DEMYSTIFYING ARTIFICIAL INTELLIGENCE

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learns & fits to

Building Blocks

These are the core technologies and essential building blocks that are used in the design • build of AI systems. One or many of these are typically combined together to help realize AI systems.

- Natural Language Processing
  - NL Understanding
  - NL Generation
- Computer Vision
  - Classification
  - Handwriting Detect
  - Text Recognition
  - Instance Segment
  - Facial Detection
  - Object Detection
  - OCR Extraction
  - Motion Estimation
- Machine Translation
- Pattern Recognition
- Knowledge Engineering
- Planning, Scheduling & Optimization
- Machine Learning
  - Deep Learning
- Speech Processing
  - Speech Recognition
  - Speaker Identification
  - Speaker Verification
  - Speech Synthesis
- Robotics

Supporting Cast: Scale Out Infrastructure (Compute, Storage, Platform) · GPU · Ontologies · Knowledge Graph · Domain Experts · Data (doh!) · Ground Truth Management · Data Acquisition & Integration · Scalable Ingestion & Enrichment Pipelines · OCR Conversion · Analytics Engine · Metadata Catalog · Business Rules & Process

AI Systems work on various types of data

Structured Data: Vehicle Data, Order / Purchase History, CRM Records, Datawarehouse, Credit Card Purchases, Billing Records, Machine Generated, Census Data, Medical Reports, Survey Responses, Trouble Tickets, Many more to come .....

Unstructured Data: Manuals, News & Research Reports, OCR, X-Rays, MRI, CAT Scans, SEC Filings, Loan, Regulatory Documents, Social Media Images, Resume, Emails, Tweets, Blogs, Multimedia Content, Call Center Recordings, Product Reviews & Images

Primary Characteristics of an AI System

AI Systems must exhibit the following characteristics. Call them the DNA, these characteristics are aligned with the key goals of an AI system that include reasoning, knowledge, planning, learning, natural language processing, perception and the ability to move and manipulate objects.

- Identifies new **patterns & relationships** from the data
- Can be **trained** by experts & also **learn** from experience
- Can capture & **represent** the learned **knowledge**
- **Continuously** learns & **reinforces** its behavior based on feedback
- Ingest **large** volume of diverse data in **variety** of formats
- **Converse** in natural language and detect **emotions**
- **Understand** natural forms of **expression** incl language, speech, images etc.
- **Hypothesize** & ranks alternatives and optimize
- **Reason > Infer >** Generate conclusions from learned knowledge
- Have **Perception** abilities like humans to interpret data
- Responds with a degree of **confidence**
- **Plan** a set of actions to reach a desired **goal** & solve problems

Theoretically, different types of AI

- **Artificial Narrow Intelligence** Specialist in one task. Pretty much all of what we know as AI is ANI.
- **Artificial General Intelligence** Specialist in a wide range of cognitive functions. Continuously reason & improve automatically.
- **Artificial Super Intelligence** Outperform humans. Very serious ethical considerations a must. Well, this may not happen also !!!

most of the current AI is ANI

Eliminate Unconscious Bias · Augment Human Intelligence · Explainable & Evidence Driven

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"ARTIFICIAL INTELLIGENCE IS THE SCIENCE AND ENGINEERING OF MAKING INTELLIGENT MACHINES" - JOHN MCCARTHY

Used Responsibly & Ethically · Transparent & Accountable · Respecting Privacy of the individual

depending on the nature of data, choose a learning algorithm

realized using · implemented using

Types of Learning Approaches

3 major approaches through which machines learn without being explicitly programmed

Supervised Learning — *Learning from set of Labeled data provided by an expert. Also classified into 2 subgroups: regression & classification.*

Raw Data → Features & Labeled Input Data → Train → Learned Model / Algorithm → Deploy, Monitor, Fix and Fine Tune

Unsupervised Learning — *Uncovering inherent structures, patterns and relationships hidden in collections of unlabeled data*

Raw Data → Algorithm → Clusters, Anomalies → Review & Use

Reinforcement Learning — *Learning what to do in an environment and how to map situations to actions to maximize a reward signal.*

Goals → START → Initialize Q & Select Actions → Agent → Perform Action → Environment → Measure, Reward & Update

learned models evaluating using

Top Algorithms

- Linear Regression
- Logistic Regression
- Naive Bayes
- Hidden Markov
- XG Boost
- SVM

Deep Learning Algorithms

- Convolutional Neural Nets (CNN)
- Deep Belief Networks (DBN)
- Auto Encoders
- LSTM
- RBM

- K-Means Clustering
- Principal Component Analysis
- Anomaly Detection
- Singular Value Decomp (SVD)

- Markov Decision Process
- Q-Learning
- Temporal Difference Learning

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Most common AI Workloads / Tasks

These are some of the most common tasks that AI systems are taught to perform and also learn continuously over time. Each of these tasks MUST provide responses with a degree of confidence or probability associated with them along with underlying evidence.

- **Named Entity Recognition** — Ability to identify and extract semantic concepts such as people, clinical drugs, diseases, stock prices, organizations, and many other types of entities from text.
- **Passage Retrieval** — Find relevant pieces of information / passages within large & varied corpus based on deep understanding of the query. Intelligent scoring algorithms to rank passages.
- **Object Class & Detection** — Given a raw image, identify which class does the image belong to. In object detection, you task is to identify where in the image does the objects lies.
- **Classification** — Coming together of machine learning & NLP to assign one or more classes to a span of text, document, including a confidence score associated with the results.
- **Emotion Detection** — Much deeper than bipolar sentiment, where in you detect the emotion (anger, joy, impolite etc) of the user based on the text he/she have authored.
- **NLP** — Pre-processing, taxonomy, tokenization, POS tagging, syntactic parsing, semantic role labeling, word sense disambiguation, meta concepts, relationships, anaphora resolution.
- **Language Translation** — Using neural net techniques like NMT to auto-detect & translate between languages. Also trainable using forced glossary, parallel phrases, corpus-level customization etc.
- **Speech Transcription** — Automatically transcribe audio to text including identifying speakers as well as handling multiple languages, understand abbreviations etc with a low error rate. Human error rates are around 5%.
- **Knowledge Extraction** — Being able to learn, represent & extract knowledge from large bodies of unstructured data. Includes knowledge graph construction and learning knowledge base embeddings.

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Common Examples of AI Systems in Action

Review Contract Docs	Audio Call Transcription	Conversational Bots	Search	Customer 360	Threat Prevention
Product Recommendations	Sentiment Analysis	Precision Marketing	Equipment Maintenance	Abnormalities from MRI, x-ray etc	Visual Search
Fraud Detection	Customer Churn Prediction	Enforce Compliance	Malware & Spam Detection	Insurance Claims Damage Assessment	Case Law
Social Listening	Employee Attrition Prediction	Lead Generation	Identify Skin Cancer from Lesions	Multi-modal, no touch Commerce	Amazon Alexa
Taxi Dispatch	Home Automation Control	Sort Vegetables	Patient Readmission Prediction	AI enabled RPA	Drug Repurposing

DevOps for AI - How are these systems built?

Here is a view of how to plan, build, test and operationalize AI using an agile approach.

- ✓ CLEARLY DEFINE YOUR PROBLEM STATEMENTS
- ✓ LIST YOUR OVERALL BUSINESS GOALS & OBJECTIVES?
- ✓ KEY QUESTIONS YOU WISH TO SEEK ANSWERS TO
- ✓ EDUCATE & MANAGE STAKEHOLDERS
- ✓ PLAN FOR ORGANIZATIONAL SKILLS
- ✓ DEFINE A CHANGE MANAGEMENT STRATEGY
- ✓ DO NOT UNDERESTIMATE NEED FOR DOMAIN EXPERTS..

built using

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Assess
- Define Business & Transformation Objectives
- Identify Hills, Backlog & Representative Users
- Perform preliminary data analasis & needs
- Identify & line up SME's & Experts
- Conduct Cost-Benefit Analysis Workshop
- Define Iterative Success Criteria
- Rapidly Prototype

Design
- Use Cases & Actors
- System Context
- Overall Architecture
- Identify Data Sources
- Meta-model / Ontology Design
- Design Comprehensive data & model security & protection schemes

Data Understanding
- Data Source Analysis
- Verify Data Quality
- Design data acquisition strategy
- Design Data Ingestion & Integration Pipeline
- Identify special needs such as OCR
- Plan for out validation, cross-validation, and bootstrapping

Build
- Prepare Ground Truth
- Prepare Blind & Validation Set
- Perform Feature Engineering
- Select appropriate algorithm
- Choose model parameters
- Iteratively Train Models
- Instrument for Usage & Feedback
- Integrate with / build consuming apps

Test & Evaluate
- Model Evaluation & Validation
- Blind Tests. Test with representative users
- Analyze Performance Metrics
- Hyperparameter Tuning
- User Acceptance Test
- Evaluate against business criteria & objectives

Deploy
- Promote & Stage Trained & Tested Models
- Version control & deploy trained models to analytical engines
- Models available as RESTful services
- Roll out communication & training plans for the user personas
- Deploy applications, processes and other components that use the deployed models

Monitor
- Continuously monitor performance
- Setup agile & proactive support mechanisms
- Constantly monitor & measure against business objectives
- Watch out for usage issues
- Setup model Governance approach

Capture & Use Feedback
- Continuously monitor & evaluate feedback
- SME & Experts committee evaluate the feedback
- Collect / define nee features
- Governance around what becomes new ground truth

Adjust & Iterate

Measuring AI Systems

The most common measures and other approaches to evaluating the performance of AI systems.
Note to self: "Accuracy alone is a very misleading metric"

Precision
Proportion of information found that is correct or relevant. A measure of accuracy often on the positive labels of interest. When testing "phone issue" classification model on 1000 examples, 700 predicted as "battery drain". But only 500 of the were correct predictions. So your precision is 500/700 = 0.71.
Low Precision ⇒ Lots of False Positives

Accuracy
Number of correct predictions made divided by the total number of predictions made over all examples you are test the model on. So you tested your model on 1000 examples. The model correctly predicted the label on 880 examples. Your accuracy is 880/1000 = 0.88.

Recall
Proportion of how many examples of interest the model has identified. Recall is a measure of how many true positives were found. In the "phone issues" model, say there are 100 SIM card examples. If your model predicted 90 out of those 100, then recall is 90/100 = 0.9.
Low Recall ⇒ Lots of False Negatives

F1 Score
F1 score conveys the balance between the precision and the recall. F1 score reaches its best value at 1 and worst score at 0.
Low F1 ⇒ Low P & R

$$F_1 = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

Confusion Matrix
Very commonly used to describe the performance of a classification model on a set of test data for which true values are known. Say you are evaluating an "Apple" detection image recog model

Actual \ Predicted	Apple	Fish
Apple	True Positive	False Negative (Type II Error)
Fish	False Positive (Type I Error)	True Negative

Word Error Rate
Metric for measuring speech recognition & machine translation systems. Derived from the Levenshtein distance, between word sequence H (hypothesis) and word sequence R (reference / ground truth).

Other Evaluation Criteria / Approaches								
Bias - Variance Tradeoff	Homogeneity Score	Akaike information criterion(AIC)	Completeness Score	Passage relevancy rating	Jaccard Similarity Score	Average Steps per Conversation	Inter Annotator Agreements	Problem Benchmarks
Conversation abandonment rates	Hamming Loss	Peer Confrontation	Adjusted Rand Index (ARI)	In-Sample Error	Log-Loss	Lift		

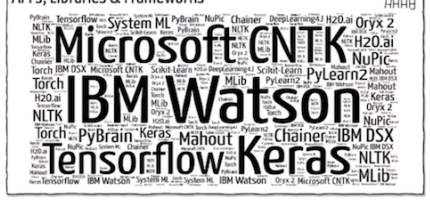
Receiver operating characteristics (ROC): Technique for visualizing, organizing and selecting classifiers based on their performance. ROC curves show the tradeoff between false positive and true positive rates. We plot **'True Negative Rate'** on X-axis and **'True Positive Rate'** on Y-axis.

Area Under the Curve (AUC): Used as a measure of quality of the classification models. A random classifier has an area under the curve of 0.5, while AUC for a perfect classifier is equal to 1. In practice, most of the classification models have an AUC between 0.5 and 1. http://stats.stackexchange.com/questions/132777/what-does-auc-stand-for-and-what-is-it

Turing Test: Suppose that we have a person, a machine, and an interrogator. The interrogator is in a room separated from the other person and the machine. The object of the game is for the interrogator to determine which of the other two is the person, and which is the machine.

Chinese Room: Does the machine *literally* 'understand' Chinese? Or is it merely simulating the ability to understand Chinese? Programming a digital computer may make it appear to understand the language but does not produce real understanding.

API's, Libraries & Frameworks



Pragmatically, what's next for AI?

- Capsule Networks
- Hyper Imaging
- Conscious Machines
- Hyper Imaging
- Contextual Learning
- Sparse Data Learning
- Ground Truth Methods
- Quantum Enabled AI
- Custom AI Chips
- Resistive Processing Units
- Adversarial networks
- Generative Models
- Deep Q Learning
- Auto Feature Elicitation
- 3-D Object Detection
- Debating Systems

Take time to understand these Key Topics & Concepts

GROUND TRUTH · REASONING · INFERENCE · PRECISION & RECALL · FEATURE ENGINEERING · TENSORS · CLASSIFICATION & REGRESSION · ANNOTATIONS · CLUSTERING · MODEL EVALUATION CRITERIA · BACK PROPAGATION · INGESTION & ENRICHMENT · KNOWLEDGE GRAPHS · CNN & RNN · TRANSFER LEARNING · ENTITY RESOLUTION · MODEL GENERALIZATION · BIAS & OVERFITTING · NLP BASICS · GRADIENT DESCENT · COST FUNCTION · SIGMOID FUNCTION · AGENTS · NEURAL MACHINE TRANSLATION · AUGMENTED INTELLIGENCE

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