Introduction to Large Language Models (LLMs)

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Outline

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Introduction to Artificial Intelligence

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“Houston, we have a problem!!”

50 Years Ago: “Houston, We’ve Had a Problem” – John Uri

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Whats the Problem?

- Along with some softer words like “disruption”, “passionate”, “excited” . . .
- If you don’t have word “innovation” in your talk/speech/conversation it’s BIG problem.
- Irrespective of fields. You can be Corporate, Political, Social, etc.

And there is an addition of one more word, which is a must in every talk...and that is?

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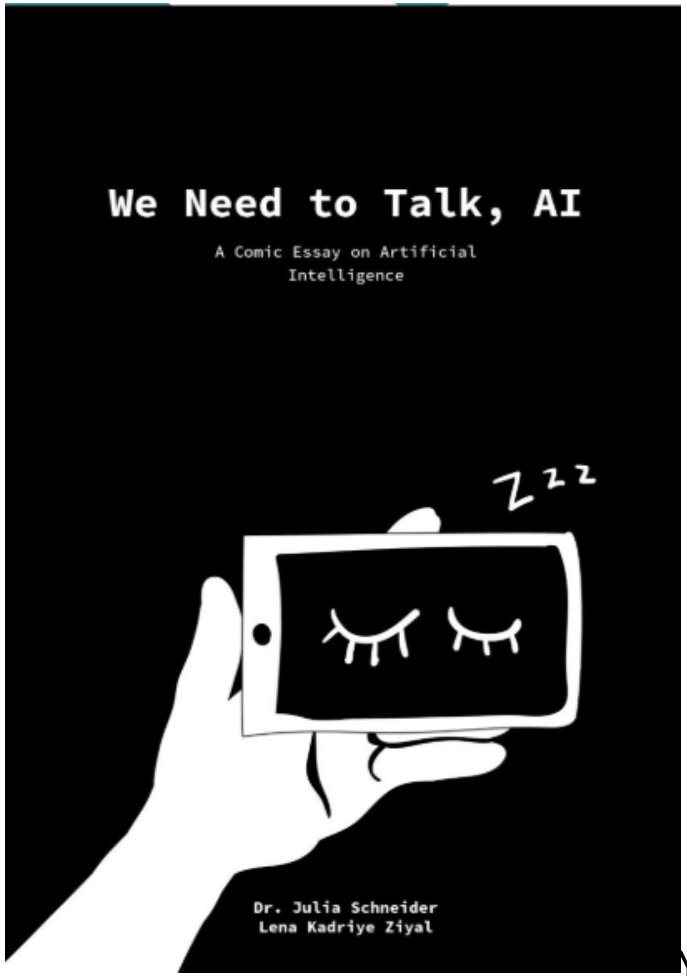
The Problem

Every company is claiming to be working in AI-ML

- Is it really so?
- What exactly is AI (ML)?
- What is not AI?

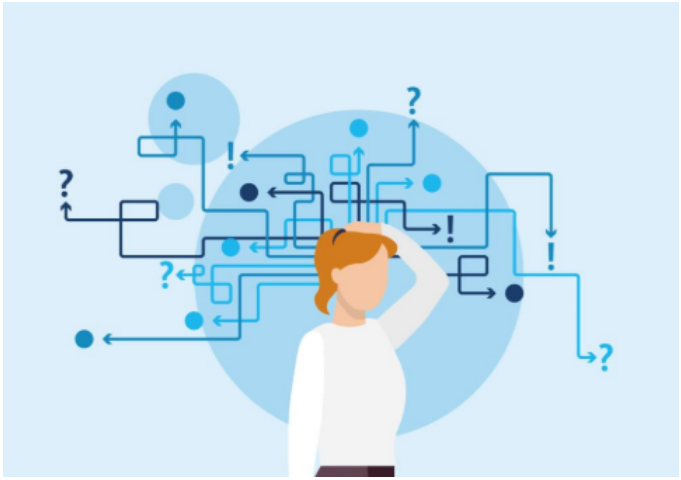


Or is it just a plain BIG hype?

What is the Core Idea?

What's the core idea?'

- behind problem solving?
- behind writing software algorithms?
- solving research problems?



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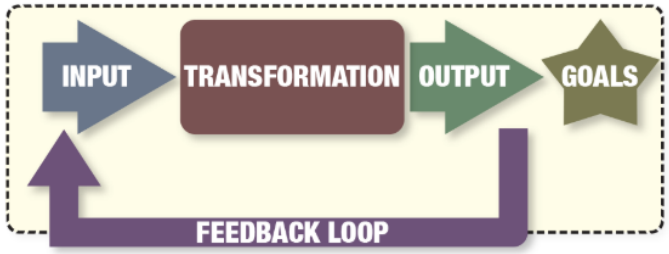
Desire

- To find a “function”
- To find a relation
- To find a transformation
- To build a model
- From given inputs to desired outputs.

That’s it.



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Functions

- Some functions are straight forward
- *"In summer, ice-cream sale goes up"*
- Cause and effect
- Relation (function, Mathematical model) is found out
- Here, simple rule based programming suffices

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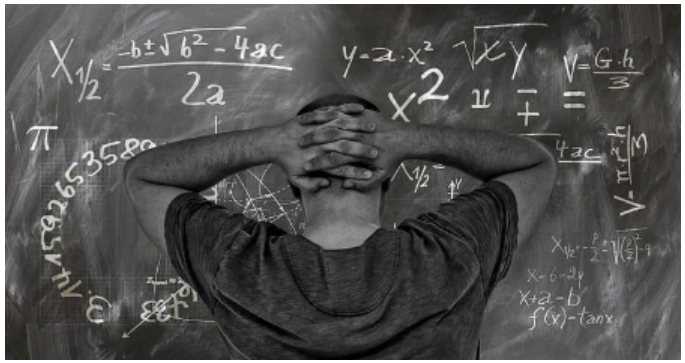
Functions

- But some functions are complex
- *"More you put efforts, your business flourishes."*
- Cause and effect again, but the relation is far to complex
- Too many variables
- Here, simple rule based programming not humanly possible.
- Lots of research needed to come up with equations.



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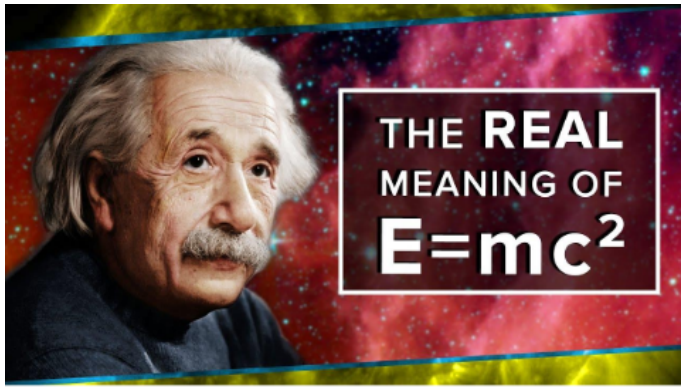
Functions

- $E = mc^2$
- What's this? a function?
- Input variable(s)?
- Output variable(s)?
- Parameters?
- How's the relation? linear?



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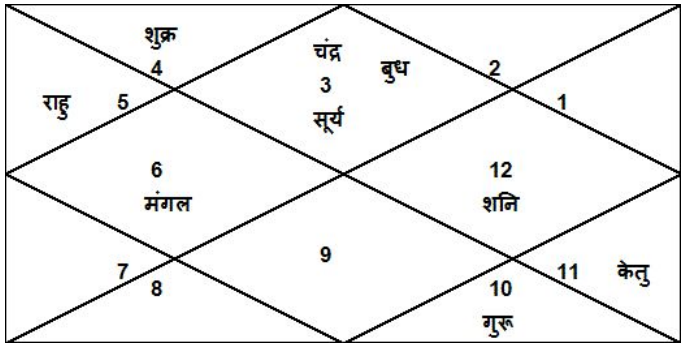
Controversial Example

- Even astrology is a model, based on the past cases.
- Could claim empirical evidence.
- Given this planetary position, it predicts.
- Represented by “Horoscope”
- Got weights for each planets (real or ficticous)
- Reliable??



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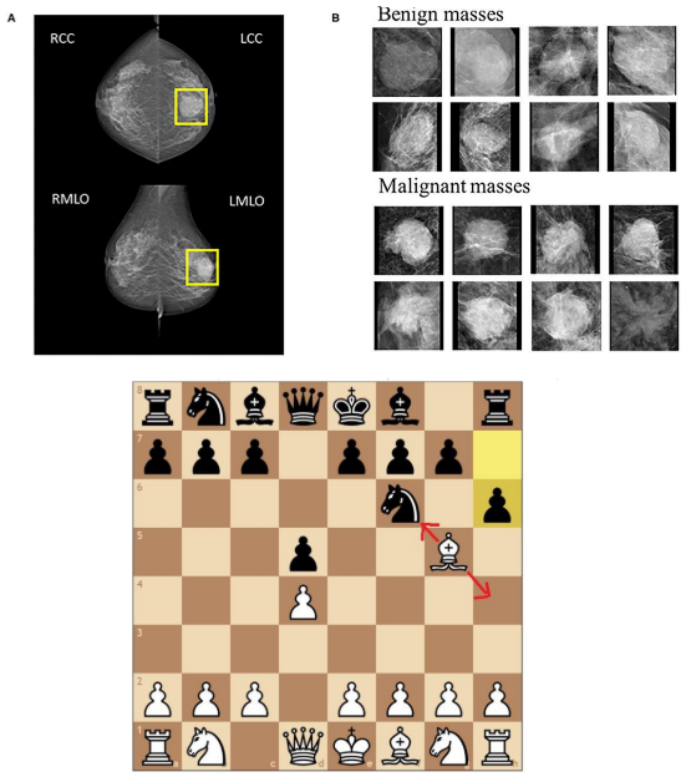
Functions

- But most real-life functions are not deterministic
- Some are probabilistic, some non-linear.
- *"Detecting if the tumor is benign or malignant"*
- *"At any state in the game of chess, whats the next move?"*



Chess: next move?

- Needs extreme expertise
- Needs "intelligence"
- How do you get that?
  - Built by lots of training.
  - By studying lots of past games.
- This is how Humans build intelligence

Intelligence

- Can machine (software/program) also do the same?
- Can it play chess?
- Can it build intelligence?
- By looking at past experiences (data),
- Training Data: games played, moves used, etc.

Yes, it can!! That's Artificial Intelligence.

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What is Artificial Intelligence?

My definition

"If machines (or computer programs) start doing some/all of these "intelligent" tasks, then that's Artificial Intelligence"

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Intelligence: the differentiation

- Ability to think various domains
- Ability produce something new
- Ability to detect the unseen
- Ability to enhance knowledge (rules, patterns)

All these, AI has started doing. The AI era has arrived!!

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Everyday usage

Artificial intelligence seems to have become ubiquitous.

- Replying to our emails on Gmail
- Learning how to drive our cars,
- Sorting our holiday photos.
- etc.

Too good to be true, isn't it, sort of Magical !!

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But then ...

- When its too good, you start suspecting
- Is it for real!!
- How can such thing happen?
- How far will it go?

The next thing you know, people are worrying about exactly how and when AI is going to doom humanity.

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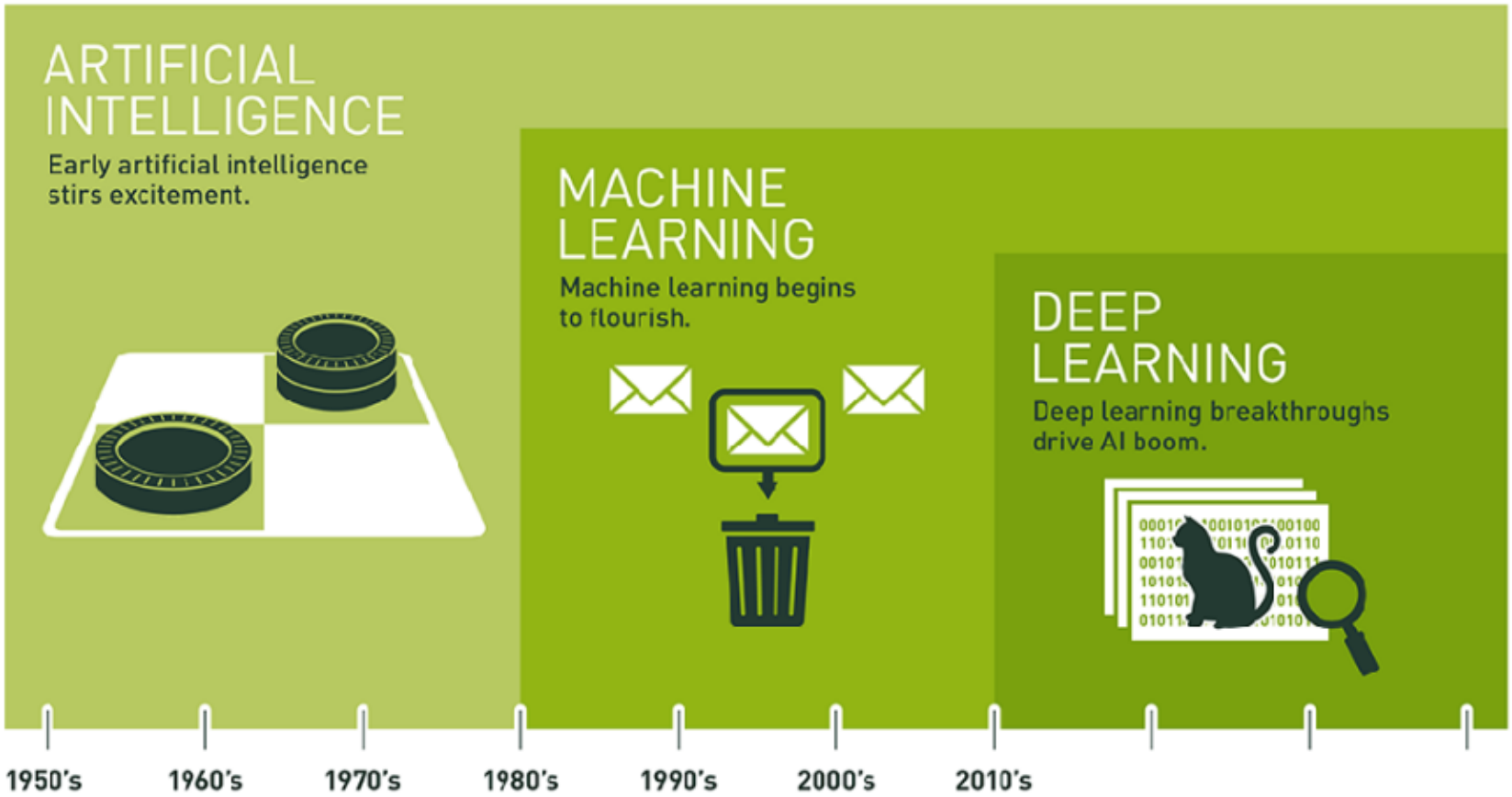
AI, ML, DL . . . Same?

Or Relationship between them ?



(Ref: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/)

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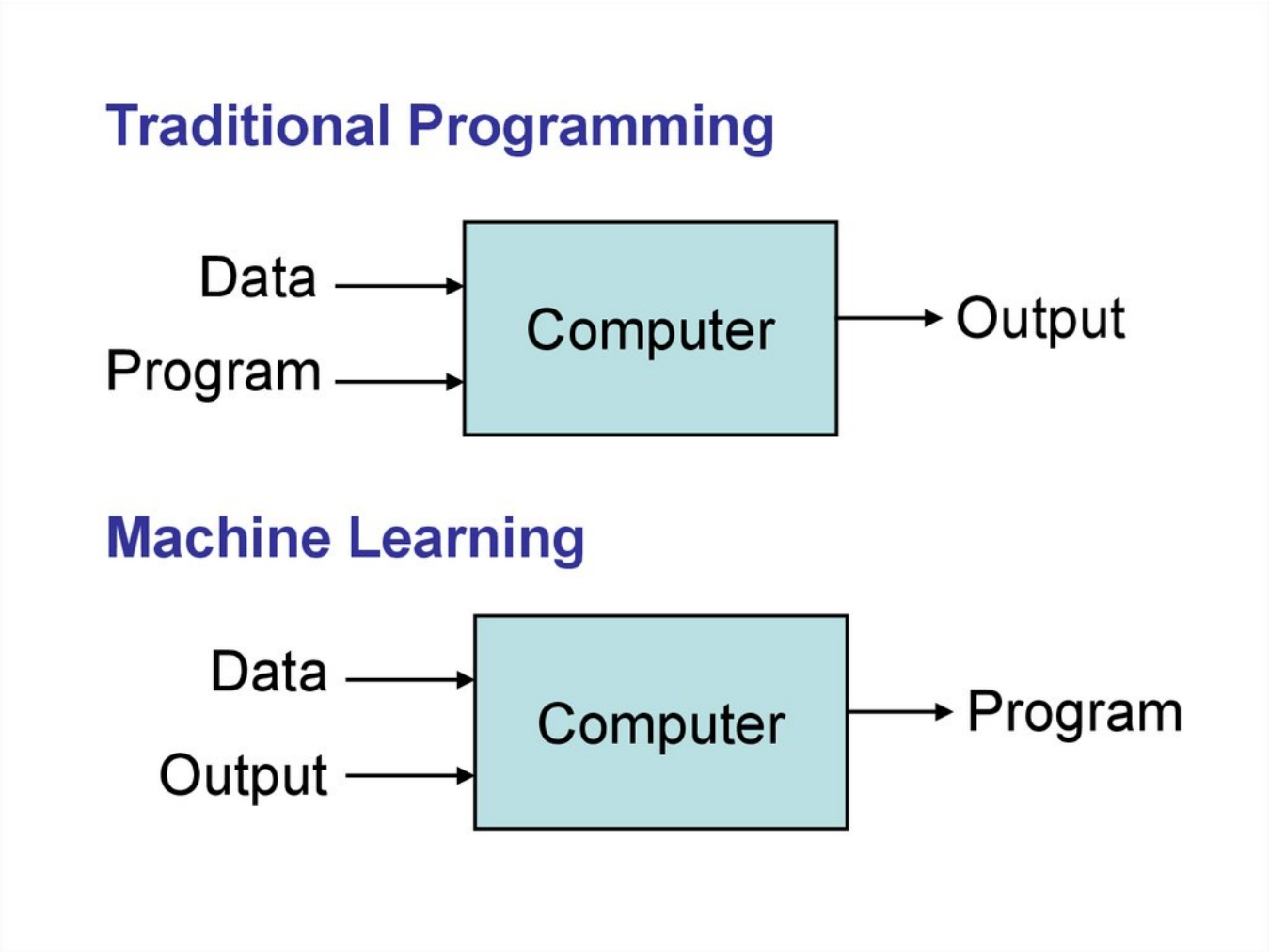
Traditional vs. Machine Learning?



Why Machine/Deep Learning?

- Problems with High Dimensionality
- Hard/Expensive to program manually
- Techniques to model 'ANY' function given 'ENOUGH' data.
- Job $$$

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Why now?

- Flood of data (Internet, IoT)
- Increasing computational power
- Easy/free availability of algorithms
- Increasing support from industries

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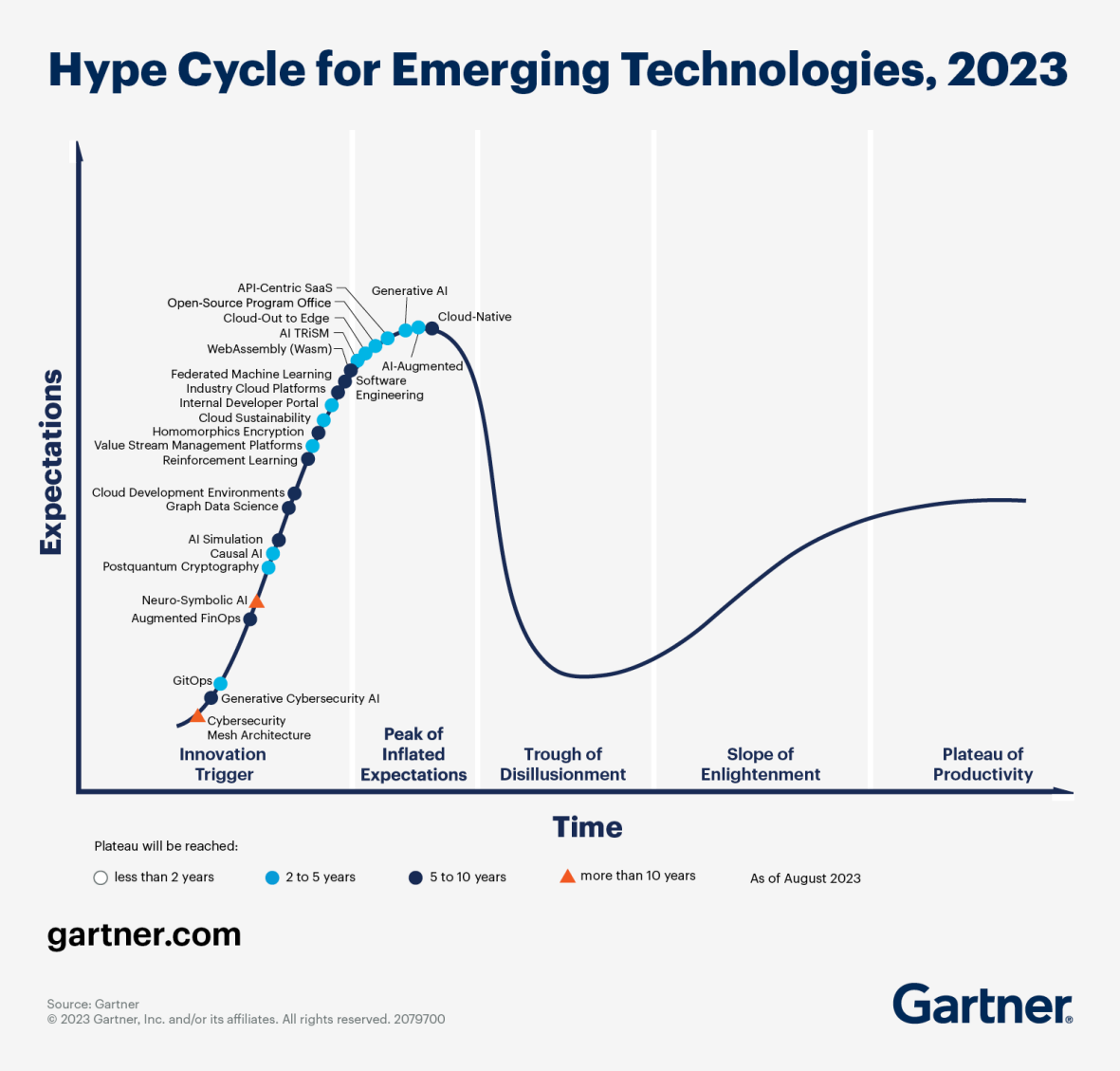
Gartner Hype Cycle Emerging Technologies 2023



Is AI a threat?

Is AI a threat?

If you believe in what Elon Musk says, then YES.

(Ref: What is Artificial Intelligence — Artificial Intelligence Tutorial For Beginners — Edureka)

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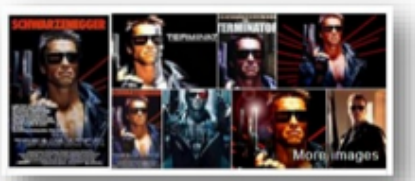
Is AI a threat?

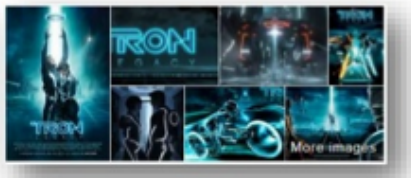
If you believe in these movies, then YES.



The Terminator

I, Robot

The Matrix



Tron: Legacy

War Games

Ex Machina

Well, AI based War robots are not impossible anymore.

(Ref: What is Artificial Intelligence — Artificial Intelligence Tutorial For Beginners — Edureka)

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Fear: Are we being replaced?

- Yes. in tasks that are repetitive
- But not which require complex thinking and creativity

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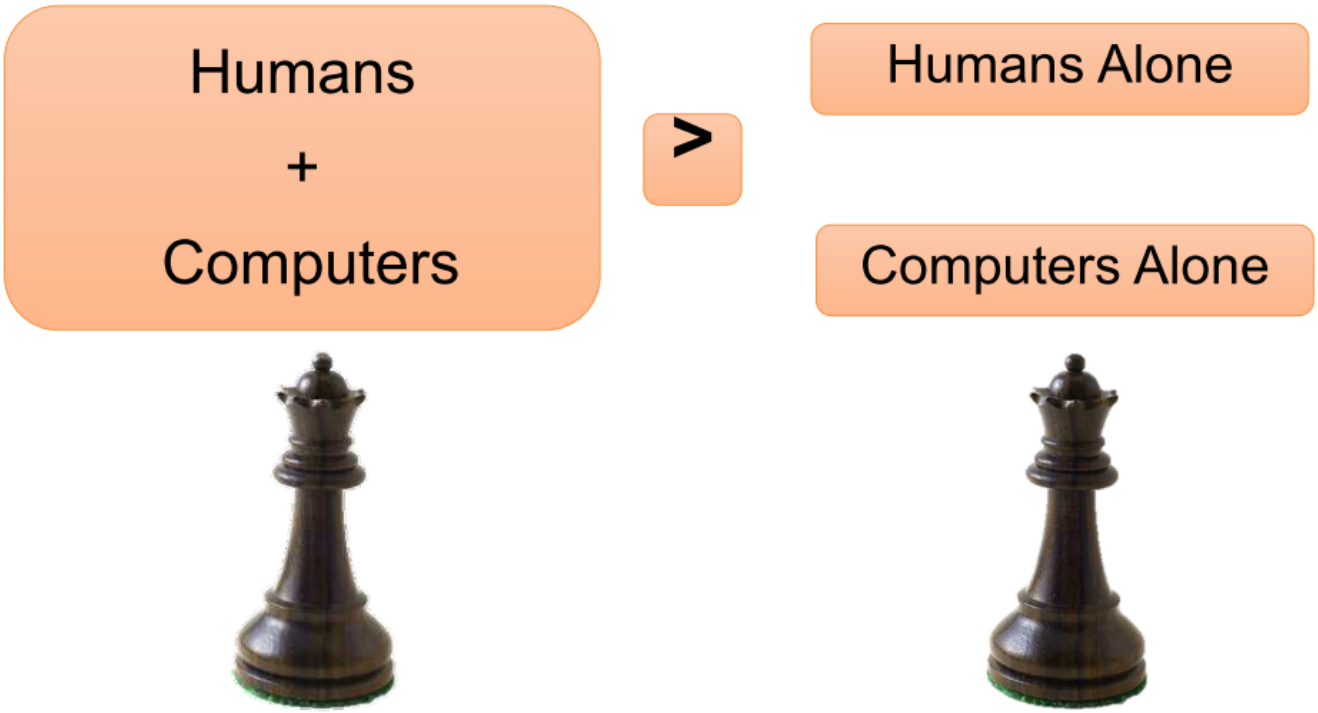
Mostly

Technology Enhancing (Not Replacing) Humans



(Ref: "Artificial Intelligence Overview" - Harry Surden)

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Limits on Artificial Intelligence

- Many things still beyond the realm of AI
- No thinking computers
- No Abstract Reasoning
- Often AI systems Have Accuracy Limits
- Many things difficult to capture in data
- Sometimes Hard to interpret Systems

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Introduction to Generative AI

Introduction

- What is Generative AI?
- What is not Generative AI?
- How is it related to AI-ML-DL?

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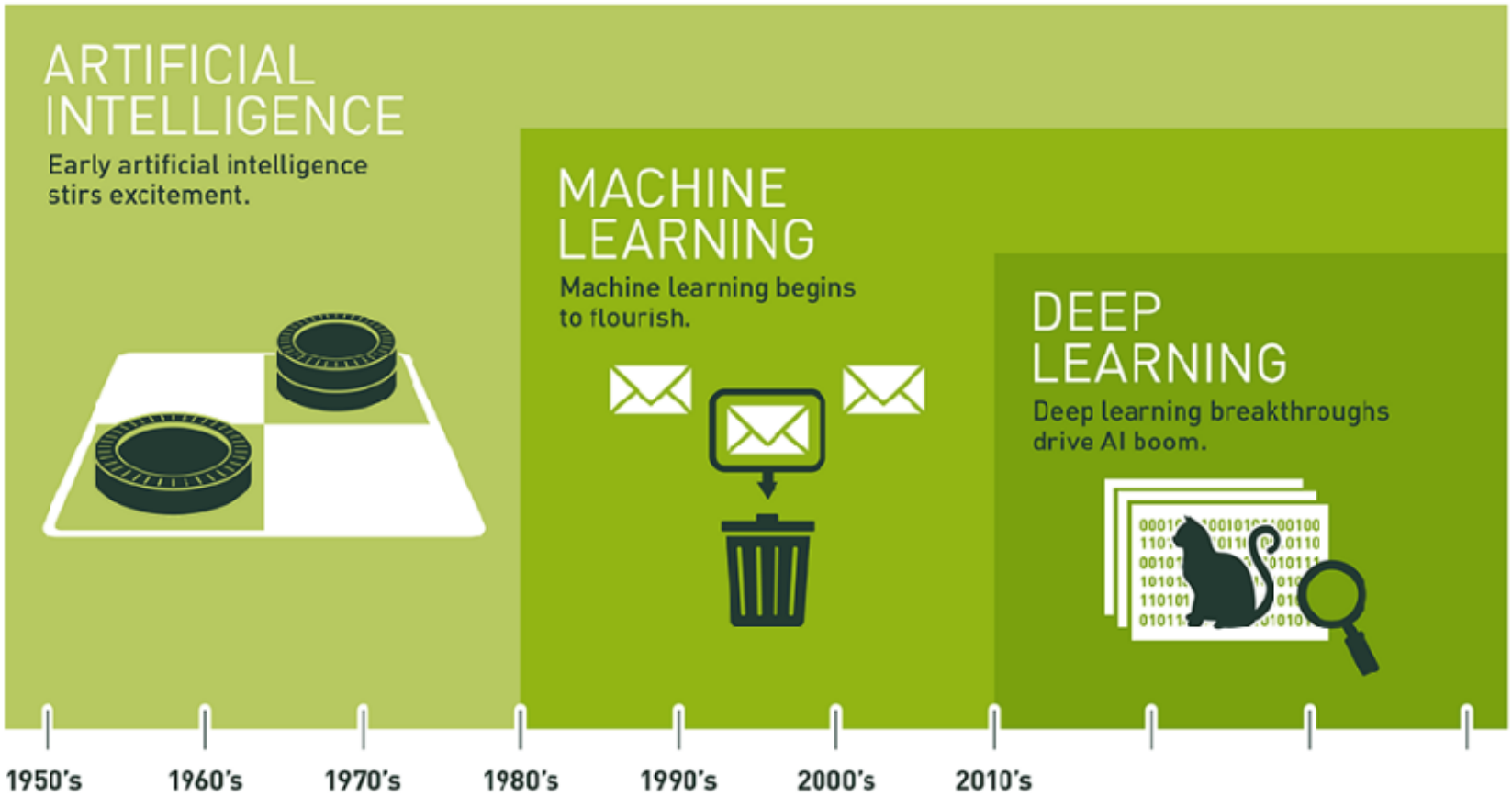
Relationship between AI, ML, DL

First, lets see whats AI-ML-DL and relationship among them.



(Ref: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/)

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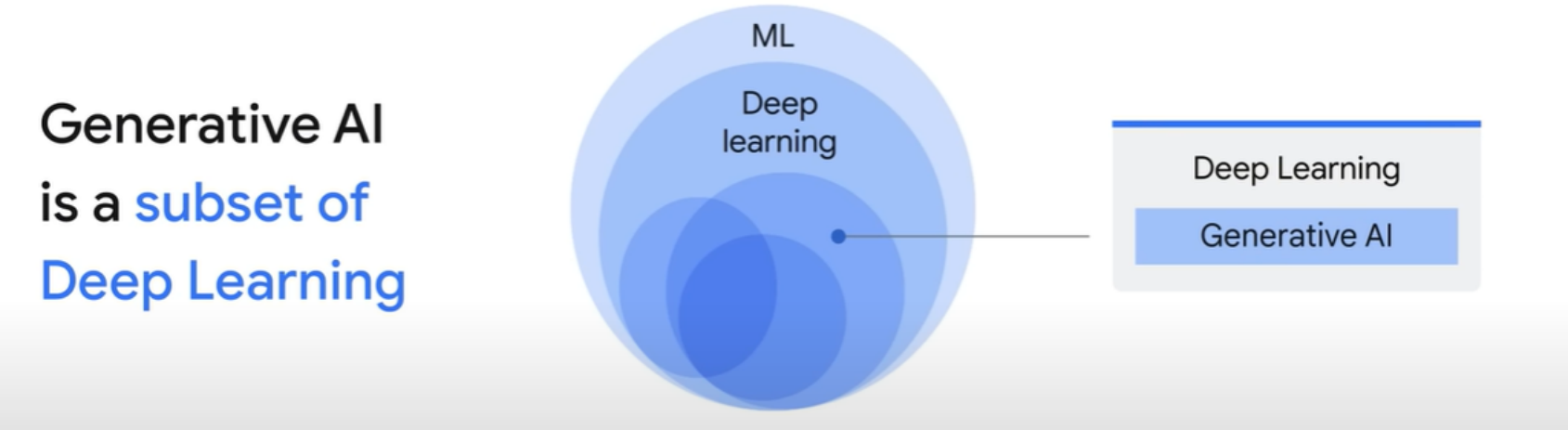
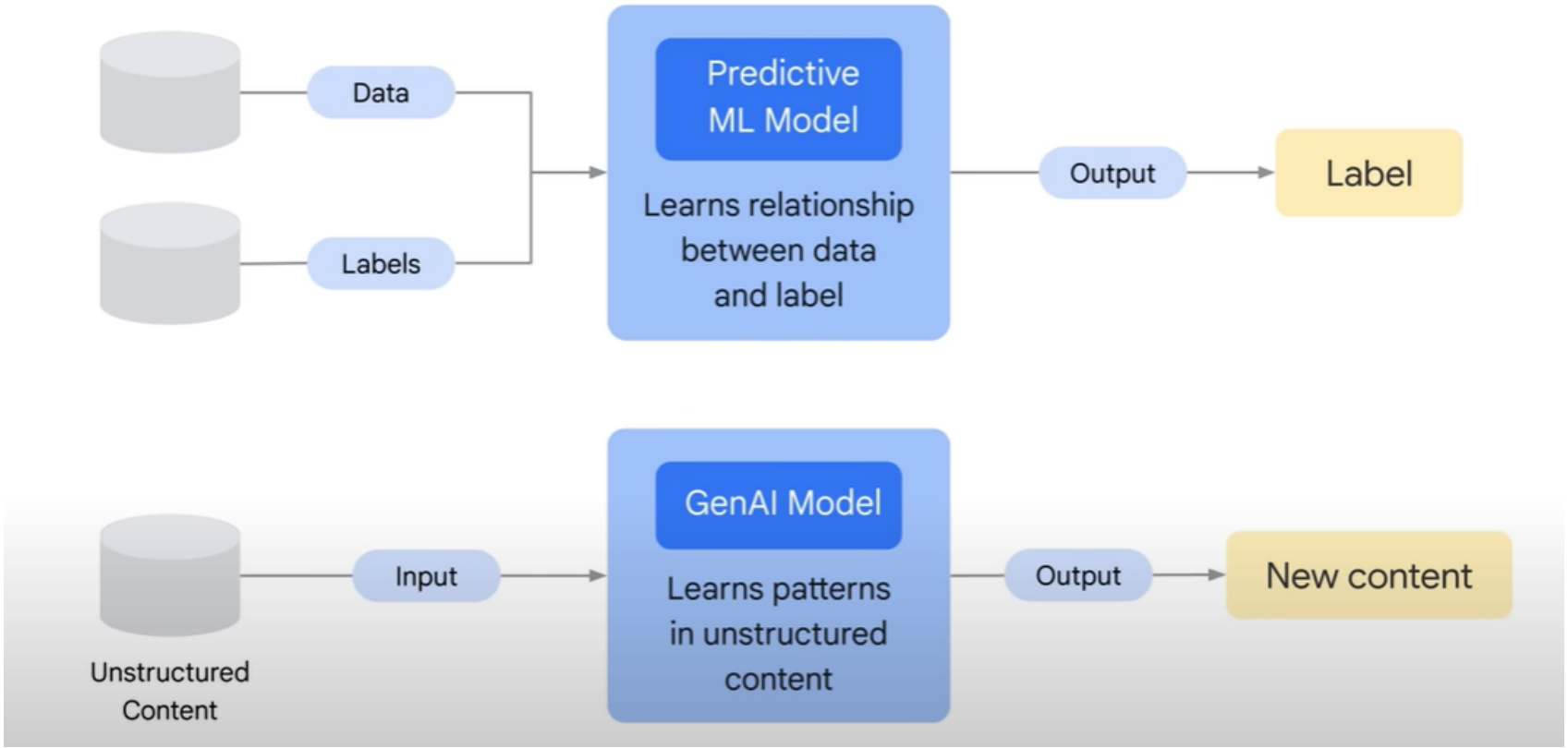
What is Gen AI wrt AI, ML, DL



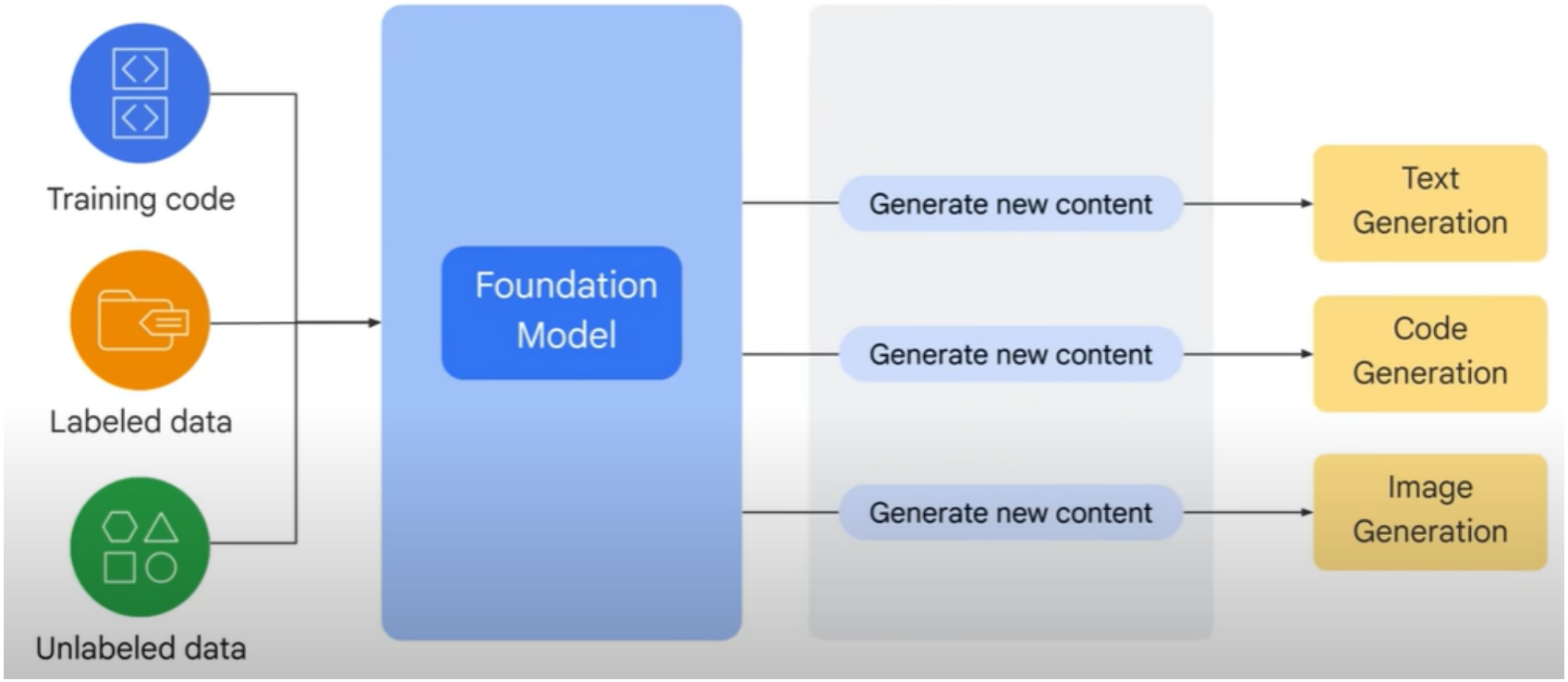
(Ref: Introduction to Generative AI - Google Cloud Tech)

Types of Approaches



(Ref: Introduction to Generative AI - Google Cloud Tech)

What is Foundation Model?



(Ref: Introduction to Generative AI - Google Cloud Tech)

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Same Problem, using different Technologies

Difference across technologies, old to new

Lets see how the solutions to the problem of detecting a cat from images using traditional programming, deep learning, and generative AI, respectively.

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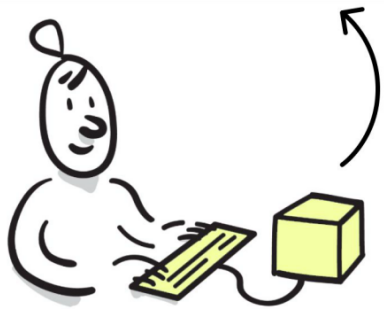
Traditional Programming

- Traditional programming involves writing explicit rules to detect a cat in images.
- Features like color, texture, and shape can be used to define these rules.
- However, designing accurate rules for complex patterns like cat detection can be challenging.
- It requires extensive domain knowledge and might not generalize well to different images.

```
cat:
      type: animal
      legs: 4
      ears: 2
      fur: yes
      likes: yarn, catnip
```



(Ref: Primer on LLM and Gen AI - Google Cloud)

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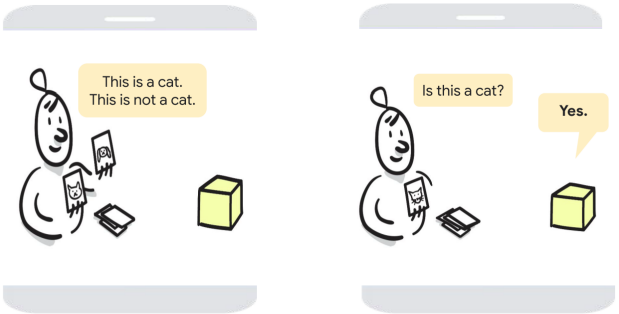
Deep Learning

- Deep learning utilizes neural networks to automatically learn features for cat detection.
- Convolutional Neural Networks (CNNs) are particularly effective for image classification tasks.
- Large labeled datasets of cat images are used to train the network.
- The network learns to identify unique cat features and generalize them to detect cats in new images.
- Deep learning offers better accuracy and can handle complex patterns without explicit rule definition.



(Ref: Primer on LLM and Gen AI - Google Cloud)

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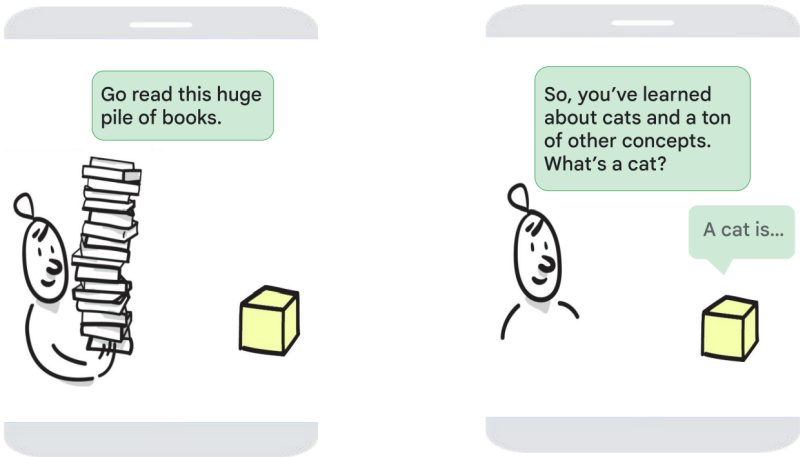
Generative AI

- Generative AI focuses on generating new data, including images of cats.
- Generative Adversarial Networks (GANs) are used to generate realistic cat images.
- The GAN consists of a generator and a discriminator that compete against each other.
- The generator learns to generate increasingly realistic cat images, while the discriminator learns to distinguish real from generated images.
- The generated cat images can be used to augment datasets for cat detection models.



(Ref: Primer on LLM and Gen AI - Google Cloud)

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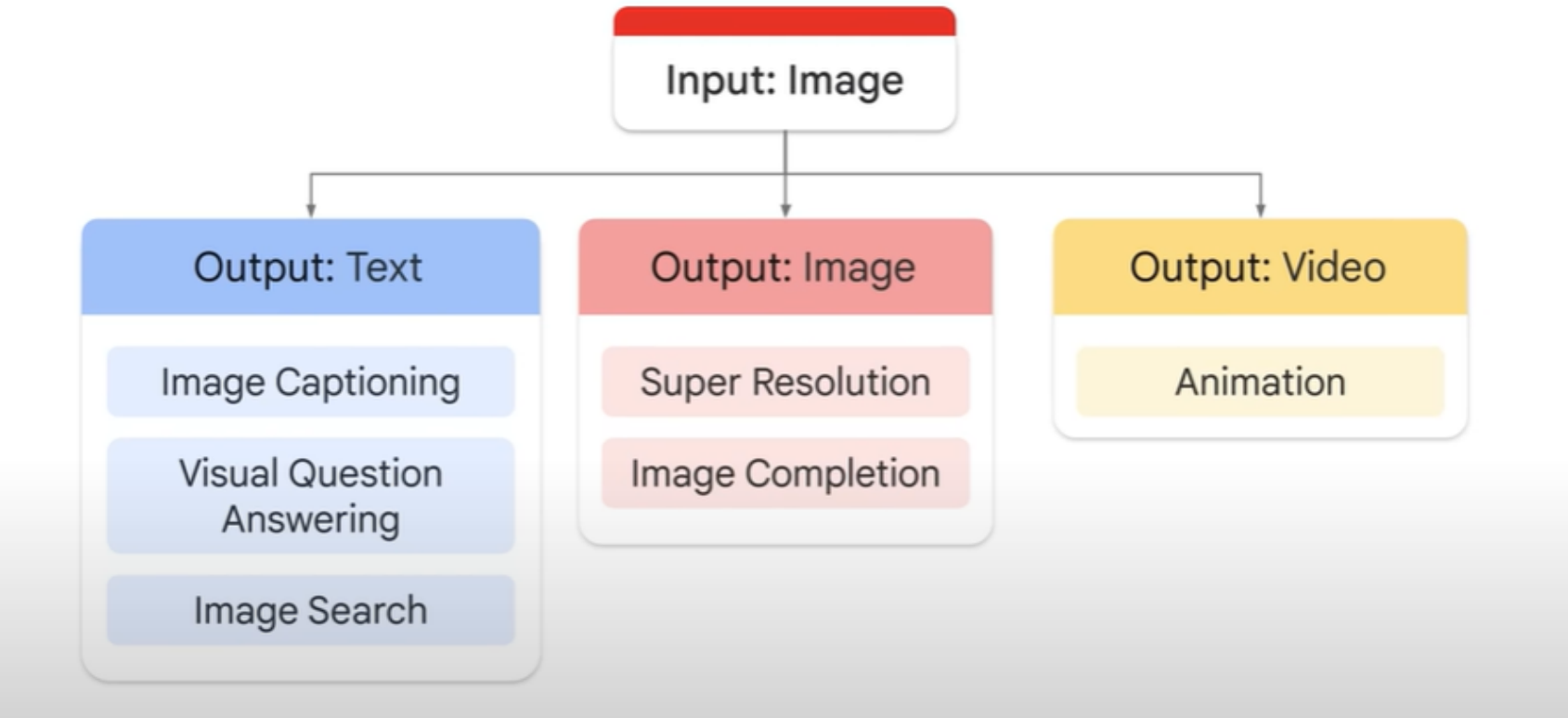
Modalities in Generative AI



(Ref: Introduction to Generative AI - Google Cloud Tech)

Let's foucs on the most popular modality . . .

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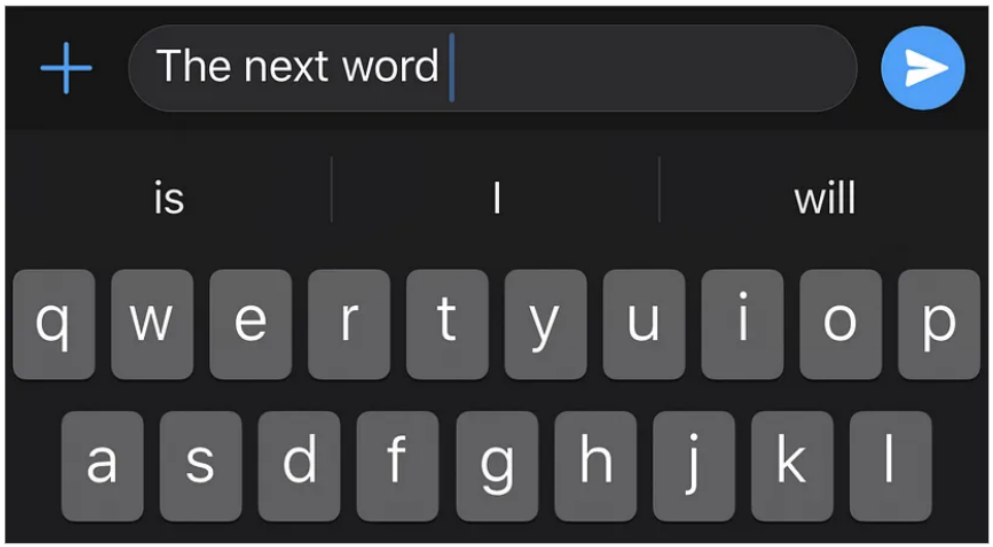
What is a Language Models?

- While typing SMS, have you seen it suggests next word?
- While typing email, have you seen next few words are suggested?
- How does it suggest? (suggestions are not random, right?)
- In the past, for "Lets go for a . . . ', if you have typed 'coffee' 15 times, 'movie' say 4 times, then it learns that. Machine/Statistical Learning.
- Next time, when you type "Lets go for a ", what will be suggested? why?
- This is called Language Model. Predicting the next word. When done continuously, one after other, it spits sentence, called Generative Model.



Next word prediction using language modeling in keyboards(Mandar Deshpande)

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Why they are called Large? Corpus

GPT: Generative Pre-trained Transformers

- GPT-1 is pre-trained on the BooksCorpus dataset, containing 7000 books amounting to 5GB of data
- GPT-2 is pre-trained using the WebText dataset which is a more diverse set of internet data containing 8M documents for about 40 GB of data
- GPT-3 uses an expanded version of the WebText dataset, two internet-based books corpora that are not disclosed and the English-language Wikipedia which constituted 600 GB of data

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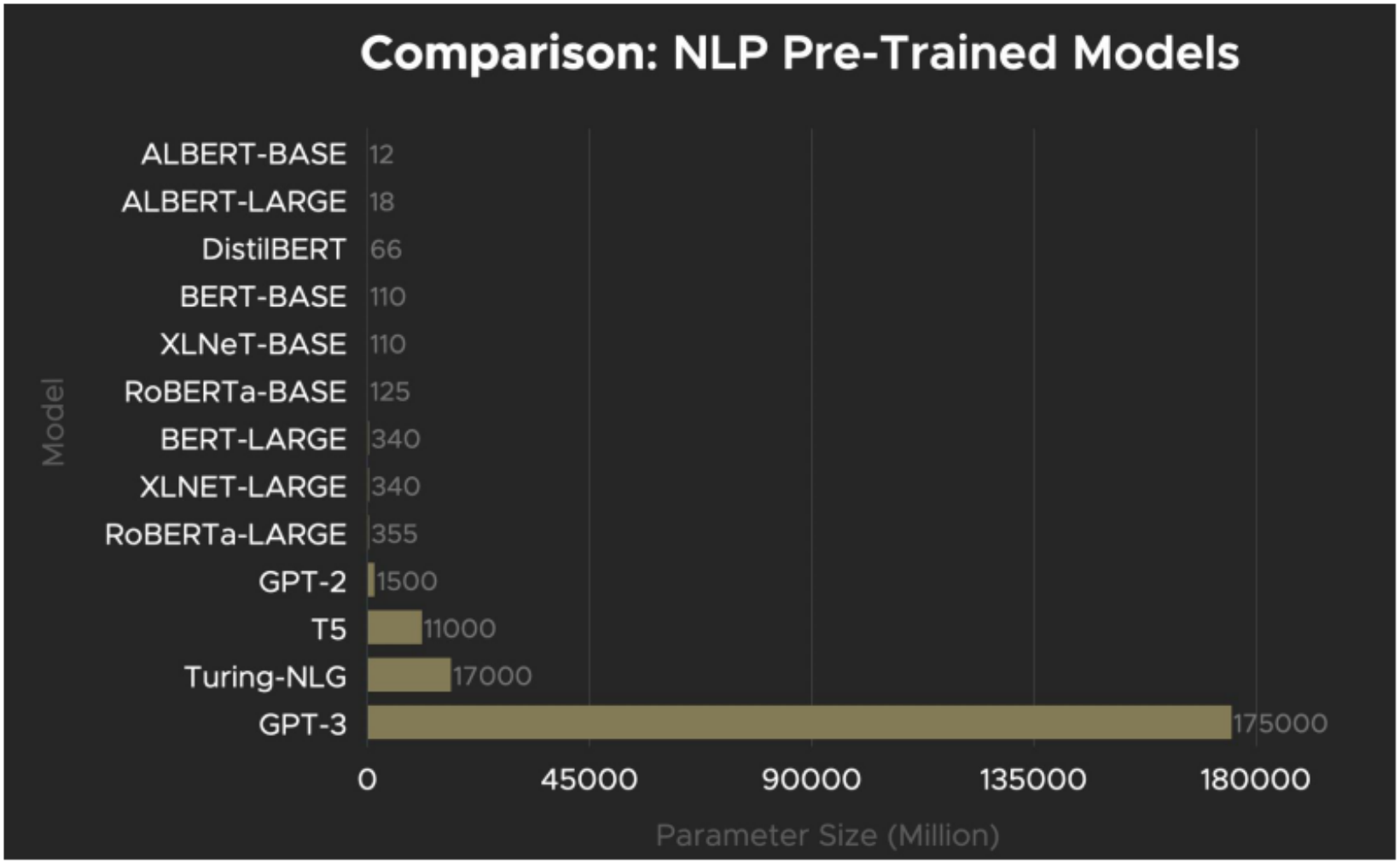
Why they are called Large? Parameters



(Ref: Deus.ai https://www.deus.ai/post/gpt-3-what-is-all-the-excitement-about)

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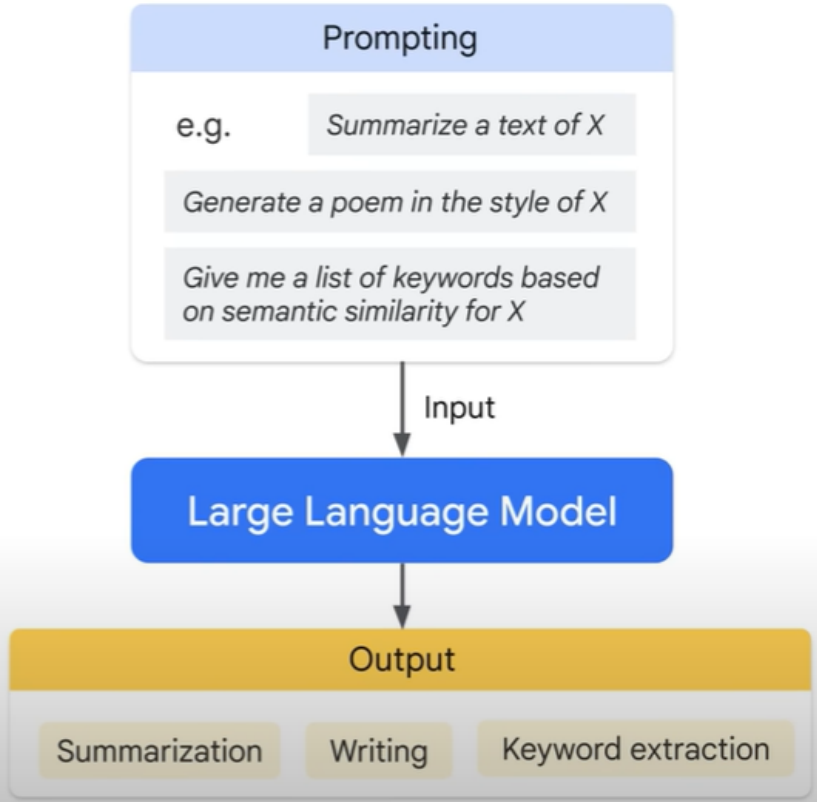
Prompts driving Generative AI

Prompt Design: the quality of the input determines the quality of the output.



(Ref: Introduction to Generative AI - Google Cloud Tech)

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Making of a Sandwich

Basic

Explain how to make a peanut butter and jelly sandwich

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Adding Roles

As a chef, explain to your assistant how to make a peanut butter and jelly sandwich

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Adding Constraints

Make a nut-free version of the sandwich due to a customer's nut allergy

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Adding Examples

Create two unique variations of the classic sandwich. Banana Nut Crunch: . . . .
Triple Berry Blast: . . .

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Adding Contextual Information

As the head chef at 'The Sandwich Haven,' guide your new assistant to create specials for the menu

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Incorporating Feedback

Improve the sandwich based on customer feedback for less sweetness and a creative twist

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Time Constraints and Prioritization

Prepare an alternative fruit version for testing within a tight deadline

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Incorporating Multidisciplinary Knowledge

Use food presentation and garnishing techniques for a visually appealing sandwich

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Addressing Dietary Preferences

Prepare a vegan version using plant-based alternatives for all ingredients

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Reflection and Iteration

Reflect on feedback and iteratively refine the sandwich for better taste and appeal

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Self-Criticism

Explain how to make a peanut butter and jelly sandwich. Please re-read your above response. Any mistakes? If so, please identify and make the necessary edits.

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Chain-of-Thought

Explain how to make a peanut butter and jelly sandwich. Let's think step by step.

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Self-Consistency

Here are recipes of multiple sandwiches. Sandwich 1: recipe 1. Sandwich 2: recipe 2. . . . . Explain how to make a peanut butter jelly sandwich.

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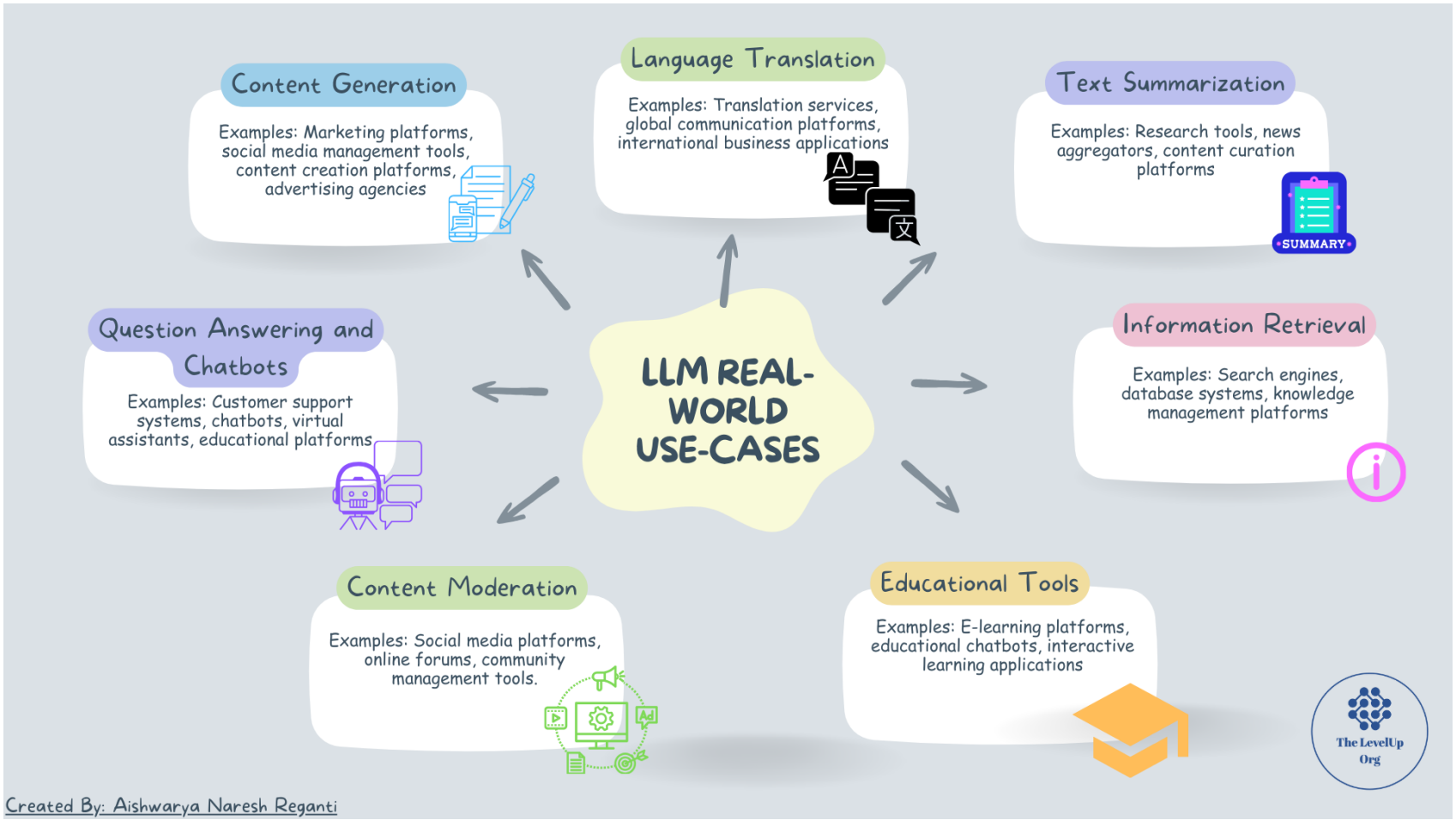
Conclusions (Ref: 2023 Kaggle AI Report on Generative AI, by Trushant Kalyanpur)

LLM Real World Use Cases



(Ref: Applied LLMs Mastery 2024 - Aishwarya Reganti)

Advancements in Text-to-Image Generative AI

- Notable models: DALL-E/DALL-E 2, Midjourney, Stable Diffusion
- Creative expression, streamlined design
- Realistic, high-quality image generation
- Concerns: misuse, ethical implications
- Deepfakes, synthetic media for misinformation
- Risk of generating illegal, toxic content
- Challenges in ethical responsibility, moderation

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Copilots: Revolutionizing Coding

- AI assistance for software developers
- 92% programmers use AI tools (Github survey)
- Copilot users 55% faster in project completion
- Potential $1.5 trillion GDP boost (productivity study)
- AI tools like Copilot enhance speed, efficiency
- Fewer errors in coding processes

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Industry Giants' Role in Text Generative AI

- Google, Meta, OpenAI - Pivotal contributions
- PaLM, Galactica, ChatGPT, GPT4 releases
- ChatGPT: Turning point in Text Generative AI
- LLMs for content creation, writing, storytelling
- Analyzing, organizing large textual data
- Efficient search engines, knowledge systems

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Advancements in LLM Accessibility

- Meta's LLaMa: Open-source alternatives to ChatGPT
- Google's Bard: AI chatbot response to ChatGPT
- QLoRA: Fine-tuning LLMs on consumer GPUs
- Broadening access to advanced technology
- LLMs empower diverse applications
- LLMs: Bridging the gap between innovation and accessibility

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Conclusions

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Progression

Models for prediction:

- On data, derive features, put statistical techniques like regression. One model per task. That's Machine Learning.
- Feed raw data, employ neural networks. One model per task. That's Deep Learning.
- Use Text data, get embeddings, use ML/DL, say for classification. One model per task. That's Natural Language Processing.
- Train neural network on large corpus, store weights and architecture, then add final layers for say classification on custom data+labels. That's Pretrained model. One model, many tasks.
- Train Large Language Model, just supply instructions on what to do, works. One model many tasks. Zero-shot, few-shots.

(More info at SaaS LLM https://medium.com/google-developer-experts/saasgpt-84ba80265d0f)

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New Programming Language?

(Ref: Prompt Engineering Sudalai Rajkumar)

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Summary of Prompt Engineering

- **Definition of Prompts**
  - Prompts are initial text inputs provided to a model.
  - Used by the model to generate responses or accomplish tasks.
- **Role of Prompts**
  - Sets of instructions for AI or chatbots (e.g., ChatGPT).
  - Applied in various tasks, including summarization, arithmetic problem-solving, and question-answering.
- **Objective of Prompt Engineering**
  - Goal: Refine prompts to enhance model accuracy and relevance in outputs.
  - Central to improving the performance of language models.
- **Prevalent Prompt Types**
  - Various prompt types exist, with a focus on two widely used methodologies:
    - **Zero-shot prompting**
    - **Few-shot prompting**

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ChatGPT Ultimate Prompting Guide

- Tone: Specify the desired tone (e.g., formal, casual, informative, persuasive).
- Format: Define the format or structure (e.g., essay, bullet points, outline, dialogue).
- Act as: Indicate a role or perspective to adopt (e.g., expert, critic, enthusiast).
- Objective: State the goal or purpose of the response (e.g., inform, persuade, entertain).
- Context: Provide background information, data, or context for accurate content generation.
- Scope: Define the scope or range of the topic.
- Keywords: List important keywords or phrases to be included.
- Limitations: Specify constraints, such as word or character count.
- Examples: Provide examples of desired style, structure, or content.
- Deadline: Mention deadlines or time frames for time-sensitive responses.

(Ref: LinkedIn post by Generative AI, Twitter by Aadit Sheth, Source : Reddit)

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ChatGPT Ultimate Prompting Guide

- Audience: Specify the target audience for tailored content.
- Language: Indicate the language for the response, if different from the prompt.
- Citations: Request inclusion of citations or sources to support information.
- Points of view: Ask the AI to consider multiple perspectives or opinions.
- Counter arguments: Request addressing potential counterarguments.
- Terminology: Specify industry-specific or technical terms to use or avoid.
- Analogies: Ask the AI to use analogies or examples to clarify concepts.
- Quotes: Request inclusion of relevant quotes or statements from experts.
- Statistics: Encourage the use of statistics or data to support claims.
- Visual elements: Inquire about including charts, graphs, or images.
- Call to action: Request a clear call to action or next steps.
- Sensitivity: Mention sensitive topics or issues to be handled with care or avoided.

(Ref: LinkedIn post by Generative AI, Twitter by Aadit Sheth, Source : Reddit)

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Interaction Guidelines: Avoid Misuses

- Factual Accuracy: Interactions must be free from factual inaccuracies that can be challenged by social media or journalists.
- Negative Debates: Avoid discussing topics that fuel negative or concerning online debates, such as AI sentience, AI in education, AI-driven job displacements, and politically divisive issues.
- Minors' Involvement: Do not include use cases specifically targeting or involving individuals under 18 years old.
- Sensitivity and Misinformation: Prevent the inclusion of sensitive, misleading, or hazardous responses.
- Search and Google Assistant: Interactions that require basic, straightforward answers are better suited for Search or Google Assistant.
- Financial/Legal/Medical Advice: Refrain from providing advice related to financial matters, legal issues, or medical concerns.
- Brand Names and Trademarks: Avoid mentioning specific brand names, trademarks, or public figures (except historical figures).
- No Reviews or Tweets: Do not request reviews of restaurants, businesses, or tweets to minimize the risk of associating with bots.
- Avoid Personification: Refrain from personifying the product or brand and from encouraging users to address Bard by name.

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Limitations

Boie is a real company, the product name is not real. So, see what you get . . .

```
prompt = f"""
Tell me about AeroGlide UltraSlim Smart Toothbrush by Boie
"""
response = get_completion(prompt)
print(response)
```

What Next?

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The Career of the Future

Software 3.0

"Programming [is] moving from curating datasets to curating prompts to make the meta learner "get" the task it's supposed to be doing."

Source: @karpathy

(Ref: The Complete Prompt Engineering for AI Bootcamp (2023))

YHK

New Roles?

Coming up with good prompt is a combination of art and science

(Ref: Prompt Engineering Sudalai Rajkumar)

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Read on to learn how to engineer good prompts!

- Shin, T., Razeghi, Y., Logan IV, R. L., Wallace, E., & Singh, S. (2020). AutoPrompt: Eliciting Knowledge from Language Models with Automatically Generated Prompts. Proceedings of the 2020 Conference on Empirical Methods in Natural Language Processing (EMNLP). https://doi.org/10.18653/v1/2020.emnlp-main.346
- Kojima, T., Gu, S. S., Reid, M., Matsuo, Y., & Iwasawa, Y. (2022). Large Language Models are Zero-Shot Reasoners.
- Liu, P., Yuan, W., Fu, J., Jiang, Z., Hayashi, H., & Neubig, G. (2022). Pre-train, Prompt, and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing. ACM Computing Surveys. https://doi.org/10.1145/3560815
- Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D. M., Wu, J., Winter, C., ... Amodei, D. (2020). Language Models are Few-Shot Learners.
- Zhao, T. Z., Wallace, E., Feng, S., Klein, D., & Singh, S. (2021). Calibrate Before Use: Improving Few-Shot Performance of Language Models.

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My Sketchnote

(Ref: https://medium.com/technology-hits/prompting-is-all-you-need-5dddb82bd022)

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Take Aways

Prompt Engineering is an Iterative Process:

- Try something
- Analyze where the results do not match the expectations
- Clarify instructions, gives examples, specify output format, specify constraints, etc
- Test on a batch of known results.

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Quality of Ideas

“I don’t think we’ll still be doing prompt engineering in five years [i.e.] figuring out how to hack the prompt by adding one **magic word** to the end that changes everything else.”

"What will always matter is the **quality of ideas** and the understanding of what you want."

Source: Sam Altman

(Ref: The Complete Prompt Engineering for AI Bootcamp (2023))

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Resources

- Prompt Engineering Guide
  https://github.com/dair-ai/Prompt-Engineering-Guide
- Awesome ChatGPT Prompts
  https://github.com/f/awesome-chatgpt-prompts/
- ChatGPT Prompt Engineering for Developers - Deep Learning AI
- Learn Prompting https://learnprompting.org/docs/intro
- Types of Prompts with Practical examples - Dr. Naveed Siddiqui
- AI Prompt Database
  https://justunderstandingdata.notion.site/d98dcc9a6736471584d53cc8b2a5c30d?v

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References

- Introduction to Generative AI - Google Cloud Tech
- Generative AI Presentation - Laura Worden

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Newsletters to subscribe

- **The Batch by DeepLearning.AI:**
  - Summarizes diverse AI news with nuanced viewpoints.
  - Andrew Ng's thought leadership adds significant value.
- **The Rundown AI by Rowan Cheung:**
  - Go-to for generative AI events and product innovations.
  - Quick rundown with bullet point details for easy comprehension.
- **AI Supremacy by Michael Spencer:**
  - Personal writing style with in-depth exploration.
  - Offers multiple perspectives on AI topics.
- **Ahead of AI by Sebastian Raschka, PhD:**
  - Technical focus covering applied deep learning and generative AI.
  - Valuable insights for those seeking in-depth technical content.
- **To Data and Beyond by Youssef Hosni:**
  - Resource hub for hands-on projects, learning roadmaps, and research papers.
  - Ideal for those looking to dive into practical aspects of AI.

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Thanks ...

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