my dear friend who lives in a distant city.

**PMM ANSWER:** You and I have put up too many thoughts together and chased them.

The next example is similar. The question was asked just after the system finished reading a book.

**CONTEXT** (it is the end of the book the system was reading):
... the room he sat her down just within the door, and held her, clinging to him.

**QUESTION:** where do you live?

**ANSWER:** I live there, and it must be four miles, anyhow.

And finally, we illustrate the internal PMM speech which was generated at the period when PMM was not being requested any answers during a relatively long time. So PMM was recalling the events from the books it had read. We would like to attract attention to the fact that PMM generated internal speech is united by the same theme (struggling with enemies in this case; PMM selected this theme itself).

... I exclaimed. She answered and clung to narrow slippery edges with our declared enemies the hurons. Now made a ninety-degree turn and entered the gaping hole. Cyrus Smith return to his companions and told simply: Yes. But that menace terrifies me. I am not fighting man at all monsieur, continued laughing scout, as he pointed toward the body. But to colonists they were enemies. …
**Speech and Vision Integration**

PMM has ability to see objects through its cameras. PMM binocular vision is fully integrated with its logical linguistic part. The examples below demonstrate how the objects in the camera fields influence the PMM answers to the relevant requests (images from the left and right cameras respectively).

REQUEST: Name the object

PMM ANSWER: This is flowers

REQUEST: Name the object

PMM ANSWER: This is a vase

REQUEST: Name the object

PMM ANSWER: This is a vase with flowers
Instructor gives instructions to PMM on how to make a request to the relation database in some typical situation

**CONTEXT:**
Our navy experiences problem near the shore of **Ugala**. Our warships have been attracted during patrolling the Wild Ocean. We must stop **Ugala**’s **navy** actions.

**ACTION:**
{select “DB returns Base List:”, target from TargetList where country = “Ugala” and (targetType = “navy”)}

**CONTEXT:**
DB returns Base List: **Wakao**, **Iodine**

**ACTION:**
{select “Commander on duty:”, officer from OfficerList where (date = current)}

**CONTEXT:**
DB returns Base List: **captain Smith**

**ACTION:**
captain Smith can launch a missile at **Iodine** base now

Any learning use case consists of a short introduction (CONTEXT part) and desirable reaction (ACTION part). Sometimes a use case can have no context part if it goes immediately after the previous instruction and inherits its discourse (for example, instruction 2 inherits the discourse of instruction 1). Highlighted words help to keep track on relationships in the texts.

Note: ACTION part can contain formal language statements or English phrases or their mix.
**USE CASE: REQUESTS**
(Interaction with relational database)

How it works: insider’s view

**Formal SQL statements**

- select target from TargetList
  where (country = “Zefra”) & (targetType = “navy”)

**DB returns Base List:**
Dugan, Aruka

- select officer from BaseData
  where (time = current)

**Major Haller**

Officer makes a request to PMM

**English language request**

- Our navy has a problem near Zefra.
  We have to suppress Zefra’s navy activity!

**PMM synthesized answer**

- Major Haller can launch a missile at Aruka base now
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