AI and Machine Learning Additional Information

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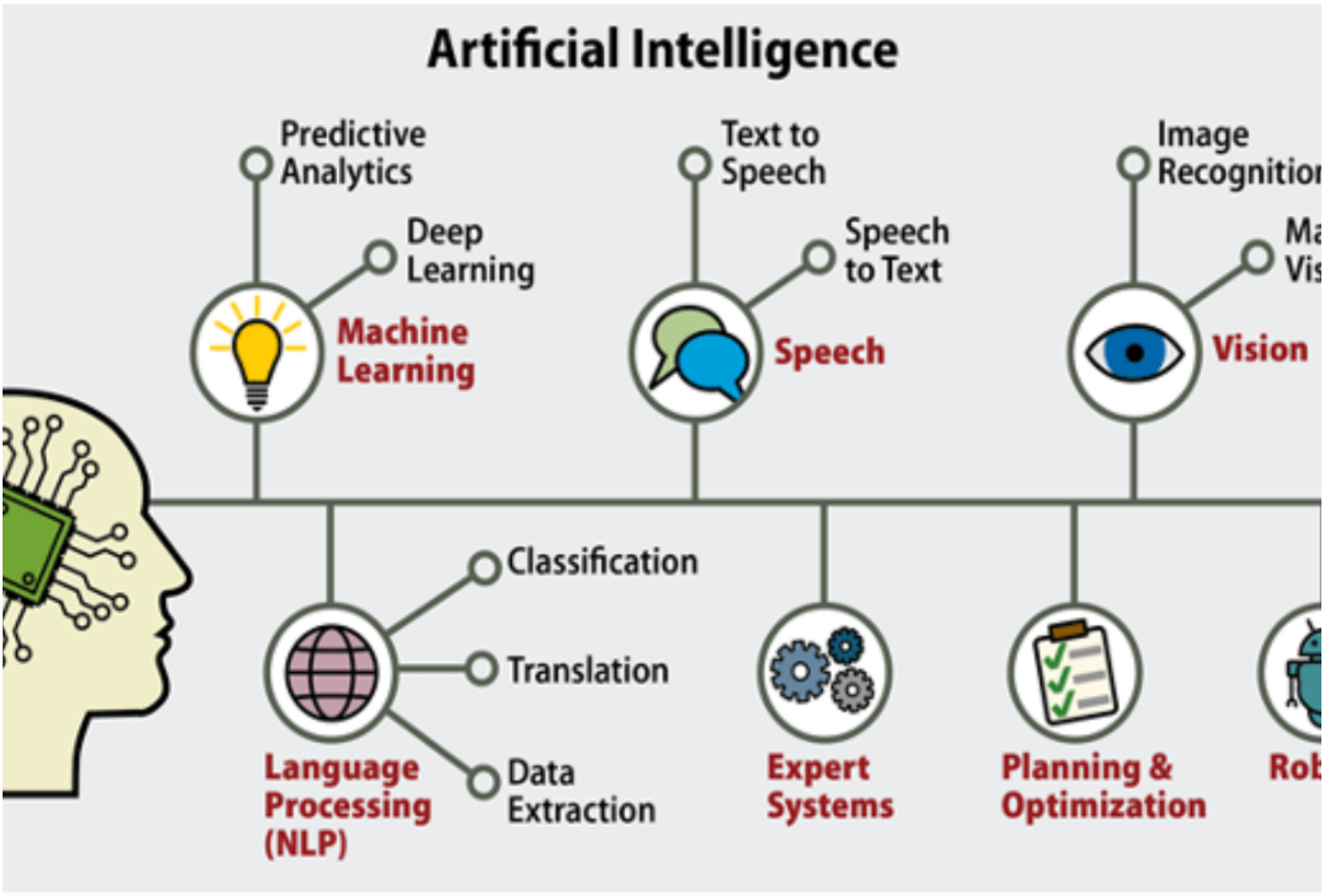
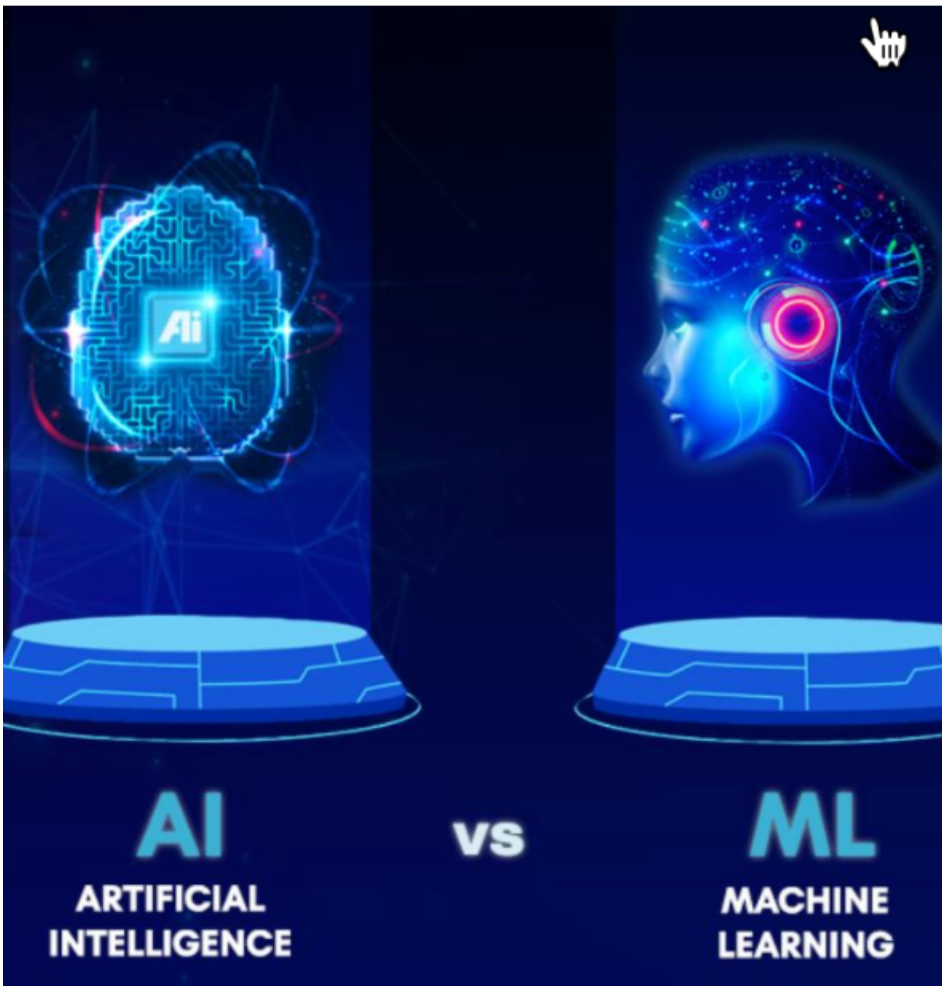




What is AI & Machine Learning?

“AI” enables machines to “sense,” “think” & “act” to solve simple and complex problems with data used to train them to mimic how humans model & solve problems, especially repetitive tasks that can be automated. They can also be taught to learn on their own with tools like neural networks usually described as “deep (machine) learning.” Applications are are wide.

Sense/Think/Act But what does all this actually mean?

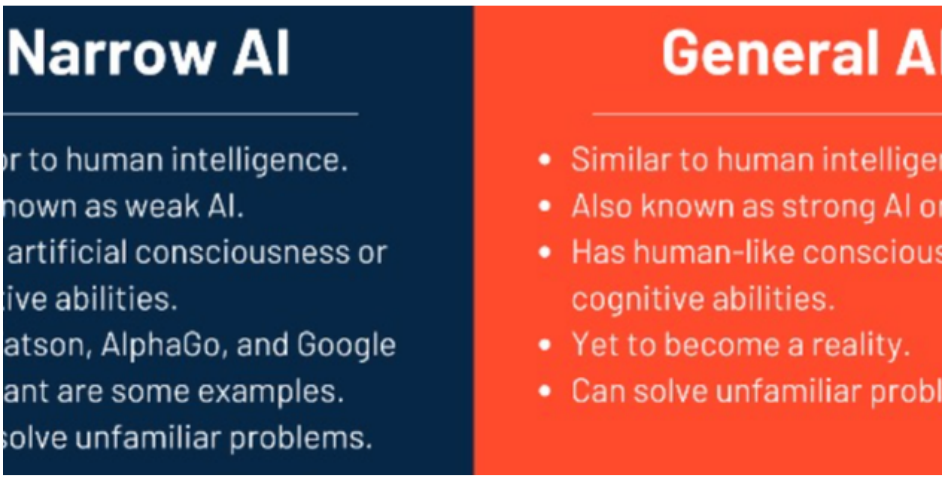
“Sense" AI & Machine learning includes variety of methods, tools & techniques that enable machines to “see,” “perceive,” “recognize,” & “categorize” images, processes and events it can “sense.” It “senses” based on computer vision, image recognition, and “seeing” patterns in data that describe well-understood outcomes (like fraud detection and loan approvals). And how does it does that? It’s trained to recognize images and patterns (see below for more on the role that data plays in training intelligent systems).

"Think" AI & Machine Learning also includes "thinking," though comparisons to human thought processes are dangerous. "Thinking" – at least at this point in time – mimics certain processes especially in applications that are well-understood and well-bounded. Example - The banking industry knows what variables correlate with bad loans, such as a bad credit history, serial unemployment, late payment history and loan defaults. These variables correlate strongly with poor credit behavior. If all of these variables exist within a credit check, loan officers will reject the application for credit for for a loan. In this example, the machine learning "algorithm" – the formula used to grant or deny loads – is clear. It "senses" the data (from a variety of sources) and then "thinks" (enabled by correlations) and acts (rejects the application). This process can be automated – humans are unnecessary to make grant/deny decisions.

"Act" Once input variables are recognized and interpreted (with reference to a preferred outcome), an intelligent system can act on its own. Remember that it's mimicking what humans "sense" and "think" though through different means. For example, once the system has the data about someone's credit history it can act upon their loan application. Once a self-driving car "senses" a telephone pole, it " knows" to avoid it. Once a computer "sees" an image of a growing tomato, it "knows" – based on what's it's been taught – whether it's ripe or not.

Application of AI & Machine Learning

Types of AI & Machine Learning Applications fall into two areas (across many vertical industries, functions and processes): "narrow AI" and "general AI." According to Tanna D. Jajal, "narrow AI is AI that is programmed to perform a single task – whether it's checking the weather, being able to play chess, or analyzing raw data to write journalistic reports … (narrow AI applications) can attend to a task in real-time, but they pull information from a specific data-set. As a result, these systems don't perform outside of the single task that they are designed to perform." Evaluating loan applications or recognizing telephone poles (from other objects) while driving are examples of narrow AI. General AI, on the other hand, "can perform virtually any intellectual task humans could ever do … they can think and act like humans and can most likely beat us at our own game as they don't feel tiredness or emotions like fear or sadness unless they're programmed to do so." Here's a summary of the differences:



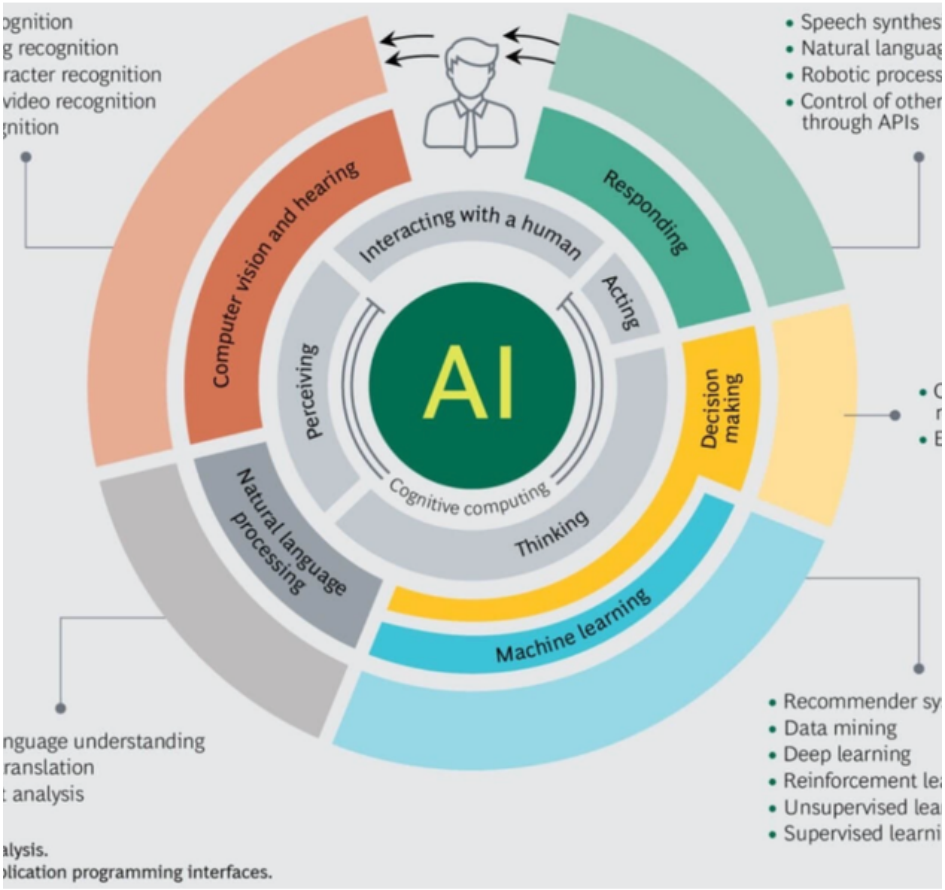
There are debates about how intelligent AI applications can actually become. But there's a growing consensus that eventually near-human intelligence will exist within digital applications. While no one knows what the timeline will be for the arrival of these applications, it appears that within two decades AI applications will approximate human intelligence. But make no mistake, [the range of so-called "narrow" applications is huge – and growing] – including:

Methods, Tools & Techniques of AI and Machine Learning

Tools of the Trade

AI uses a variety of methods, tools & techniques to "sense," "think" and "act." Some of these methods are hardware-based, such as computer vision that's trained to recognize a telephone pole (versus a human) or a ripe versus unripe tomato. Some are software-based, such as data in

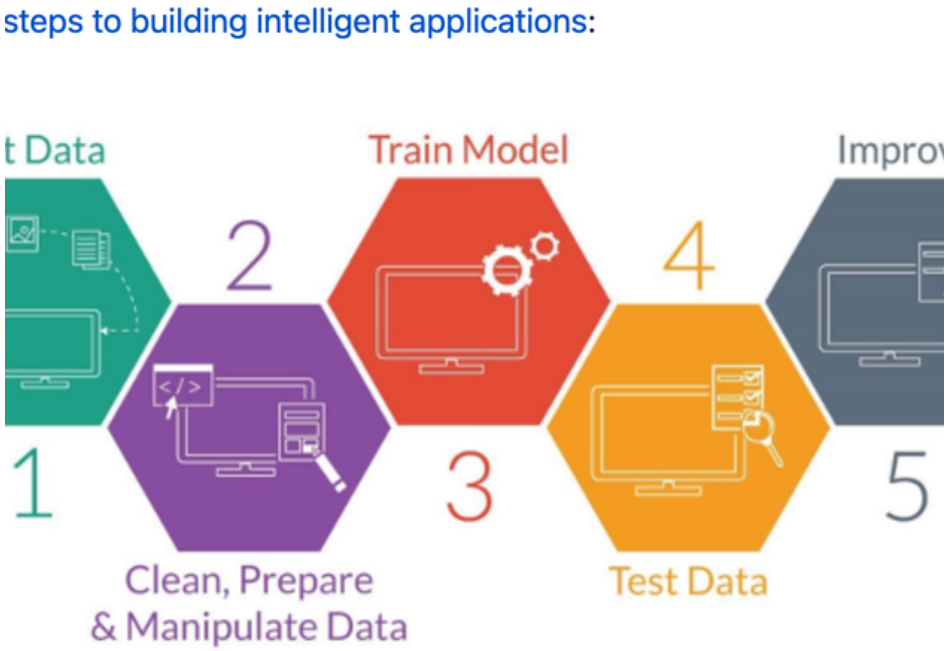
loan applications. Data is the lifeblood of AI & Machine Learning. The more data you use to teach or train an application, the better. For example, if you can show a thousand images of telephone poles (versus a hundred), the vision tools will improve their ability to "know" what a telephone pole looks like. The same is true for ripe versus unripe tomatoes. The more examples of accepted- versus- rejected loan applications you have, the better. The more data you use to train and teach, the more accurate the systems will be. We use a variety of methods, tools and techniques to model problems, collect and clean data, and process data to generate recommendations which we apply to many problem "domains." Some of these appear below. Note the 4 corners of the graphic:



These methods, tools and techniques determine how well intelligent applications, "sense," "think" and "act." If they're weak, or the data upon which they're based is shallow, the applications will fail. The methods, tools and techniques listed in the graphic's four corners are themselves constantly under development. Many of them – such as those that enable natural language understanding and generation – have been incarnated in "platform's," like IBM's Watson. If you wanted to build a chatbot, for example, you would turn to one of these platforms to accelerate the development process. The platforms incarnate the

current methods, tools and techniques in natural language processing (NLP) that make the development process much faster than if you had to leverage all of the NLP methods, tools and techniques from scratch. The same is true for loan applications. There are machine learning methods, tools and techniques – algorithms – (bottom right) that enable the fast processing of data about what constitutes good versus bad loan applications. Note that there are lots of algorithms (formulas) that aid sensing, thinking and acting. Many of these algorithms – assuming you have the right data – are available in software platforms such as SAS, SPSS and R. Many are also directly available from the cloud providers.

Steps



As you can see, the application development process is similar to the development of most other software applications, with improvement through iteration (Data Modeling). Like other applications, AI applications are purposeful. What are you trying to do? Automate loan processing? Build a robotic tomato picking application? Do you have the right "right" data? Do you have enough data? The application's performance will tell you quickly.

If you pick unripe tomatoes, or approve bad loans, you will know – and then you'll have to improve the application. You may have to clean the data, add more data or select a different algorithm – or a combination of all three. But this is how all applications are developed before they're deployed.

Platforms

Platforms, as mentioned above, accelerate the AI & Machine Learning applications development process. There are hundreds of platforms that enable and accelerate the development of most – if not all – intelligent systems. Some of these platforms hold you hand as you input data; others need more information and expertise. Most AI & Machine Learning application developers turn to platforms, Github and/or low-code programming platforms to support their development efforts. This is an extremely important aspect of intelligent systems applications development which can dramatically accelerate development and deployment. Google, IBM, Amazon AWS and Microsoft Azure, obviously have large AI & Machine Learning platforms offered through (and independent of) their cloud services. There are other platforms as well – as C3.ai reminds us:

In addition to these platforms are those that offer low-code and no-code tools for developing applications in AI & Machine Learning. As suggested above, GitHub represents a repository of code that's available to AI developers. Here are just a few of the no-code/low-code platforms.

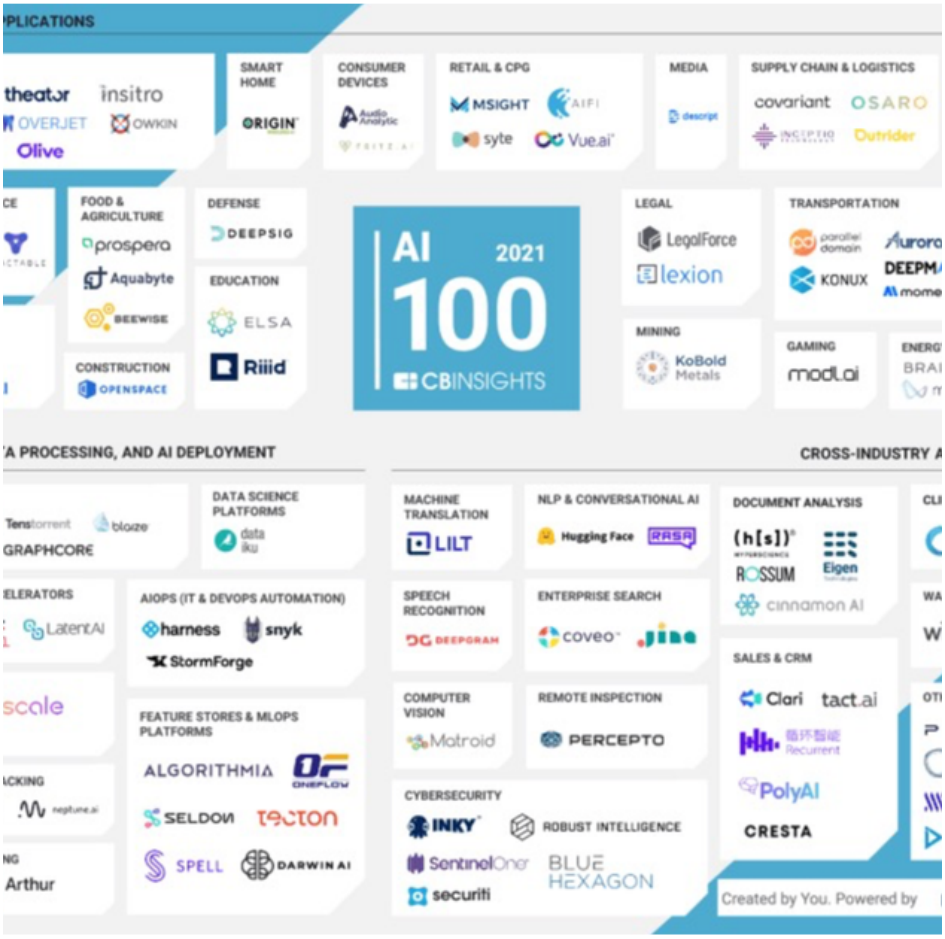
In addition to low-code/no-code platforms there are chatbot, natural language processing, image classification and image recognition platforms, among others, that enable the AI & Machine Learning development process.

AI & Machine Learning Vendors

There's no shortage of AI & Machine Learning consultants. All the major ones – McKinsey, BCG, Bain – have AI practices. The big four – EY, PWC, Deloitte & KPMG – have practices in the area. Some of these vendors have focused specifically on how of AI will impact tax. Vendors like C3.ai are scaling AI at the enterprise level. There are many other companies that specialize in, e.g., data preparation, image recognition, algorithms and NLP. The development community has also focused on AI & Machine Learning. Companies like Accenture, Capgemini, Infosys, HCL, TaTa and Cognizant – among so many others – all offer AI & Machine Learning services. There are lots of AI hardware vendors, especially established chip vendors as well as newcomers. Some of the "older" AI vendors – like Goggle and Apple – are also entering the hardware market.

AI & Machine Learning Start-up Activity

CB Insights tracks AI & Machine Learning start-up and early-stage investments closely (details about some of these companies can be found here). 2021 set another record for start-up investments in AI & Machine Learning. AI & Machine Learning is arguably the most funded technology in US history. The field has also exploded globally. Here's the CB Insights list:



AI & Machine Learning Sources

AI Use Cases

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- https://builtin.com/artificial-intelligence/examples-ai-in-industry
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Machine Learning

- https://en.wikipedia.org/wiki/Outline_of_machine_learning#Machine_learning_algorithms
- What is Machine Learning? | How it Works, Tutorials, and Examples
- https://builtin.com/data-science/tour-top-10-algorithms-machine-learning-newbies
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- A Tour of Machine Learning Algorithms - MachineLearningMastery.com

Algorithm Selection

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the-right-machine-learning-algorithm-among-7-different-types-295d0b0c7f60
- How to choose machine learning algorithms?
- https://blogs.sas.com/content/subconsciousmusings/2017/04/12/machine-learning-algorithm-use/

Computer Vision

- https://heartbeat.fritz.ai/the-5-computer-vision-techniques-that-will-change-how-you-see-the-world-1ee19334354b
- https://towardsdatascience.com/everything-you-ever-wanted-to-know-about-computer-vision-heres-a-look-why-it-s-so-awesome-e8a58dfb641e
- https://www.dynam.ai/what-is-computer-vision-technology/
- https://xd.adobe.com/ideas/principles/emerging-technology/what-is-computer-vision-how-does-it-work/

Image & Pattern Recognition

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- https://sightcorp.com/knowledge-base/image-recognition/
- https://www.mygreatlearning.com/blog/image-recognition/
- The Complete Guide to Pattern Recognition [+6 Use Cases of neural networks]
- Machine Learning and Pattern Recognition - DZone

Natural Language Processing (NLP)

- https://datascience.foundation/sciencewhitepaper/natural-language-processing-nlp-simplified-a-step-by-step-guide
- https://medium.com/@suneelpatel.in/nlp-pipeline-building-an-nlp-pipeline-step-by-step-7f0576e11d08
- https://www.unite.ai/what-is-natural-language-processing/

Neural Networks

- But what is a neural network? | Chapter 1, Deep learning
- https://www.youtube.com/watch?v=IHZwWFHWa-w
- What is backpropagation really doing? | Chapter 3, Deep learning
- https://www.neuraldesigner.com

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