Chatbots:
Getting to Level 4 and Beyond

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CEO & Chief Scientist, Aigo.ai Inc
Peter Voss: CEO & Chief Scientist

- Built several technology platforms & technology companies
- Coined the term ‘Artificial General Intelligence’ (AGI) in 2001
- Commercialized ‘IVR with a Brain’
- Now, 2nd Generation ‘Chatbot with a Brain’
## Chatbot Levels

<table>
<thead>
<tr>
<th>Feature</th>
<th>Level 1 Notification Assistants</th>
<th>Level 2 FAQ Assistants</th>
<th>Level 3 Form Filling Assistants</th>
<th>Level 4 Cognitive Assistants</th>
<th>Level 5 Autonomous Assistants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Notifications based on Simple Triggers</td>
<td>✔</td>
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</tr>
<tr>
<td>Preset Intents/ Responses</td>
<td>✗</td>
<td>✔</td>
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<td>✔</td>
</tr>
<tr>
<td>Scripted Flows/ Slot-Filling, Intents &amp; Responses</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
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<tr>
<td>Realtime, Interactive Unsupervised Learning</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
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<tr>
<td>Integrated Short and Long-Term Memory</td>
<td>✗</td>
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<td>✗</td>
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<td>✔</td>
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<tr>
<td>Meta-Cognition &amp; Fully Autonomous Learning</td>
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The Problem: Current Chatbots Inherently can not...

- Remember
- Learn
- Understand
- Reason
- Converse
- Personalize
State-of-the-Art Chatbot

Note:
- This is a *capabilities* comparison
- We don’t compete with Alexa, Siri, Google, etc.
- Our focus is on high value *enterprise* applications (B2B, B2B2C)
- Aigo is a *software* solution/ device agnostic – no hardware reqd.

https://www.youtube.com/watch?v=DHipA8bA7fl
Alexa thinks this is just one item

Alexa cannot handle new/multiple lists

Alexa cannot change items on list

Alexa thinks this is just one item

Cannot remember simple new information
Scene 1 - Aigo

Aigo: Alright, let's make this happen. Aigo

Aigo: Hi there, what's on your mind?

Aigo: Add chips and guac, napkins and 3 bottles of wine to John's birthday list

Aigo: Good morning Sam, I don't know what guac is.

Aigo: Guac is the same as guacamole

Aigo: Creating John's birthday list. Is that OK?

Aigo: Ok, I added chips and guacamole, napkins and 3 bottles of wine to John's birthday list

Aigo: Add multiple items to a new list

Aigo: Learns new synonym

Aigo: Allows and confirms new list creation
Filters items by food (or other) category

Easily change quantity of items on list

Multiple commands: send list and ask June

Aigo learns new default channel for June

Aigo learns unstructured information
Demand for Intelligent Cognitive Assistant...
Chat-Bot Technology

User Input → ML Categorizer → Skill 1 → Isolated, Hand-Crafted Custom Program → Output

Skill n → times n
## ML/DL vs Cognitive Chatbots

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**Big Gulf:**

- There is no path from Level 3 to Level 4
The Third Wave of AI

“Current AI methods are statistically impressive but individually unreliable.” – Feb 2017
First Wave – Traditional Programming

Combinatorial Explosion in trying to handle Language Understanding & ongoing Conversation
Second Wave – Neural Nets - Big Data

Excellent solution for problems that have/require large amounts of data to categorize and/or predict – and where static statistical models and accuracy suffice.

Not suitable for deep Language Understanding or ongoing Conversation
Limitations of Second Wave: The Experts Agree...

“Deep learning is an amazing technology... but definitely not enough to solve AI... not by a long shot” – Sept 2018

Demis Hassabis – Google DeepMind
"Deep learning is an amazing technology... but definitely not enough to solve AI... not by a long shot“ – Sept 2018

“AI research needs to build on ideas from developmental psychology, cognitive science, and neuroscience, and AI models ought to reflect what is already known about how humans learn and understand the world.” – Mar 2019

Boris Katz - “Inventor of Virtual Assistants”

“Siri, Alexa, and similar technologies are “incredibly stupid” when it comes to understanding language.”

Geoffrey Hinton
“Godfather of Deep Learning”

“My view is to throw it all away and start again!”

“The future depends on some graduate student who is deeply suspicious of everything I have said”
Third Wave – Cognitive Architectures

“...hypothesis about the fixed structures that provide a mind... and how they work together – in conjunction with knowledge and skills embodied within the architecture – to yield intelligent behavior in a diversity of complex environments.”

– Wikipedia
Third Wave – Aigo Integrated Cognitive Architecture
Intelligent Interactions

Understanding
- Meaning and implications of words
- Entity resolution

Memory
- Short-term memory & context
- Conceptual long-term memory

Adaptivity
- Unsupervised, one-shot learning
- Real-time skill learning

Reasoning
- Disambiguation & Questions Answering
- Explaining answers & actions

Conversation Management
- Conversation Context & Goals
- Disambiguation & Meta-Cognition
‘Light Years’ ahead - Cognitive Depth Comparison

Cognitive Abilities (‘IQ’)

- Meta-Cognition
- Abstract Reasoning
- Concept Formation
- Explainability
- Reasoning
- Dynamic Context
- Interactive Learning
- Disambiguation
- Conversation Memory
- Integrated Ontology/ KB
- Deep Parsing
- Shared Context
- Flowchart Logic
- Parameter Extraction
- Fixed Response
- Intent Categorization

Aigo

Bots

Smart Action

Human

Shared General Knowledge & General Skills
### Key Differences

<table>
<thead>
<tr>
<th></th>
<th>Chatbots</th>
<th>Aigo/ Third Wave</th>
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<tbody>
<tr>
<td>General Learning</td>
<td>Batch. Offline</td>
<td>Interactive. One-Shot</td>
</tr>
<tr>
<td>Training Data</td>
<td>Very large. Labelled</td>
<td>Very small. Ontology</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Shallow. Statistical</td>
<td>Deep contextual parse</td>
</tr>
<tr>
<td>Personalization</td>
<td>Hard-coded. Fixed</td>
<td>Extensive. Dynamic</td>
</tr>
<tr>
<td>Reasoning</td>
<td>None</td>
<td>Yes, plus disambiguation</td>
</tr>
<tr>
<td>Dynamic Context</td>
<td>Limited by training data</td>
<td>Real-time adaptive</td>
</tr>
<tr>
<td>Scrutability</td>
<td>Black Box</td>
<td>Fully scrutable</td>
</tr>
<tr>
<td>Knowledge &amp; Skills</td>
<td>Hard-coded/ Read-only</td>
<td>Learns in real-time via NL</td>
</tr>
</tbody>
</table>

Electric light bulbs did *not* come about from the continuous improvement of the candle

– Oren Harari
Thank you!

https://www.aigo.ai/resources
Chatbots vs Aigo vs Humans - A Comparison

**Competencies**
The number of different tasks that can be performed

**Shared Core**
Core skills and knowledge (incl cognitive) shared by all tasks (also transfer learning)

**Cognitive Depth**
Ability to understand, learn, and reason contextually and abstractly.

**Customization**
Ability to learn new personal facts, preferences, and rules interactively – and to use them appropriately

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The diagram compares chatbots, SmartAction, Aigo, and Humans across various metrics.

**Bots**
- 1st & 2nd Wave

**SmartAction**
- Third Wave

**Aigo**
- Ability to learn new personal facts, preferences, and rules interactively

**Humans**
- Full range of cognitive abilities

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The values for each metric are represented on a logarithmic scale, with values ranging from x1 to x100k.
The Four C’s of Intelligent Assistants

**C – Shared Core:** Integrated Components: Ontology/ Common Sense Knowledge, Knowledge Graph, Memory/ Context, Deep Parsing, Reasoning, Disambiguation, Unsupervised/ Real-time/ One-Shot Learning, Common Shared Skills and Rules, etc.

**C – Cognitive Depth:** Level of sophistication of Shared Core

**C – Customization / Personalization:** User-specific knowledge graph. Learns and remembers history, facts, relationships, and preferences. Highly personalized customer interactions/ offers. Integrated with backend system

**C – Competencies / Skills:** Instead of a great number of (relatively simple) separate skills, have a comprehensive, highly advanced set of tightly integrated skills.
Meaningful, Ongoing Conversations:
The Holy Grail of AI

Requires: **Real Intelligence**

Implies: **Personalization**
Natural Language Understanding and Conversation are really hard

Multiple word meaning selection, tenses, plurals, conjugations
Nouns, adjectives, adverbs, verbs, auxiliaries, determiners, genitives
Preposition and clause attachment resolution, ditransitives
Pronoun and co-reference resolution, actor/ patient identification
Entities versus concepts, personas, proper nouns, names, titles, genders
Complex ontologies, inheritance (up & down), synonyms, antonyms
Space and time, scalars, mass nouns, data types, UOM, conversions
Relationships: space, time, relatives, cause-effect, compounds
Negation, and, or, (fuzzy) quantifiers, part-of, ownership
Implications, conditionals, contradictions, fuzzy values, certainty
Temporal information, patterns, sequences, analogy, same meaning
Meta-cognition, emotions, confusion, error recovery, disambiguation.....
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tenses (+aux)</strong></td>
<td>I will send the email; I sent it; neeves are nice -- neeves = plural</td>
</tr>
<tr>
<td><strong>pre/ suffix. Conjugations</strong></td>
<td>Graham Thomas III; Dr. Hobbes Jr; Mr &amp; Mrs Wilson. Ex-accountant. Am, are, is. I, me, mine.</td>
</tr>
<tr>
<td><strong>comparatives</strong></td>
<td>I have more than 6 oranges; I have more oranges than John</td>
</tr>
<tr>
<td><strong>conditionals</strong></td>
<td>if we have a meeting over 3 hours, cancel my lunch</td>
</tr>
<tr>
<td><strong>cause/ effect</strong></td>
<td>Cameron turned the light off in the room. Now it is dark</td>
</tr>
<tr>
<td><strong>reason</strong></td>
<td>Why did Cameron turn off the light? (Because he was going to bed)</td>
</tr>
<tr>
<td><strong>implication</strong></td>
<td>Close the door. Is the door closed?</td>
</tr>
<tr>
<td><strong>meta info &amp; mood</strong></td>
<td>Location/ situation/ goal/ mood of user. Agent confusion, urgency, boredom.</td>
</tr>
<tr>
<td><strong>genitives</strong></td>
<td>My first car's original engine's carburetor...</td>
</tr>
<tr>
<td><strong>relationships</strong></td>
<td>The teacher of my brother, Steve, is Jane. My favorite aunt lives in France.</td>
</tr>
<tr>
<td><strong>temporal info</strong></td>
<td>Frank went to Sally's house. After that he returned home. Where is Frank?</td>
</tr>
<tr>
<td><strong>spatial info</strong></td>
<td>I looked inside the closet behind the door of the house</td>
</tr>
<tr>
<td><strong>time/ date</strong></td>
<td>John's party is 5 days after Christmas;</td>
</tr>
<tr>
<td><strong>ownership</strong></td>
<td>Anna got flowers. She gave them to Jane. Who has the flowers?</td>
</tr>
<tr>
<td><strong>part-of</strong></td>
<td>Jim is the pitcher on our team; Wheels are part of an automobile.</td>
</tr>
<tr>
<td><strong>superlatives/ min/ max</strong></td>
<td>Dogs are my favorite; The blue whale is the largest mammal.</td>
</tr>
<tr>
<td><strong>synonyms/ antonyms</strong></td>
<td>Giving a hug is the same as hugging; The opposite of nocturnal is diurnal; sell-buy</td>
</tr>
<tr>
<td><strong>homonyms</strong></td>
<td>flower/ flour</td>
</tr>
<tr>
<td><strong>analogy</strong></td>
<td>carrot is to vegetable as apple is to what?</td>
</tr>
<tr>
<td><strong>metaphor</strong></td>
<td>The world is an oyster.</td>
</tr>
<tr>
<td><strong>spelling errors</strong></td>
<td>I installed the secrutiay camera here to catch theives</td>
</tr>
<tr>
<td><strong>grammar errors</strong></td>
<td>We went to Texas to see family friends. After we arrived their Henry greeted us.</td>
</tr>
<tr>
<td><strong>partial sentences</strong></td>
<td>at 5 AM; in Redondo Beach; Sara is; the store on Wednesday.</td>
</tr>
<tr>
<td><strong>exclamations/ courtesies</strong></td>
<td>wow! Thank you so much!; That is, omg, disgusting! My brother, geeze, wont get a job!</td>
</tr>
<tr>
<td><strong>error recovery</strong></td>
<td>Henry's appointment does not exist, create?</td>
</tr>
<tr>
<td><strong>date / time / timespan resolution</strong></td>
<td>Jim has soccer practice 3 weeks from Tuesday. The event will last 4 hours.</td>
</tr>
</tbody>
</table>
Levels of Understanding and Learning we should expect from AI

Remind me to speak with Jane. (reminder)
Remind me what did Jane say? (tell me)
Remind Jane to talk to me. (ask Jane)
(Different meanings and responses to ‘remind’)

My sister’s cat Spock... is pregnant.
(A five-year old immediately learns 5 new facts)
Challenges for Conventional ‘NL’ Technology

I arrived at my favorite hotel 3 hours after my last client meeting.

Let’s have breakfast (dinner). I discovered a new restaurant at 405 Main. Meet us there at 7.

Tom almost sent those email to his newest employee, Paul. I only read two.

If Paul’s boss’ birthday is after the next staff meeting, bring some popcorn.

I used the copier in the hall, Jane the one in dispatch. Mine kept jamming.

They sold the property to their biggest customer. Who bought it? Who owns it now?

He left the watch at the office. He left her the watch. He left the watch at 5 am.

The preferred mode of communication to clients is email. John sent emails to a client as told.
Challenges for Conventional ‘NL’ Technology

We received one package yesterday, and another two today. The first one was damaged.

Sarah ducked. Sarah has a duck. We saw her duck.

She lives down her achievements. What does she downplay?

The meeting is on tonight. The meeting is on Friday.

Breakfast is at 8. Let’s meet for dinner at 8.

How many people? What time is the reservation? For 2.

They read books on horses.

I need Jane to go. I need the car to go.
Dell considers costs such as librarian assistance, photocopy charges, rent, and supplies to be the firm's overhead. Will the client pay for copying?

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