Artificial Intelligence: Vision of the Future
Automation Innovation Conference 2017

Dr. Anand S. Rao
Global Artificial Intelligence Lead
Today’s discussion

01 AI & Cognitive Computing – What is the difference?

02 Enterprise Applications of Artificial Intelligence

03 Evolving your Artificial Intelligence Capability
AI & Cognitive Computing – What is the difference?
AI as Sense-Think-Act

Sense

Artificial Intelligence is becoming ubiquitous intelligence with the ability to see, hear, speak, smell, feel, understand gestures, interface with your brain, and dream.

Think

AI is helping us do tasks faster, better and cheaper – Automated Intelligence; helping us make better decisions – Augmented Intelligence, or even taking over what we do – Autonomous Intelligence.

Act

Artificial Intelligence is equaling or surpassing humans in a number of other tasks – playing games, driving cars, recommendations (movies, books, finance, research), etc.
More Formally...

<table>
<thead>
<tr>
<th>AI that can sense...</th>
<th>AI that can think...</th>
<th>AI that can act...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hear</strong></td>
<td><strong>Understand</strong></td>
<td><strong>Physical</strong></td>
</tr>
<tr>
<td><strong>See</strong></td>
<td><strong>Perceive</strong></td>
<td><strong>Cognitive</strong></td>
</tr>
<tr>
<td><strong>Speak</strong></td>
<td><strong>Assist</strong></td>
<td><strong>Creative</strong></td>
</tr>
<tr>
<td><strong>Feel</strong></td>
<td><strong>Plan</strong></td>
<td><strong>Reactive</strong></td>
</tr>
</tbody>
</table>

- **Natural language**
- **Audio & speech**
- **Machine vision**
- **Navigation**
- **Visualization**

- **Knowledge & representation**
- **Planning & scheduling**
- **Reasoning**
- **Machine Learning**
- **Deep Learning**

- **Robotic process automation**
- **Deep question & answering**
- **Machine translation**
- **Collaborative systems**
- **Adaptive systems**

**More Formally...**

**Statistics** | **Econometrics** | **Optimization** | **Complexity Theory** | **Computer Science** | **Game Theory** | **FOUNDATION**
Enterprise applications of AI fall under four categories:

- **Human in the loop**
  - Hardwired / specific systems: Assisted Intelligence
  - Adaptive systems: Augmented Intelligence

- **No human in the loop**
  - Hardwired / specific systems: Automated Intelligence
  - Adaptive systems: Autonomous Intelligence
Artificial Intelligence vs Cognitive Computing

**Artificial Intelligence**

- The study of agents that receive percepts from the environment and perform actions. *(Russell and Norvig)*
- The science and engineering of making intelligent machines, especially intelligent computer programs *(John McCarthy)*

**Cognitive Computing**

- Cognitive computing is the simulation of human thought processes in a computerized model.
- Cognitive computing involves self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brain works.
AI covers a wide range of capabilities that spans the foundational, cognitive, system, and sensory layers.

**What is Artificial Intelligence?**

Artificial Intelligence can be defined as the theory and development of systems that can continuously sense its environment, think, make decisions, and take actions that influence the environment to achieve its goals.
AI is becoming an essential component for enabling analytics maturity

**Backward-looking**

<table>
<thead>
<tr>
<th>Descriptive Analytics</th>
<th>Diagnostic Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe, summarize and analyze historical data (What happened?)</td>
<td>Identify causes of trends and outcomes (Why it happened?)</td>
</tr>
</tbody>
</table>

**Forward-looking**

<table>
<thead>
<tr>
<th>Predictive Analytics</th>
<th>Prescriptive Analytics</th>
<th>Adaptive &amp; Autonomous Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predict future outcomes based on the past facts and future simulations (What could happen?)</td>
<td>Recommend ‘right’ or optimal actions or decisions (What should be done?)</td>
<td>Monitor, decide, and act autonomously or semi-autonomously (How do we adapt to change?)</td>
</tr>
</tbody>
</table>

**Benefits of AI**

- Descriptive and diagnostic analytics can be enabled with **assisted intelligence** by using AI to uncover patterns in large, complex datasets
- AI also is pivotal for tapping into unstructured data sources such as text, audio, video, and images
- Predictive and prescriptive analytics can be enhanced with **augmented intelligence** to provide deeper insight into the implications of decision making
- Useful techniques include agent-based simulation, reinforcement learning, etc.
- Adaptive analytics are driven by **autonomous intelligence**
- AI learns with new information over time

---

**Increasing Sophistication & Impact**
The AI Revolution is here, and goes beyond automation; huge opportunity exists for both productivity & consumption gains.

Global GDP Impact of AI through 2030

2030 IMPACT: $15.7T

- Consumption Contribution: 60%
- Productivity Contribution: 40%

Are you ready to exploit the opportunities from AI & overcome the challenges?

Source: Sizing the Prize, World Economic Forum, Dalian, 2017, PwC - AI Lab.
Enterprise Applications of Artificial Intelligence
Organizations carry out a huge number of activities and make countless decisions across the value chain that are being optimized with AI

Over 300+ AI Use Cases Across 8 Sectors – Sizing the Prize

- Market Share
- Customer Experience
- Acquisition Rate
- Innovation Rate
- Operational Efficiency
- Customer Satisfaction
- Talent Retention
- Inventory Turn
Automating business processes will result in significant cost savings (3x over offshoring) and productivity increases resulting from reduction in labor needs (110-140m knowledge workers by 2025)

**PwC - AI Lab Case:** Robotic Process Automation of end-to-end loan processing at a major US Bank

- Demonstrate benefits of RPA in a Proof of Concept within the Loans processes
  - (a) Loan onboarding, increases, payments, billing, maintenance
  - (b) Loan enquiries/processing;
  - (c) Reconcile cash breaks and reports;
  - (d) Document onboarding;
  - (e) Payment applications;
  - (f) Build/run reports
- Cost reduction of $30-35M
Process Mining discovers performance bottlenecks in existing processes and process simulation can be used to resolve these bottlenecks.
Process mining and process simulation were used to identify ideal pathways and resolution of process bottlenecks.

Source: Using process mining to bridge the gap between BI and BPM. IEEE Computer Society, 2011.

**PwC - AI Lab Case:** Process mining of event log containing events of sepsis cases from a hospital to streamline patient pathways.

- **1000 cases, 15,000 events, 16 different activities**
- **39 data attributes (eg. Group responsible for activity, test results etc.)**

- **39 data attributes (eg. Group responsible for activity, test results etc.)**
A comprehensive NLP architecture and a NLP pipeline are critical for automating cognitive processes and generating insights.

### NLP Platform

<table>
<thead>
<tr>
<th>Compute Infrastructure</th>
<th>NLP Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Text Processing and Preparation</td>
</tr>
<tr>
<td>Document Stores</td>
<td>Tokenization</td>
</tr>
<tr>
<td>Index Database</td>
<td>Grammar Parsing</td>
</tr>
<tr>
<td>Graph Store</td>
<td>Text Normalization</td>
</tr>
<tr>
<td>Distributed Processing</td>
<td>Text Cleaning</td>
</tr>
<tr>
<td>Machine Learning</td>
<td>Word Disambiguation</td>
</tr>
<tr>
<td>Graph Analysis</td>
<td>Vectorization</td>
</tr>
<tr>
<td>Map/Reduce</td>
<td></td>
</tr>
</tbody>
</table>

### NLP Components

#### Text Processing and Preparation

- Tokenization
- Grammar Parsing
- Text Normalization
- Text Cleaning
- Word Disambiguation
- Vectorization

#### NLP Capabilities

<table>
<thead>
<tr>
<th>Information Extraction</th>
<th>Summarization</th>
<th>Document Processing</th>
<th>Text Emotion</th>
<th>Question &amp; Answer</th>
<th>Translation</th>
<th>Chatbots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity Recognition</td>
<td>Key Phrase Extraction</td>
<td>Topic Modeling</td>
<td>Sentiment</td>
<td>Document Search</td>
<td>Language to Language</td>
<td>Retrieval agents</td>
</tr>
<tr>
<td>Semantic Linkage</td>
<td>Sentence Extraction</td>
<td>Document Classification</td>
<td>Mood</td>
<td>Question Parsing</td>
<td>Speech to Text</td>
<td>Dialogue Generation</td>
</tr>
<tr>
<td>Structured Data</td>
<td>Natural Language Generation</td>
<td>Novelty Detection</td>
<td>Sarcasm</td>
<td>Answer Scoring</td>
<td>Image to Text</td>
<td>Intent Recognition</td>
</tr>
</tbody>
</table>
Cognitive process automation goes beyond traditional robotic process automation by combining process learning, large-scale machine learning, and NLP to automate processes that are more complex.

**PwC - AI Lab Case:** Using Machine Learning and NLP to automate pharmaceutical adverse event detection

- PwC - AI Lab developed an end-to-end pipeline using natural language processing, machine learning and a big data architecture to automate the extraction of adverse events from clinician notes.
- PwC - AI Lab’s solution improves the case ingestion and review process, which can reduce workforce needs by 3x over the next 10 years.

Source: Using process mining to bridge the gap between BI and BPM. IEEE Computer Society, 2011.
AI in Healthcare
Deep learning and speech analytics on audio data is enabling companies to better understand customer and sales/service rep behaviours.

- Several of the findings from this analysis, including suggested interaction frequencies, channel patterns, and improvements to sales scripts were incorporated into sales training programs.

- PwC - AI Lab worked with a client interested in answering the question: “what makes an effective sales call?”

- Using speech-to-text APIs from commercial providers as well as PwC - AI Lab proprietary deep learning models, we extracted useful features from tens of thousands of call transcriptions and call metadata.

- This information was combined with structured transaction data to gather additional insights.
Gamification of Strategy

Multi-agent collaborative systems, digital twins, computational social choice and cloud platforms were used to evaluate large-scale go-to-market strategic scenarios for ridesharing and autonomous vehicles.

PwC - AI Lab Case: Gamifying Strategy: Rideshare/AV

How profitable is the ‘personal mobility’ market?

How do AV, Electric Cars, Connected cars change this market?


Which cities to enter and how to price and compete in this market?
Multi-agent collaborative systems, digital twins, computational social choice and cloud platforms were used to evaluate large-scale go-to-market strategic scenarios for ridesharing and autonomous vehicles.

To capture the complexities of customer choice, the dynamic model was built as an Agent-Based model, where consumers made choices based on their own characteristics and experience.

Over 200,000 strategic scenarios were simulated to explore the ‘least regret’ strategy to enter and dominate markets.

Insights helped senior executives select the right strategies for each market and make strategic and operational decisions.

Recently won the 2017 AI Alconics award at the AI Summit.
03
Building AI Capability
## Benefiting from AI requires separating myths from facts

<table>
<thead>
<tr>
<th>Myth 1: Artificial Intelligence is a distinct monolithic area of study</th>
<th>Fact 1: Artificial Intelligence is an interdisciplinary area with many distinct sub-fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myth 2: All types of problems can be solved by a single AI solution (e.g., Watson, Palantir, insert your favorite solution)</td>
<td>Fact 2: Different types of problems require different type of AI techniques and solutions to be used</td>
</tr>
<tr>
<td>Myth 3: Machine Learning automatically (magically) learns from data without any human intervention</td>
<td>Fact 3: Machine Learning requires a laborious process of acquiring and cleansing large amounts of data, selecting, training, and guiding the algorithm</td>
</tr>
</tbody>
</table>

### AI Uses
- Searching, Querying & Conversing
- Describing, Classifying, Understanding & Visualizing
- Diagnosing, Discovering & Reasoning
- Trending, Forecasting, Projecting & Predicting
- Simulating, Learning, Optimizing, & Adapting
- Recognizing, Sensing, and Recommending
Areas of focus for Enterprise AI

Adaptive Roadmap

- Robotic process automation
- Cognitive/Intelligent process automation
- Process mining and learning
- Chatbots
- Virtual assistants

Robotic Process Automation (RPA)
- Information retrieval
- Question & Answering systems
- Language generation
- Speech-to-text and text-to-speech
- Machine translation

Machine Learning & Deep Learning
- Supervised machine learning
- Unsupervised machine learning
- Convolutional neural nets, LSTM
- Generative Adversarial Networks
- Deep learning for text, voice, images, video

Intelligent Agents & Simulation
- Agent-based modelling
- Social simulation
- Reinforcement learning
- Management cockpits
- Collaborative systems

Natural Language Processing (NLP)
- Adaptive Roadmap
Getting started with Enterprise AI

**Step 1: Business-Aligned AI Strategy**

Develop an AI Strategy that is aligned with your overall business vision and objectives.

**Step 2: AI capability model**

Develop an AI capability across the enterprise in the relevant assisted, augmented and autonomous intelligence.

**Step 3: Institutionalizing AI**

Institutionalize the portfolio of successful AI capabilities by embedding analytics in core processes, adopting cloud and open-source platforms.

**Step 4: AI Governance & Change**

Ensure appropriate governance of all forms of intelligence by educating and changing customer and employee perception of AI.
People Impacts of Automation & Augmentation

AI will impact how a company thinks about the future of work and its workforce

**How risks of AI are managed**
How will people, cyber security, productivity and reputation risks be managed? How will bias, performance, and control risks be addressed?

**How people are reskilled and prepared for lifelong learning**
How effective is your learning function at building an adaptive workforce?

**Impact on jobs, compensation, structure and transition**
What capabilities are required? How will jobs, structures and compensation evolve?

**How AI aligns with corporate purpose**
Is your organization demonstrating a commitment to sustaining jobs in the local community & retraining people?

**How open people are to new ways of working and capacity for change**
How will current behaviors and/or mindsets change? What can leaders do to drive awareness and adoption?

**Impact on people policies and decision-making process**
What types of people policies are necessary to enable the new ways of working? How can people develop ‘trust’ in AI systems
Five success factors to derive maximum benefits from artificial intelligence, big data, and analytics

01
Start from business decisions

02
Demonstrate value through pilots before scaling

03
Blend intuition and data-driven insights

04
Address ‘big data’ – don’t forget ‘lean’ data

05
Fail forward – test and learn culture
Thank you.

Get in touch.

Dr. Anand S. Rao
PwC - AI Lab Global Artificial Intelligence Lead
Email: anand.s.rao@PwC - AI Lab.com
Twitter: @AnandSRao

© 2017 PwC - AI Lab. All rights reserved. Not for further distribution without the permission of PwC - AI Lab. "PwC - AI Lab" refers to the network of member firms of PricewaterhouseCoopers International Limited (PwC - AI LabIL), or, as the context requires, individual member firms of the PwC - AI Lab network. Each member firm is a separate legal entity and does not act as agent of PwC - AI LabIL or any other member firm. PwC - AI LabIL does not provide any services to clients. PwC - AI LabIL is not responsible or liable for the acts or omissions of any of its member firms nor can it control the exercise of their professional judgment or bind them in any way. No member firm is responsible or liable for the acts or omissions of any other member firm nor can it control the exercise of another member firm’s professional judgment or bind another member firm or PwC - AI LabIL in any way.