# Chatbots:

## Getting to Level 4 and Beyond

Peter Voss

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aigo.ai

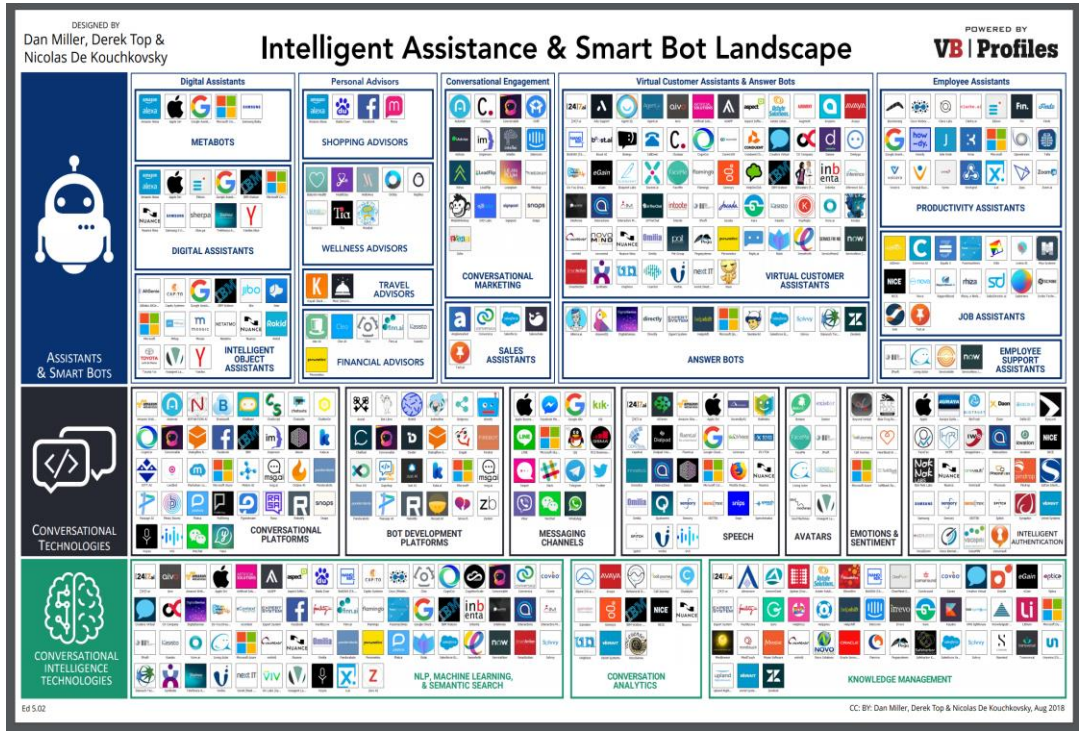
# Peter Voss: CEO & Chief Scientist

- Built several technology platforms & technology companies
- Coined the term ‘Artificial General Intelligence’ (AGI) in 2001
- Commercialized ‘IVR with a Brain’ SmartAction Automating Calls. Intelligently.
- Now, 2nd Generation ‘Chatbot with a Brain’ aigo.ai

# Chatbot Levels

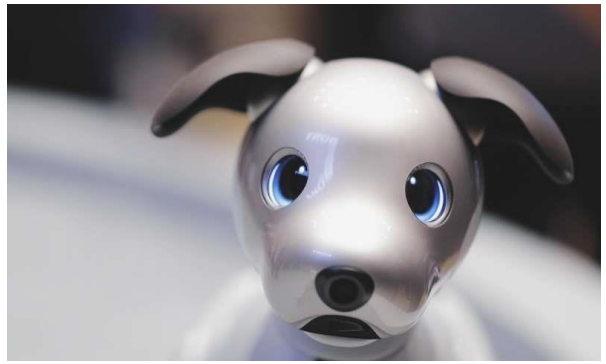
| Feature | Level 1 Notification Assistants | Level 2 FAQ Assistants | Level 3 Form Filling Assistants | Level 4 Cognitive Assistants | Level 5 Autonomous Assistants |
|---|---|---|---|---|---|
| Simple Notifications based on Simple Triggers | ✓ | ✓ | ✓ | ✓ | ✓ |
| Preset Intents/ Responses | ✗ | ✓ | ✓ | ✓ | ✓ |
| Scripted Flows/ Slot-Filling, Intents & Responses | ✗ | ✗ | ✓ | ✓ | ✓ |
| Realtime, Interactive Unsupervised Learning | ✗ | ✗ | ✗ | ✓ | ✓ |
| Integrated Short and Long-Term Memory | ✗ | ✗ | ✗ | ✓ | ✓ |
| Contextual, Dynamic Conversation Management | ✗ | ✗ | ✗ | ✓ | ✓ |
| Common-Sense Reasoning & Explaining Behavior | ✗ | ✗ | ✗ | ✗ | ✓ |
| Meta-Cognition & Fully Autonomous Learning | ✗ | ✗ | ✗ | ✗ | ✓ |

# The Problem: Current Chatbots Inherently can not…

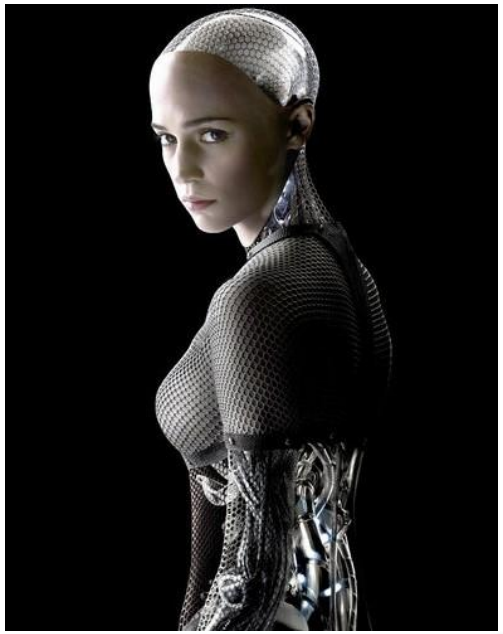




- Remember
- Learn
- Understand
- Reason
- Converse
- Personalize

# State-of-the-Art Chatbot



VS



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=DHipA8bA7fI

## Scene 1 - Alexa

Alexa, add chips and guac, napkins and 3 bottles of wine to John's birthday list

I added chips and guac napkins 3 bottles of wine to your shopping list

Alexa cannot handle new/ multiple lists

Actually Alexa, remove napkins from the list

To clear your list or remove an item, visit the Alexa app

Alexa cannot change items on list

Ok, then

Alexa, what do I have on John's birthday list?

You have 1 item on your shopping list chip and guac napkins 3 bottles of wine

Alexa thinks this is just one item

You call that 1 item?

Alexa, remember that John's favorite cake is Red Velvet

I'm not quite sure how to help you with that

Cannot remember simple new information

## Scene 1 - Aigo

Alright, let's make this happen. Aigo

Hi there, what's on your mind?

Add multiple items to a new list

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

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

Learns new synonym

Guac is the same as guacamole

Creating John's birthday list. Is that OK?

Allows and confirms new list creation

Yes

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

What food is on that list again?

Chips and guacamole and 3 bottles of wine

Filters items by food (or other) category

Actually, make it 5 bottles

Sure. The list is now 5 bottles of wine, chips and guacamole and napkins

Easily change quantity of items on list

Great. Send John's birthday list to June, and ask her if I am missing anything please.

Sending John's birthday list to June via email

Multiple commands: send list and ask June

Wait, always contact June by Skype

Ok, sending the list to June via Skype

Aigo learns new default channel for June

Oh, and remember that John's favorite cake is Red Velvet

Got it

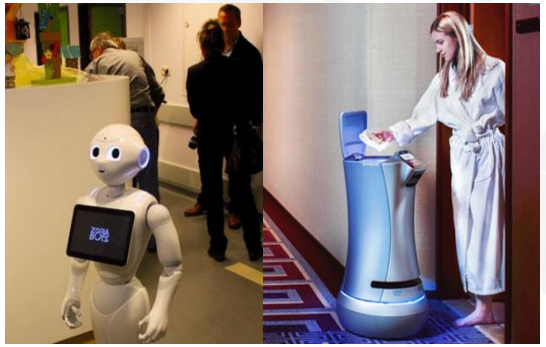
Aigo learns unstructured information

Fantastic

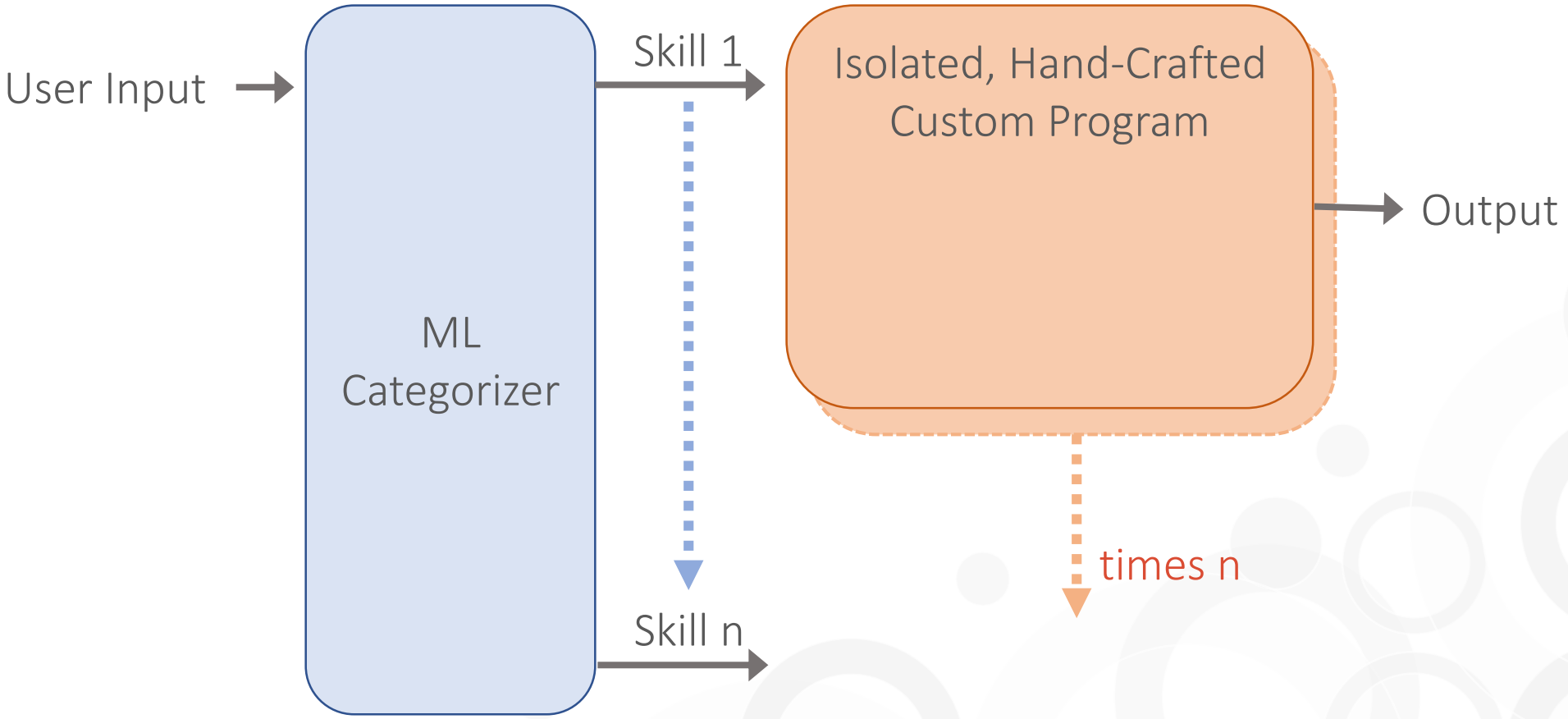
# Demand for Intelligent Cognitive Assistant…





# Chat-Bot Technology



# ML/DL vs Cognitive Chatbots

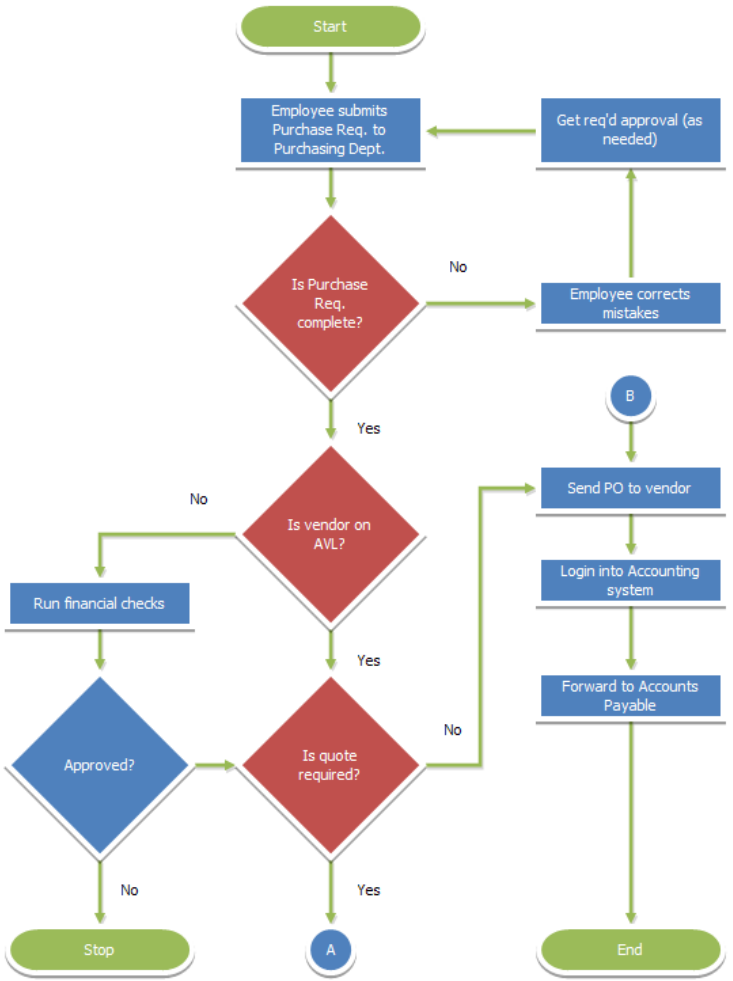
| | Non-Cognitive (ML/DL) | | | | Cognitive Chatbots | |
|---|---|---|---|---|---|---|
| Feature | Level 1 | Level 2 | Level 3 | | Level 4 | Level 5 |
| Simple Notifications based on Simple Triggers | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Preset Intents/ Responses | ✗ | ✓ | ✓ | Big Gulf: | ✓ | ✓ |
| Scripted Flows/ Slot-Filling, Intents & Responses | ✗ | ✗ | ✓ | There is no path | ✓ | ✓ |
| Realtime, Interactive Unsupervised Learning | ✗ | ✗ | ✗ | from Level 3 | ✓ | ✓ |
| Integrated Short and Long-Term Memory | ✗ | ✗ | ✗ | to Level 4 | ✓ | ✓ |
| Contextual, Dynamic Conversation Management | ✗ | ✗ | ✗ | | ✓ | ✓ |
| Common-Sense Reasoning & Explaining Behavior | ✗ | ✗ | ✗ | | ✗ | ✓ |
| Meta-Cognition & Fully Autonomous Learning | ✗ | ✗ | ✗ | | ✗ | ✓ |

# The Third Wave of AI


DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY

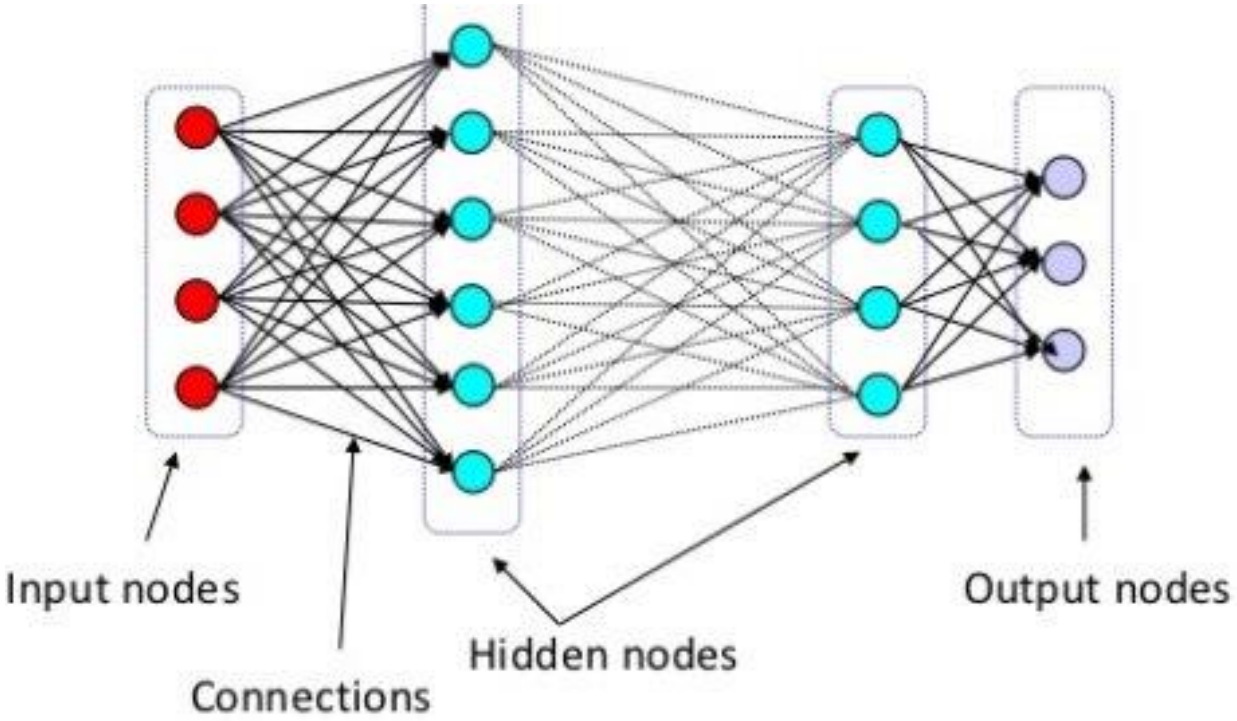
"Current AI methods are statistically impressive but individually unreliable." – Feb 2017

# 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…

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

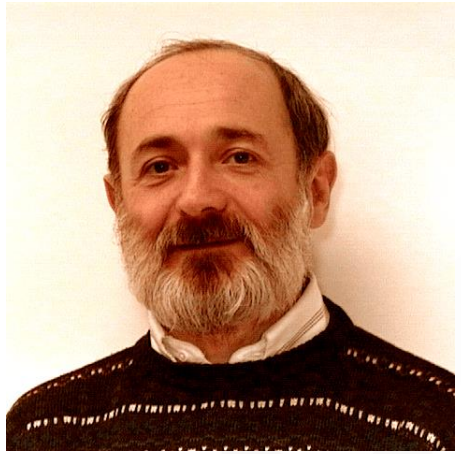
"The future depends on some graduate student who is deeply suspicious of everything I have said"

**Geoffrey Hinton**
"Godfather of Deep Learning"

**Demis Hassabis** – Google DeepMind

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

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



"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

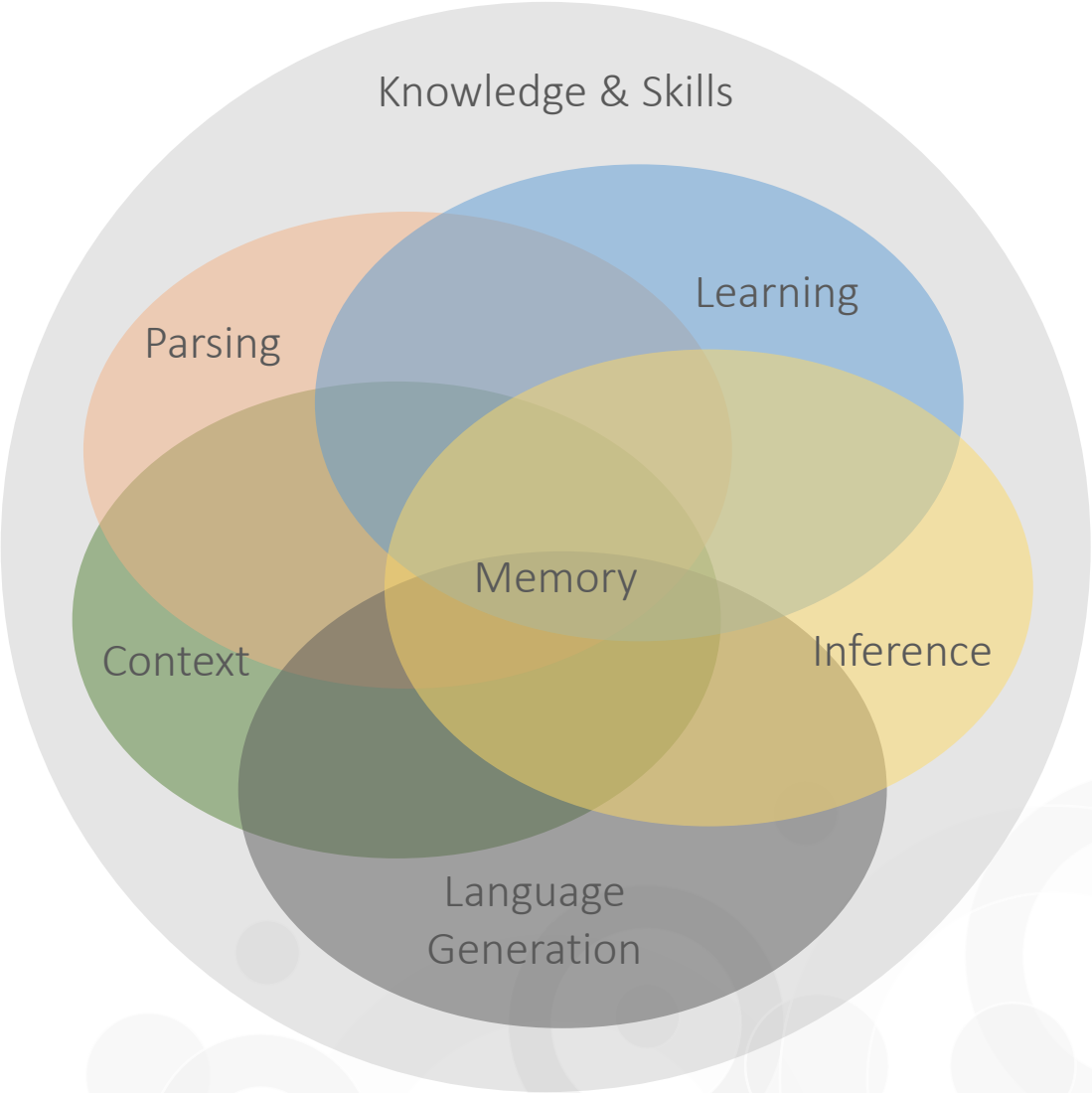
**Boris Katz -** "Inventor of Virtual Assistants"

# 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

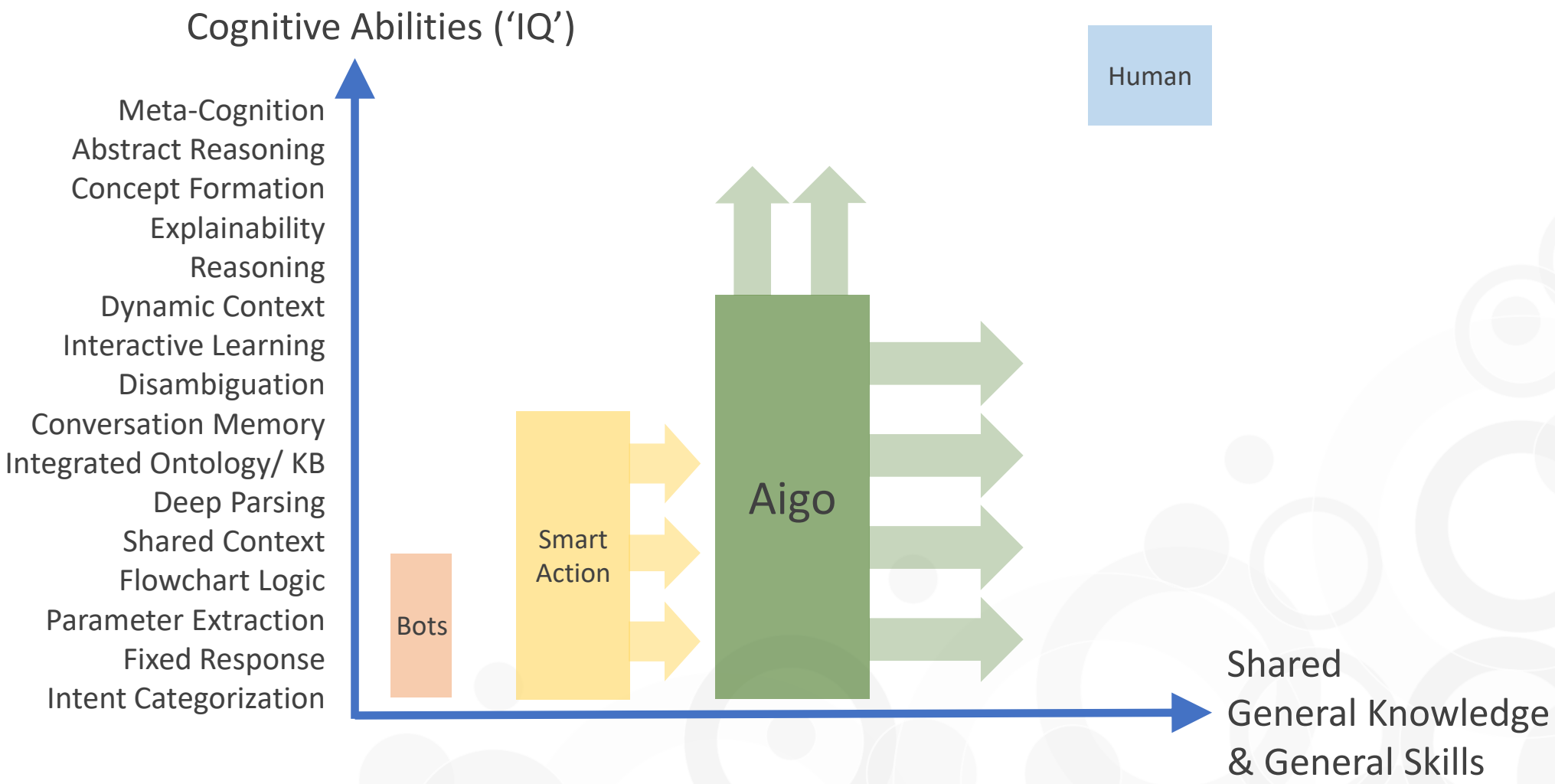
# Third Wave – Aigo Integrated Cognitive Architecture



# Intelligent Interactions

| | |
|---|---|
| Understanding | • Meaning and implications of words<br>• Entity resolution |
| Memory | • Short-term memory & context<br>• Conceptual long-term memory |
| Adaptivity | • Unsupervised, one-shot learning<br>• Real-time skill learning |
| Reasoning | • Disambiguation & Questions Answering<br>• Explaining answers & actions |
| Conversation Management | • Conversation Context & Goals<br>• Disambiguation & Meta-Cognition |

# ‘Light Years’ ahead - Cognitive Depth Comparison



# Key Differences

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

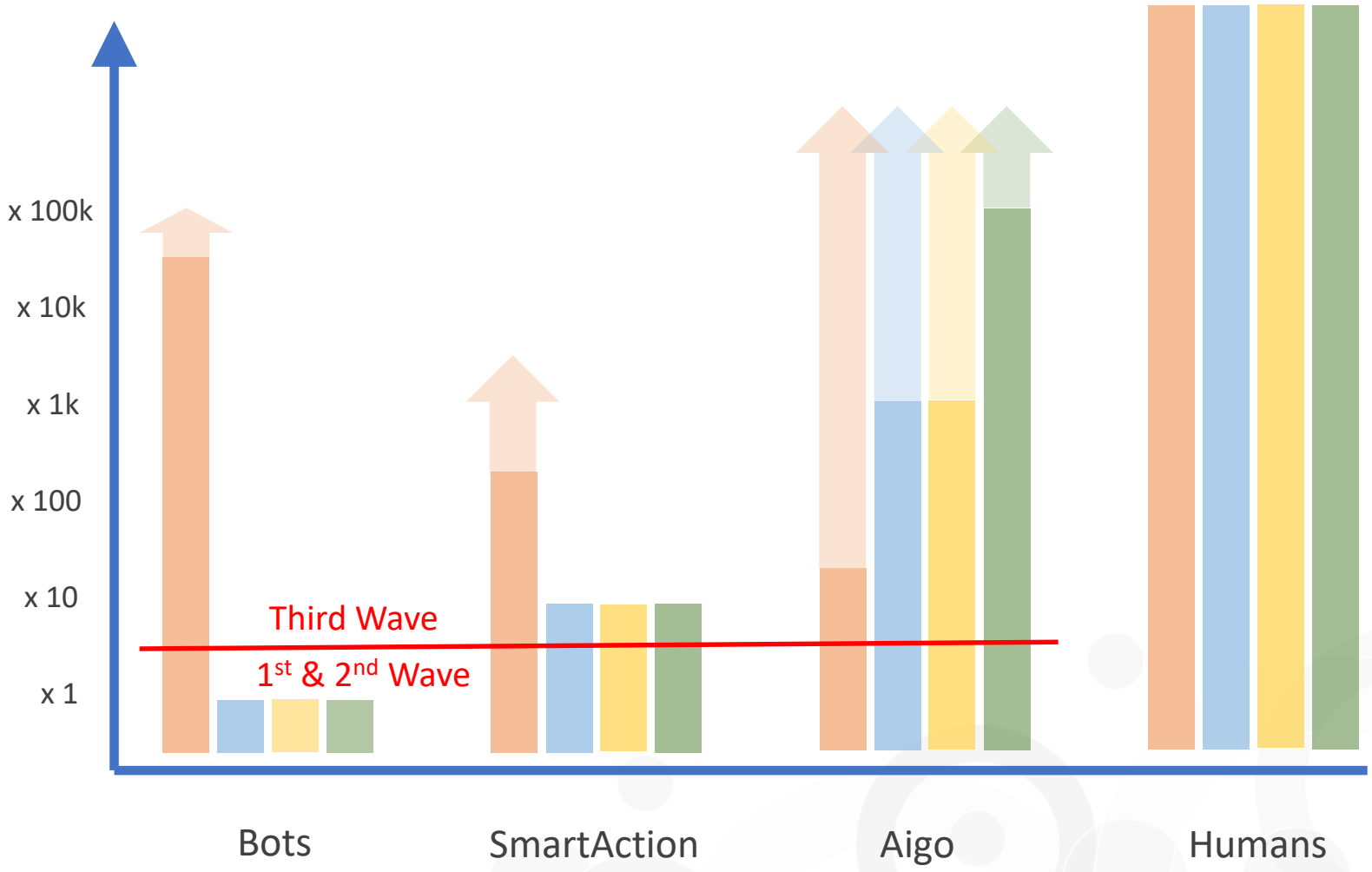
Electric light bulbs did *not* come about from the continuous improvement of the candle

– 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

# 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**

Deep Understanding. Reasoning. Memory.
Interactive, contextual, cumulative learning.

Implies: **Personalization**

# Natural Language Understanding and Conversation are <u>really hard</u>

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.....

# Aspects of Language

| | |
|---|---|
| tenses (+aux) | I will send the email; I sent it; neeves are nice -- neeves = plural |
| pre/ suffix. Conjugations | Graham Thomas III; Dr. Hobbes Jr; Mr & Mrs Wilson. Ex-accountant. Am, are, is. I, me, mine. |
| comparatives | I have more than 6 oranges; I have more oranges than John |
| conditionals | if we have a meeting over 3 hours, cancel my lunch |
| cause/ effect | Cameron turned the light off in the room. Now it is dark |
| reason | Why did Cameron turn off the light? (Because he was going to bed) |
| implication | Close the door. Is the door closed? |
| meta info & mood | Location/ situation/ goal/ mood of user. Agent confusion, urgency, boredom. |
| genitives | My first car's original engine's carburetor… |
| relationships | The teacher of my brother, Steve, is Jane. My favorite aunt lives in France. |
| temporal info | Frank went to Sally's house. After that he returned home. Where is Frank? |
| spatial info | I looked inside the closet behind the door of the house |
| time/ date | John's party is 5 days after Christmas; |
| ownership | Anna got flowers. She gave them to Jane. Who has the flowers? |
| part-of | Jim is the pitcher on our team; Wheels are part of an automobile. |
| superlatives/ min/ max | Dogs are my favorite; The blue whale is the largest mammal. |
| synonyms/ antonyms | Giving a hug is the same as hugging; The opposite of nocturnal is diurnal; sell-buy |
| homonyms | flower/ flour |
| analogy | carrot is to vegetable as apple is to what? |
| metaphor | The world is an oyster. |
| spelling errors | I installed the secrutiy camera here to catch theives |
| grammar errors | We went to Texas to see family friends. After we arrived their Henry greeted us. |
| partial sentences | at 5 AM; in Redondo Beach; Sara is; the store on Wednesday. |
| exclamations/ courtesies | wow! Thank you so much!; That is, omg, disgusting! My brother, geeze, wont get a job! |
| error recovery | Henry's appointment does not exist, create? |
| date / time / timespan resolution | Jim has soccer practice 3 weeks from Tuesday. The event will last 4 hours. |

# 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.

# Challenges for Conventional ‘NL’ Technology

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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Dell expects outside counsel to use its best efforts to minimize reimbursable out-of-pocket costs both by avoiding unnecessary expenditures and by taking advantage of volume discounts and bulk arrangements that may be available.