



Week 3

Artificial Intelligence Program Infrastructure and Architecture

Assignments [60%]

EXAMS [40%]

> Agenda // Program

WEEK	SUBJECT	ASSIGNMENT / TO BE DELIVERED	DATES
2	Intro / AI Function / Enablers		Sep 13
3	Infra and Architecture / On-prem vs. Cloud / CSPs		Sep 20
4	Data Pipeline / Processes / Framework / AutoML	#1 Image Classifier [5%]	Sep 27
5	Data Pipeline / Processes / Framework / AutoML		Oct 4
6	More Data / SSIS / ADF / Data Quality	#2 Machine Learning Studio [10%]	Oct 11
7	Azure services – Intro	EXAM 1 [20%]	Oct 18
8	READING WEEK	NO CLASSES	Oct 25
9	Azure services – Cognitive Services 1		Nov 1
10	Azure services – Cognitive Services 2	#3 Draw your own Architecture (in class) [5%]	Nov 8
11	Azure services – Cognitive Services 3		Nov 15
12	Azure services – Cognitive Services 4	#4 Azure pipeline // Sentiment Analysis [20%]	Nov 22
13	AWS Academy – Cloud Foundations 		Nov 29
14	AWS Academy – Machine Learning 	#5 AWS Academy – Cloud Foundations [10%]	Dec 6
15	Enterprise Architecture	EXAM 2 [20%]	Dec 13

> Agenda

- On prem vs. cloud
 - SaaS, PaaS, IaaS
 - AI Workstations / Servers
 - AI Processing (CPU / GPU / ASIC)
 - Storage Solutions
 - Embedded Devices
 - Edge Devices
 - Infra Requirements
- Assignment #1 – Image Classifier

Programmer on vacation, still thinking about the **bug**



Infra and Architecture

On prem vs. Cloud



> On Premises vs. Cloud



> On Premises vs. Cloud



> On Premises vs. Cloud

- **Computing Environment** —cloud-based systems offer more complete packaging in **provided physical and logical infrastructure to host services, virtual servers, intelligent applications**, and containers for their subscribers.
 - **Licensing** — cloud-based systems offer **Pay per use** (Subscription Model) vs. on-premises need continuous maintenance of OS and software licenses.
 - **Maintenance** —cloud-based systems offer 360 degree of key infrastructure services such as physical hardware, computer networking, firewalls and network security, data-center fault tolerance, compliance, and physical security of the buildings.
- **Availability** — cloud-based systems prove to be better because many services and platforms use SLAs to ensure that customers know the capabilities of the platform they are using.
 - **Support** — cloud-based systems offer a variety of available data type support + standardization of the environment.
 - **Total Cost of Ownership (TCO)** — cloud-based systems yield substantial economies of scale and lowers total cost of ownership (TCO).

> On Premises vs. Cloud

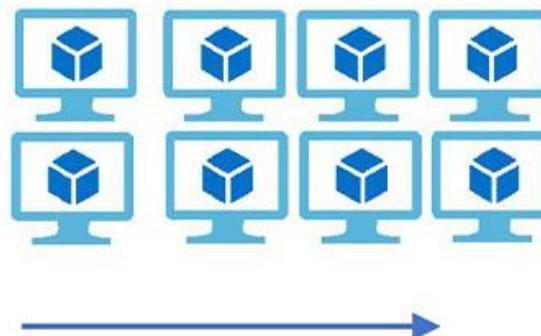
Vertical Scaling

(Increase size of instance (RAM , CPU etc.))



Horizontal Scaling

(Add more instances)



- **Scalability** — Horizontal scaling means that you scale by adding more machines into your pool of resources whereas Vertical scaling means that you scale by adding more power (CPU, RAM) to an existing machine. On-premises are generally the scaling horizontally; server administrators add another server node to a cluster. The main disadvantage is that software has to handle all the data distribution + parallel processing complexities, and worse than that, limited number of software are available to take advantage of the horizontal scaling option. The vertical scaling, on the other hand, can easily manage and install hardware within a single machine despite the system to be incredibly powerful.

> On Premises vs. Cloud | Costs

+CAPEX

On-Premises

9%

Software Licenses

Customisation & Implementation

Hardware

IT Personnel

Maintenance

Training

Ongoing Costs

- Apply Fixes, Patches, Upgrade
- Downtime
- Performance tuning
- Rewrite customizations
- Rewrite integrations
- Upgrade dependent applications
- Ongoing burden on IT
- Maintain/upgrade hardware
- Maintain/upgrade network
- Maintain/upgrade security
- Maintain/upgrade database

Cloud Computing

68%

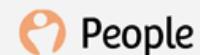
Subscription Fee

Implementation, Customisation & Training

Ongoing Costs

- Subscription fee

+OPEX



> On Premises vs. Cloud | SaaS

SaaS: Software as a Service

Software as a Service, also known as cloud application services, represents the most utilized option for businesses in the cloud market. SaaS utilizes the internet to deliver applications, which are managed by a third-party vendor, to its users. Most SaaS applications run directly through your web browser, which means they do not require any downloads or installations on the client side.

Examples of SaaS

Popular examples of SaaS include:

- Google Workspace (formerly GSuite)
- Dropbox
- Salesforce
- Cisco WebEx

> On Premises vs. Cloud | PaaS

PaaS: Platform as a Service

Cloud platform services, also known as Platform as a Service (PaaS), provide cloud components to certain software while being used mainly for applications. PaaS delivers a framework for developers that they can build upon and use to create customized applications. All servers, storage, and networking can be managed by the enterprise or a third-party provider while the developers can maintain management of the applications.

Examples of PaaS

Popular examples of PaaS include:

- AWS Elastic Beanstalk
- Windows Azure
- Azure SQL Server (depends)
- Heroku
- OpenShift

> On Premises vs. Cloud | IaaS

IaaS: Infrastructure as a Service

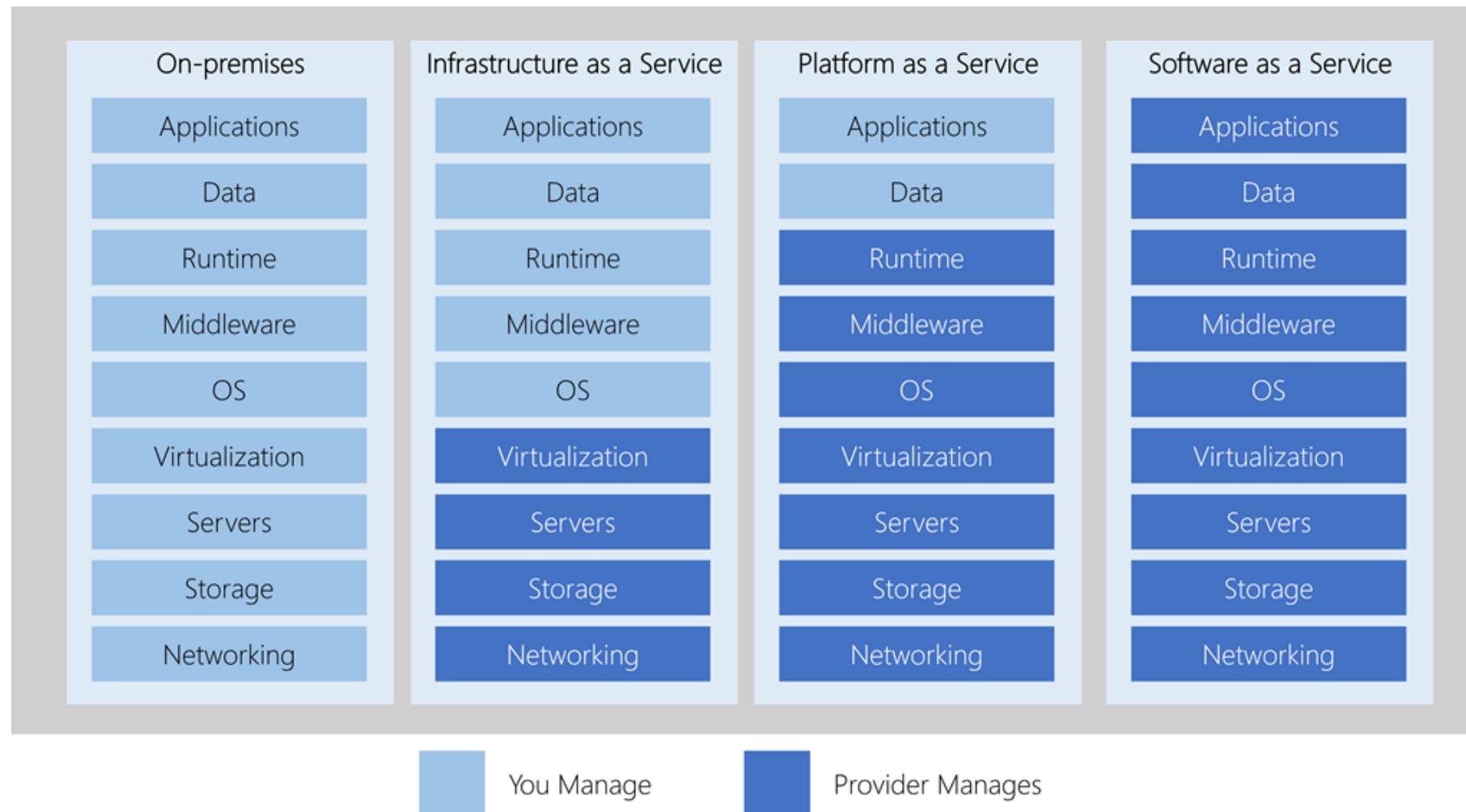
Cloud infrastructure services, known as Infrastructure as a Service (IaaS), are made of highly scalable and automated compute resources. IaaS is fully self-service for accessing and monitoring computers, networking, storage, and other services. IaaS allows businesses to purchase resources on-demand and as-needed instead of having to buy hardware outright.

Examples of IaaS

Popular examples of IaaS include:

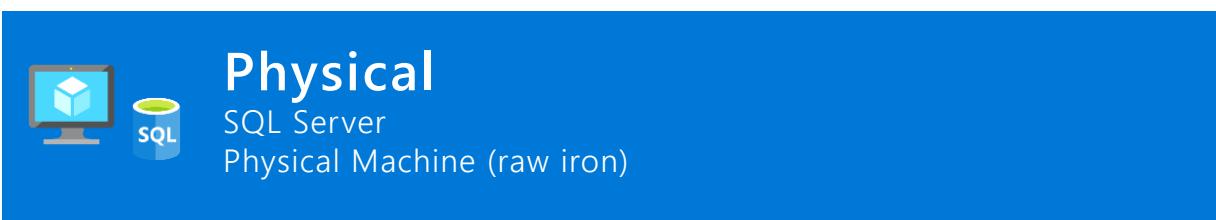
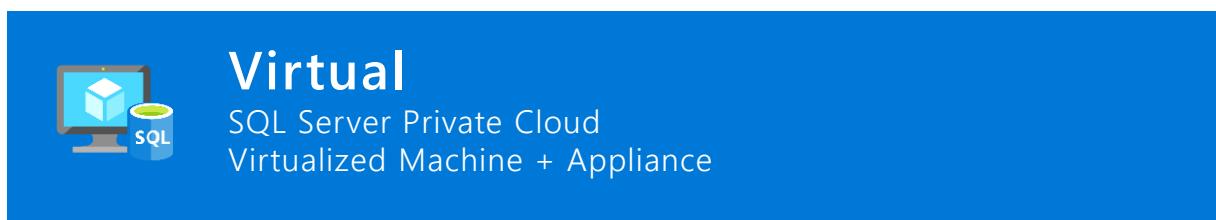
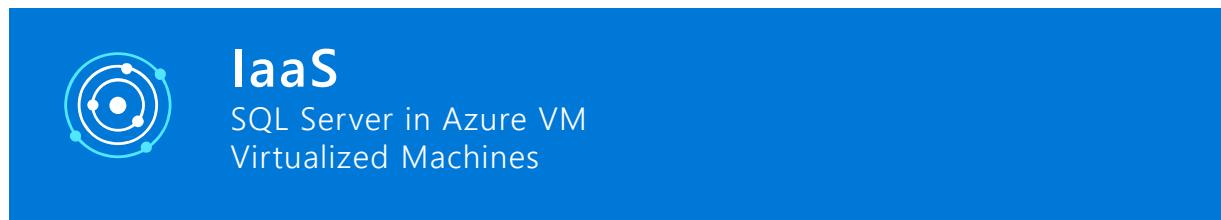
- DigitalOcean
- Linode
- Amazon Web Services (AWS)
- Cisco Metacloud
- Microsoft Azure

> On Premises vs. Cloud



Data platform continuum

Shared lower cost



Dedicated higher cost

Higher administration

Lower administration

Which tool for the job?

Infrastructure as a Service



Applications

Data

Runtime

Middleware

O/S

Virtualization

Servers

Storage

Networking

You manage and Support

Managed and supported by Microsoft

Platform as a Service



Applications

Data

Runtime

Middleware

O/S

Virtualization

Servers

Storage

Networking

You manage and Support

Managed and supported by Microsoft

Software as a Service



Applications

Data

Runtime

Middleware

O/S

Virtualization

Servers

Storage

Networking

Managed and Supported by Microsoft

> Example | SQL instance

IaaS vs. PaaS

SQL Server on a virtual machine is considered IaaS. The other deployment options in the Azure SQL platform, Azure SQL Managed Instance and Azure SQL Database, are platform as a service (PaaS) deployments. These PaaS Azure SQL deployment options contain a fully managed database engine that automates most of the database management functions, like upgrading, patching, backups, and monitoring. Here are some key features of SQL Managed Instance and SQL Database:

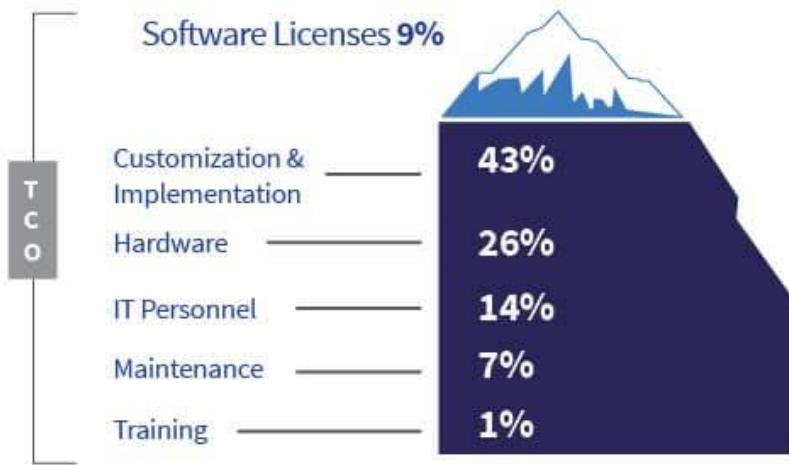
- **Business continuity** enables your business to continue operating in the face of disruption.
- **High availability** guarantees your databases are up and running 99.99% of the time. No need to worry about maintenance or downtimes.
- **Automated backups** are created and use Azure read-access geo-redundant storage (RA-GRS) to provide geo-redundancy.
- **Long-term backup retention** enables you to store specific full databases for up to 10 years.
- **Geo-replication** creates readable replicas of your database in the same datacenter (region) or a different one.
- **Scalability**. You can easily add more resources (CPU, memory, storage) without long provisioning.
- **Network security** features protect your data over the network. These features include firewalls to restrict connectivity, Azure Private Link to ensure your data isn't exposed to the internet, and integration with virtual networks for connectivity to on-premises environments.
- **Advanced security** detects threats and vulnerabilities in your databases and enables you to secure your data.
- **Automatic tuning** analyzes your workload. It provides recommendations that can optimize performance of your applications by adding indexes, removing unused indexes, and automatically fixing query plan problems.
- **Built-in monitoring** capabilities enable you to get insights into the performance of your databases and workload and troubleshoot performance problems.
- **Built-in intelligence** automatically identifies potential problems in your workload and provides recommendations that can help you to fix those problems.

> Considerations

Cloud Lowers Total Cost of Ownership

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On-Premise Software



"Customers can spend up to four times the cost of their software license per year to own and manage their applications."

- Gartner
"The End of Software"

Cloud Computing



"Cloud computing yields substantial economies of scale and skill, and lowers total cost of ownership (TCO)."

- The Hurwitz Group
"The Compelling TCO Case for Cloud Computing"

On Prem

AI Workstations and Servers



> AI Workstations



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1000+ research groups trust Lambda



Technical specifications

GPU	Up to 4x NVIDIA GPUs RTX 30XX (Ampere), Quadro RTX A6000, RTX 8000, and RTX 6000 options
Processor	AMD Ryzen or Intel Core i9 Configurable up to 64 cores, 128 threads, and 256 MB cache
Memory	Up to 256 GB Fits up to eight 32 GB DIMMs at 3200 MHz
OS drive	Up to 2 TB 3,200 MB/s seq. read and 2,000 MB/s seq. write
Extra storage	Up to 61 TB Fits up to eight 7.68 TB SATA SSDs.
Power supply	Up to 1600 watts of maximum continuous power at voltages between 100 and 240V
Size & weight	Width: 13.1" (332 mm) Height: 16.3" (415 mm) Depth: 18.4" (458 mm) Weight: 38 pounds (17.2 kg)

> AI Servers



Lambda Blade

Servers

GPU Workstation

TensorBook

GPU Cloud

Resources

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Caltech

Los Alamos
NATIONAL LABORATORY



Anthem



Easy system administration

> AI Servers and Workstations

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Dell Precision 5820 Tower

The new Dell Precision 5820 Tower is ideal for cognitive solution development and inference applications.

- Up to 6x Hard Disk Drive (HDD)/Solid State Drive (SSD) Storage
- Ubuntu 18.04 Factory Installed
- NVIDIA NGC-Ready for install of NVIDIA Data Science Software, powered by RAPIDS

up to 18 cores with Xeon®	up to 256GB DDR4 Memory	up to 2x NVIDIA Quadro® RTX™ 8000 48GB GPUs
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Dell Precision 7920 Tower

The Dell Precision 7920 Tower handles learning model training and larger solution frameworks with ease.

- Up to 10x Hard Disk Drive (HDD)/Solid State Drive (SSD) Storage
- Ubuntu 18.04 Factory Installed
- NVIDIA NGC-Ready for install of NVIDIA Data Science Software, powered by RAPIDS

up to Dual 56 cores with Xeon-SP	up to 3TB DDR4 Memory	up to 3x NVIDIA Quadro® RTX™ 8000 48GB GPUs
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AI Accelerator

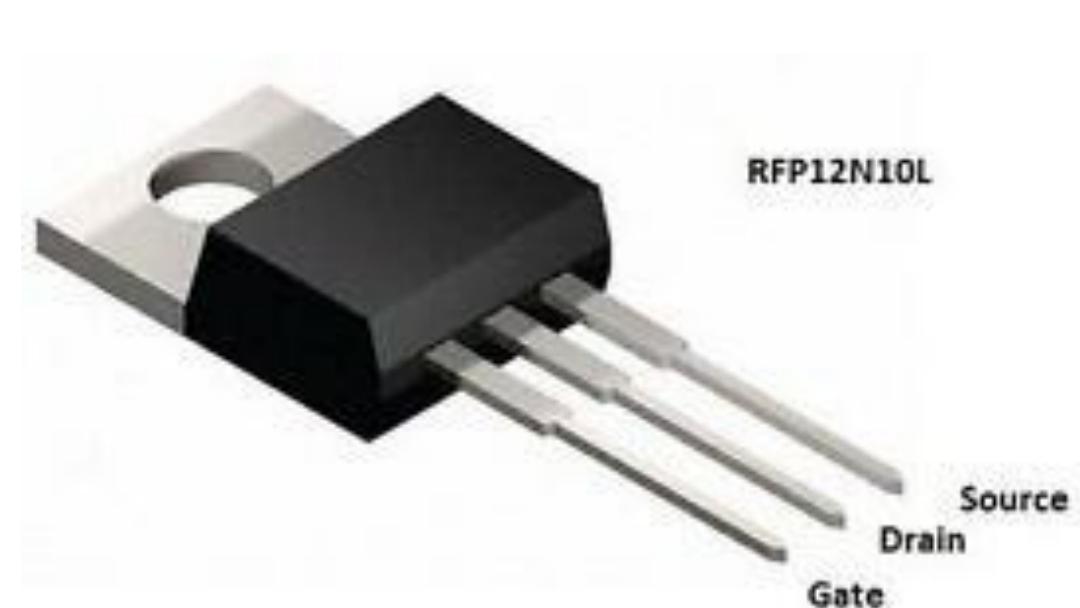


> AI Processing | AI accelerator

An **AI accelerator** is a class of specialized hardware accelerator or computer system designed to accelerate artificial intelligence applications, especially artificial neural networks, machine vision and machine learning.

Typical applications include algorithms for robotics, internet of things and other data-intensive or sensor-driven tasks. They are often manycore designs and generally focus on low-precision arithmetic, novel dataflow architectures or in-memory computing capability.

As of 2018, a typical AI integrated circuit chip contains billions of MOSFET transistors.



> AI Processing | GPU's

A **graphics processing unit (GPU)** is a specialized electronic circuit designed to rapidly manipulate and alter memory to accelerate the creation of images in a frame buffer intended for output to a display device. GPUs are used in embedded systems, mobile phones, personal computers, workstations, and game consoles.

Modern GPUs are very efficient at manipulating computer graphics and image processing. Their highly parallel structure makes them more efficient than general-purpose central processing units (CPUs) for algorithms that process large blocks of data in parallel.

In a personal computer, a GPU can be present on a video card or embedded on the motherboard.

> AI Processing | GPU's | Examples



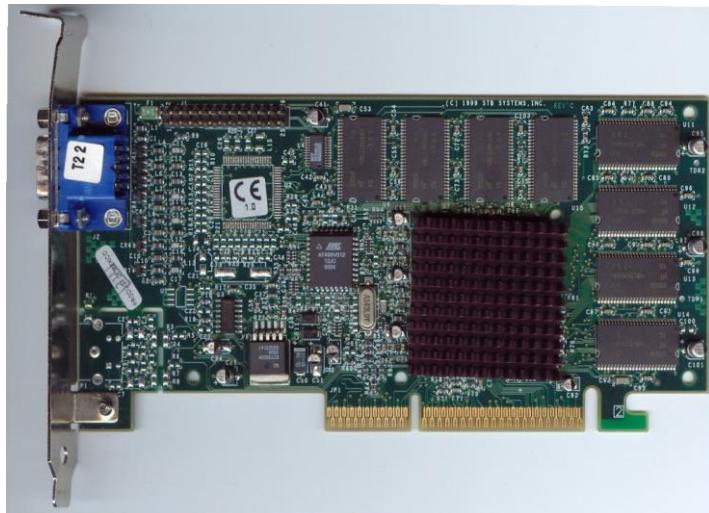
dedicated to generating 2D computer graphics on a television screen or computer display.

Atari ANTIC

microprocessor on an

Atari 130XE motherboard

(1977 / 1978)



computer gaming video cards manufactured and designed by 3dfx Interactive.

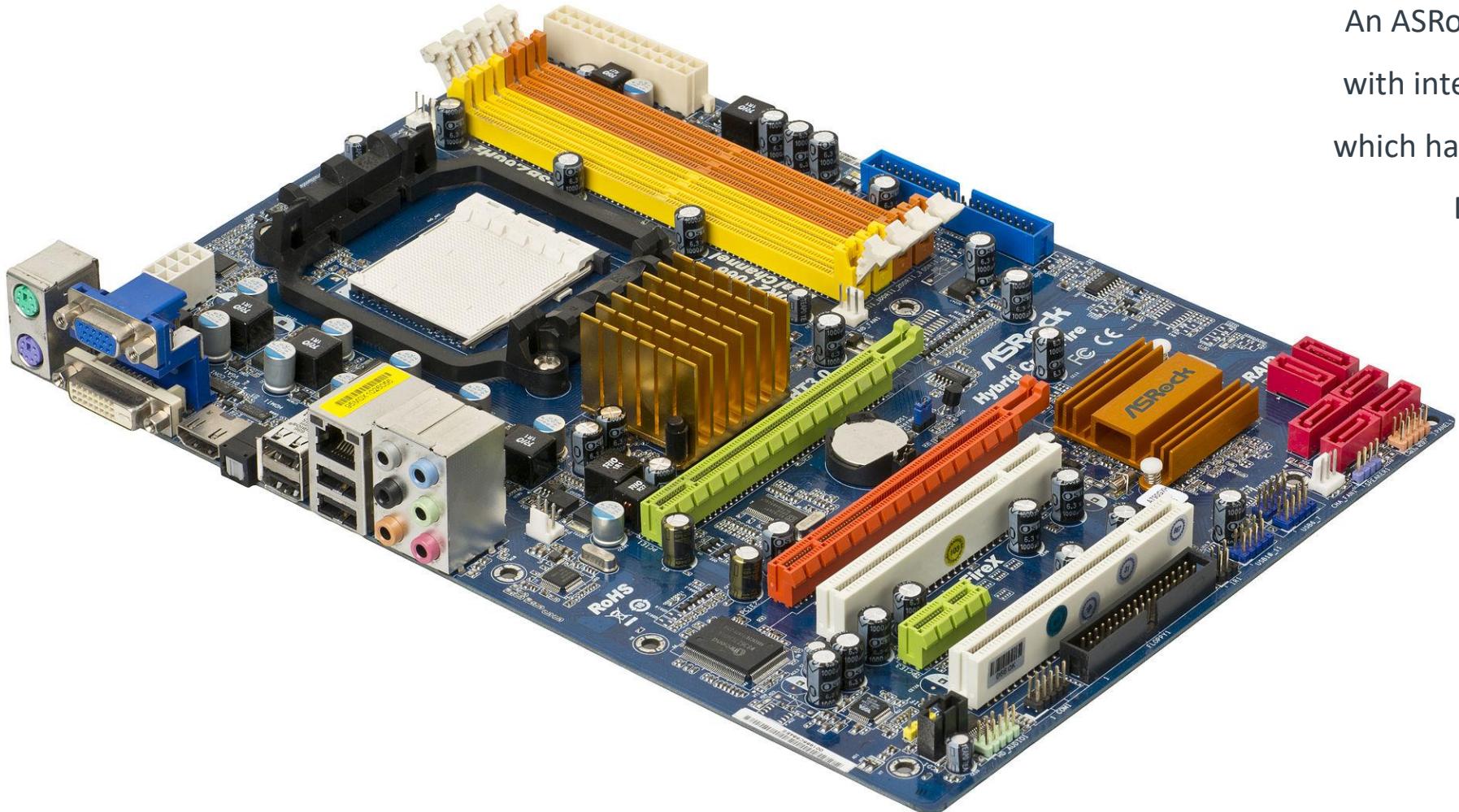
Voodoo3 2000 AGP card

(1998 / 1999)



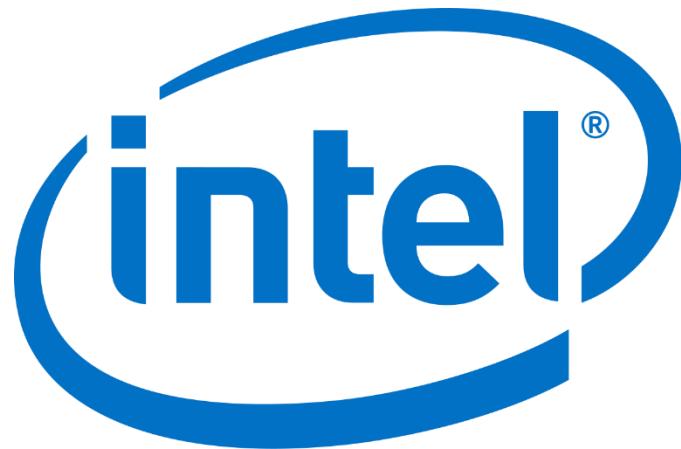
MSI GeForce RTX 2080 TI GAMING X TRIO Video Card

> AI Processing | GPU's | Examples



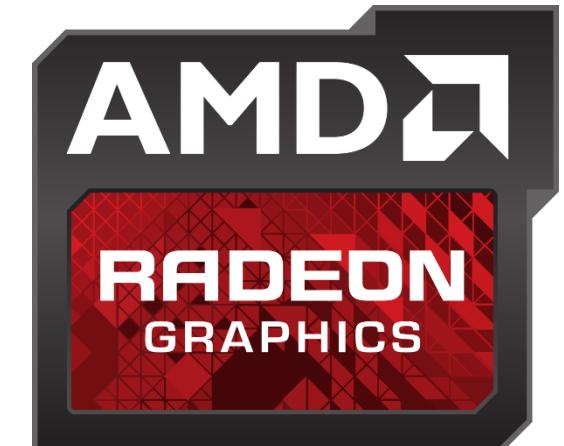
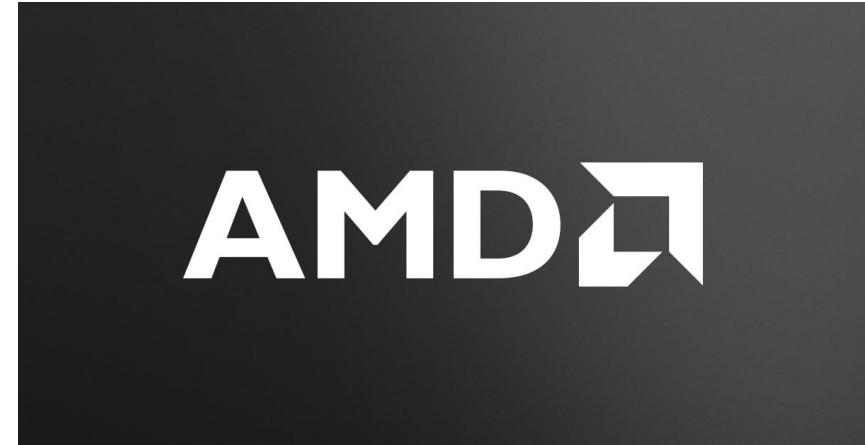
An ASRock motherboard with integrated graphics, which has HDMI, VGA and DVI outs.

> AI Processing | GPU's | Companies



NVIDIA[®]

https://youtu.be/e2_hsjpTi4w



> AI Processing | GPU's | Specific Use

Most GPUs are designed for a specific usage, real-time 3D graphics or other mass calculations:

1. Gaming

1. GeForce GTX, RTX
2. Nvidia Titan
3. Radeon HD, R5, R7, R9, RX, Vega and Navi series

2. Cloud Gaming

1. Nvidia Grid
2. AMD Radeon Sky

3. Workstation (Video editing, encoding, decoding, transcoding and rendering (digital content creation), 3D animation and rendering, VFX and motion graphics (CGI), videogame development and 3D texture creation, product development/3D CAD, structural analysis, simulations, CFD analysis and scientific calculations...)

1. Nvidia Quadro
2. AMD FirePro
3. AMD Radeon Pro
4. AMD Radeon VII

4. Cloud Workstation

1. Nvidia Tesla
2. AMD FireStream

5. Artificial Intelligence training and Cloud

1. Nvidia Tesla
2. AMD Radeon Instinct

6. Automated/Driverless car

1. Nvidia Drive PX

NVIDIA RTX A6000

First Look for Data Science 48GB Ampere GPU

<https://m.youtube.com/watch?v=85-K7qTSvS8>

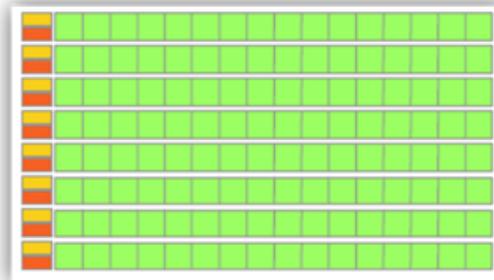
> AI Processing | GPU's | Specific Use

CPU

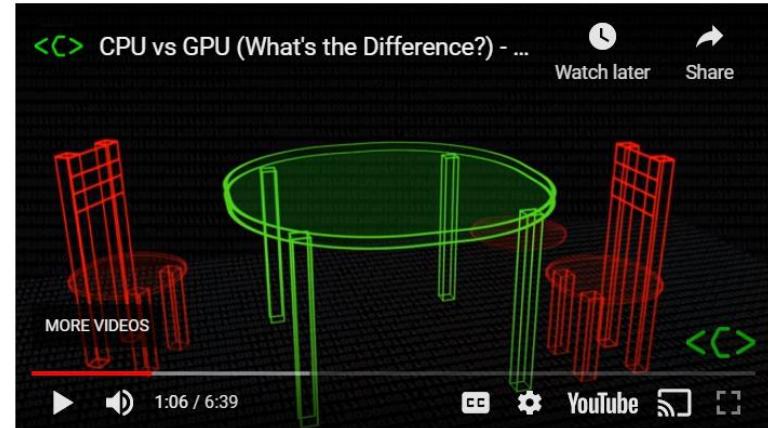


- * Low compute density
- * Complex control logic
- * Large caches (L1\$/L2\$, etc.)
- * Optimized for serial operations
 - Fewer execution units (ALUs)
 - Higher clock speeds
- * Shallow pipelines (<30 stages)
- * Low Latency Tolerance
- * Newer CPUs have more parallelism

GPU



- * High compute density
- * High Computations per Memory Access
- * Built for parallel operations
 - Many parallel execution units (ALUs)
 - Graphics is the best known case of parallelism
- * Deep pipelines (hundreds of stages)
- * High Throughput
- * High Latency Tolerance
- * Newer GPUs:
 - Better flow control logic (becoming more CPU-like)
 - Scatter/Gather Memory Access
 - Don't have one-way pipelines anymore



https://youtu.be/_cyVDoyl6NE



<https://youtu.be/-P28LKWTzrl>

> AI Processing | FPGA's

Deep learning frameworks are still evolving, making it hard to design custom hardware. Reconfigurable devices such as **field-programmable gate arrays (FPGA)** make it easier to evolve hardware, frameworks and software alongside each other.

Microsoft has used FPGA chips to accelerate inference. The application of FPGAs to AI acceleration motivated Intel to acquire Altera with the aim of integrating FPGAs in server CPUs, which would be capable of accelerating AI as well as general purpose tasks.



> AI Processing | Storage Solutions



> AI Processing | Storage Solutions



NVMe (**n**onvolatile **M**emory **E**xpress) is a new storage access and transport protocol for flash and next-generation solid-state drives (SSDs) that delivers the highest throughput and fastest response times yet for all types of enterprise workloads.

To help deliver a high-bandwidth, low-latency user experience, the NVMe protocol accesses flash storage via a PCI Express (PCIe) bus, which supports tens of thousands of parallel command queues and thus is much faster than hard disks and traditional all-flash architectures, which are limited to a single command queue.

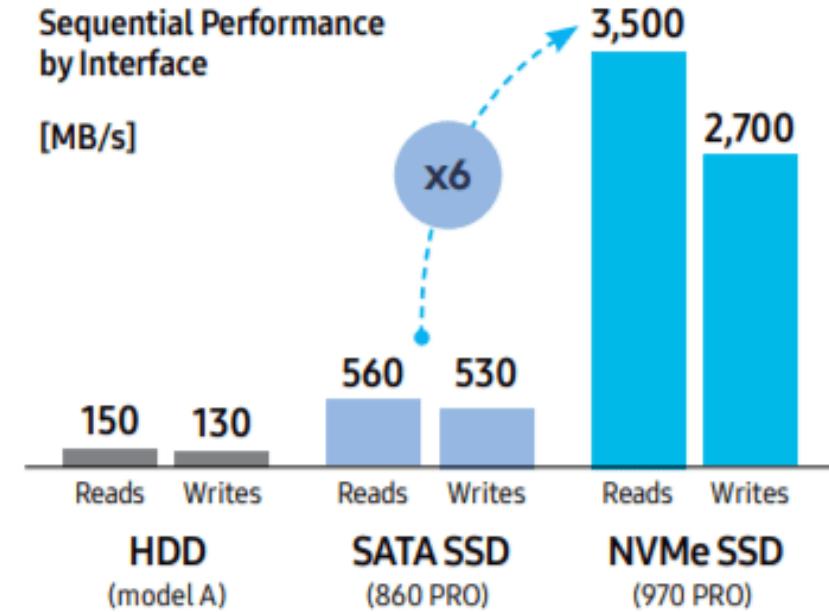
The NVMe specification takes advantage of nonvolatile memory in all kinds of computing environments. And it's future-proof, extendable to work with not-yet-invented persistent memory technologies.

> AI Processing | Storage Solutions

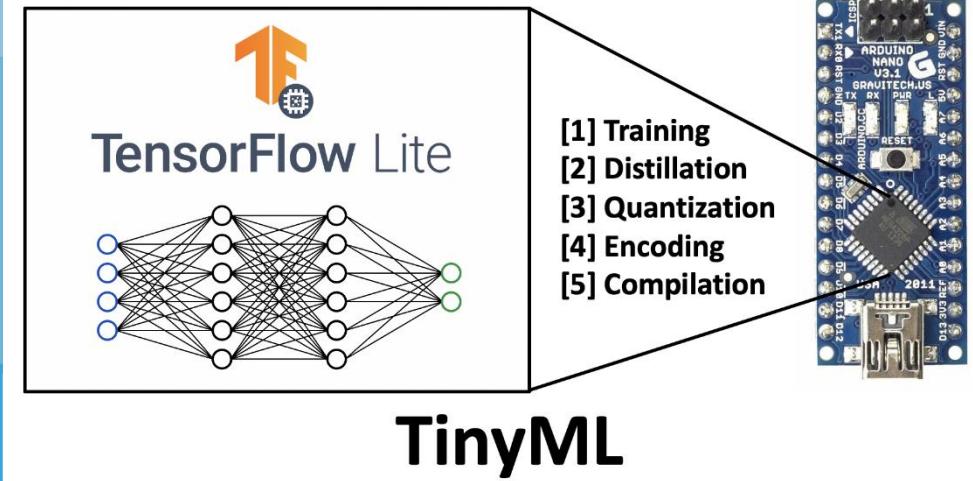
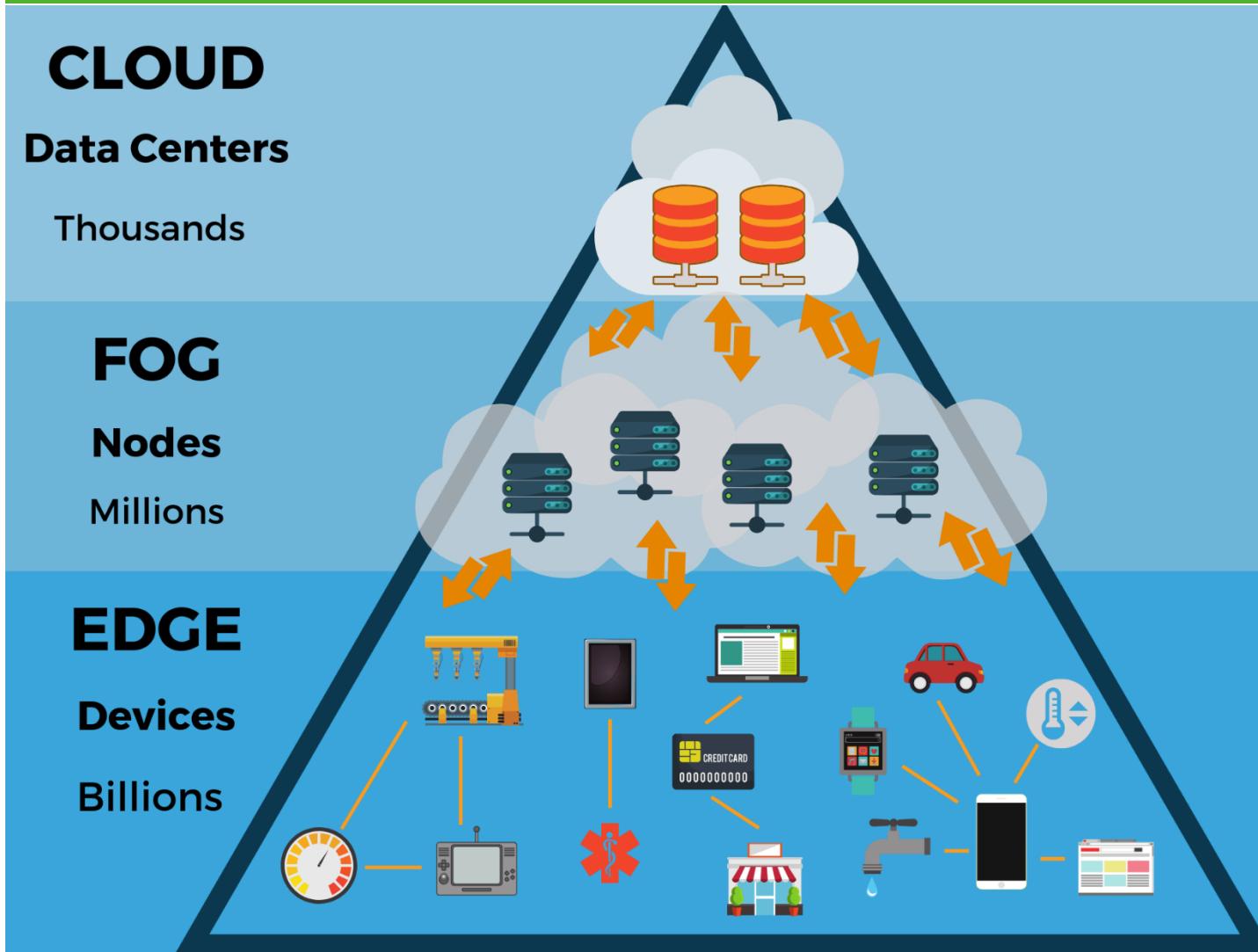
The NVMe Difference

The Non-Volatile Memory express (NVMe) interface is specifically engineered to overcome constraints of older interfaces by increasing NAND flash storage transfer speeds. Sequential speeds are approximately 6 times faster than SATA SSDs as NVMe enables your drive to reach its full potential.

* Performance may vary based on SSD's firmware version, system hardware and configuration.



> AI Processing | Embedded Devices

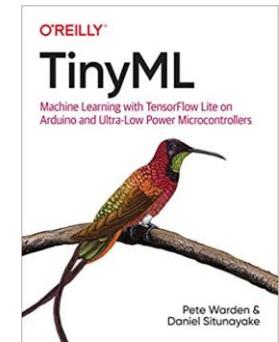


> AI Processing | Embedded Devices

Tiny machine learning (tinyML) is the intersection of machine learning and embedded internet of things (IoT) devices. The field is an emerging engineering discipline that has the potential to revolutionize many industries.

The main industry beneficiaries of tinyML are in edge computing and energy-efficient computing. TinyML emerged from the concept of the internet of things (IoT). The traditional idea of IoT was that data would be sent from a local device to the cloud for processing.

Some individuals raised certain concerns with this concept: privacy, latency, storage, and energy efficiency to name a few.



<https://tinymlbook.com/>

> AI Processing | Embedded Devices | Benefits

Energy Efficiency - Transmitting data (via wires or wirelessly) is very energy-intensive, around an order of magnitude more energy-intensive than onboard computations (specifically, multiply-accumulate units). Developing IoT systems that can perform their own data processing is the most energy-efficient method. AI pioneers have discussed this idea of “data-centric” computing (as opposed to the cloud model’s “compute-centric”) for some time and we are now beginning to see it play out.

Privacy - Transmitting data opens the potential for privacy violations. Such data could be intercepted by a malicious actor and becomes inherently less secure when warehoused in a singular location (such as the cloud). By keeping data primarily on the device and minimizing communications, this improves security and privacy.

Storage - For many IoT devices, the data they are obtaining is of no merit.

Imagine a security camera recording the entrance to a building for 24 hours a day. For a large portion of the day, the camera footage is of no utility, because nothing is happening. By having a more intelligent system that only activates when necessary, lower storage capacity is necessary, and the amount of data necessary to transmit to the cloud is reduced.

Latency - For standard IoT devices, such as Amazon Alexa, these devices transmit data to the cloud for processing and then return a response based on the algorithm’s output. In this sense, the device is just a convenient gateway to a cloud model, like a carrier pigeon between yourself and Amazon’s servers. The device is pretty dumb and fully dependent on the speed of the internet to produce a result. If you have slow internet, Amazon Alexa will also become slow. For an intelligent IoT device with onboard automatic speech recognition, the latency is reduced because there is reduced (if not no) dependence on external communications.

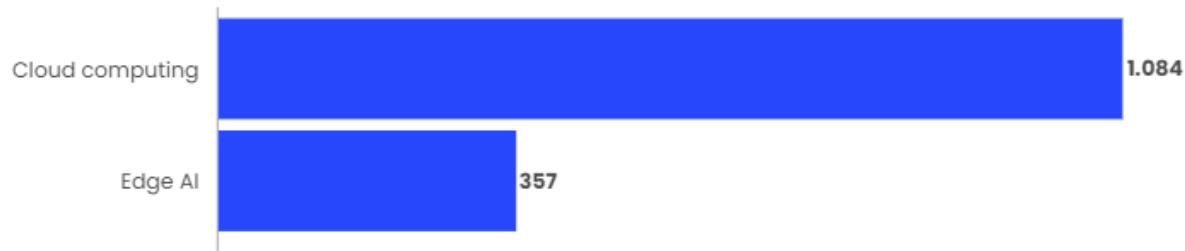
> Edge AI Devices

Edge AI is a system that uses Machine Learning algorithms to process data generated by a **hardware device at the local level**. The device does not need to be connected to the Internet to process such data and make decisions in real time, in a matter of milliseconds. This considerably reduces the communication costs derived from the cloud model. In other words, Edge AI takes the data and its processing to the closest point of interaction with the user, whether it is a computer, an IoT device or an Edge server.

An example of this technology can be seen in the speakers of **Google, Alexa or the Apple Homepod**, which have learned words and phrases through Machine Learning and then stored them locally on the device. When the user communicates something to applications such as Siri or Google, they send the voice recording to an Edge network where it is passed to text via AI and a response is processed. Without an Edge network the response time would be seconds, with Edge the times are reduced to less than 400 milliseconds.

> Edge AI Devices | Latency

**Cloud Latencies vs. Edge AI Latencies
(in milliseconds)**



Edge AI eliminates the privacy issue of transmitting millions of data and storing it in the cloud, as well as the bandwidth and latency limitations that reduce data transmission capacity.

Edge technology is essential for many industries, for example, for autonomous cars will help reduce power consumption by increasing battery durability. It will also be applicable to robots, surveillance systems and others. As a result, the market for Edge AI software is expected to grow in value from \$355 million in 2018 to \$1.12 trillion by 2023.

> Edge AI Devices | Benefits



- **Reduces costs and latency times** for an improved user experience. This facilitates the integration of wearable technologies focused on the user experience, where you interact in real time to make payments, or where bracelets monitor your exercise and sleep patterns.
- **It increases the level of security** in terms of data privacy through local processing. Data is no longer shared in a centralized cloud.
- Technically, the reduction in required bandwidth should lead to a **reduction in the costs of the contracted internet service**.
- Edge technology devices **do not require specialized maintenance** by data scientists or AI developers. The graphic data flows are automatically delivered for monitoring; therefore, it is an autonomous technology.

> Cloud vs. Edge Computing

	Cloud computing	Edge computing
Computations	Done on cloud (servers)	Done on edge devices (browsers, phones, tablets, laptops, smart watches, activity watchers, cars, etc.)
Requirements	Network connections: availability and speed for data transfer	Hardware: memory, compute power, energy for doing computations
Examples	<ul style="list-style-type: none">• Most queries to Alexa, Siri, Google Assistant• Google Translate for rare language pairs (e.g. English - Yiddish)	<ul style="list-style-type: none">• Wake words for Alexa, Siri, Google Assistant• Google Translate for popular language pairs (e.g. English - Spanish)• Predictive text• Unlocking with fingerprints, faces

> Questions...

What would be the **capacity requirements** for a given AI system?

Performance/cost benefit of hardware. ie. we can spend more, and have it crunch models faster but what are the costs and benefits.

What are the **costs of buying server hardware vs using Cloud resources?**

> Infra Requirements...

1. High computing capacity

To fully take advantage of the opportunities presented by AI, organizations need sufficient performance computing resources, including CPUs and GPUs. A CPU-based environment can handle basic AI workloads, but deep learning involves multiple large data sets and deploying scalable neural network algorithms. For that, CPU-based computing might not be sufficient. For example, GPUs can accelerate deep learning by 100 times compared to traditional CPUs. Computing capacity and density will also grow, as will demand for high-performance networks and storage.

2. Storage capacity

It's fundamental that your infrastructure has the ability to scale storage as the volume of data grows. Figuring out what kind of storage an organization needs depends on many factors, including the level of AI an organization plans to use and whether they need to make real-time decisions. For example, a FinTech company that uses AI systems for real-time trading decisions may need fast all-flash storage technology, while for other companies slower but very large storage will be the most suitable solution. Businesses need to factor in how much AI data applications will generate. AI applications make better decisions when they're exposed to more data. As databases grow over time, companies need to monitor capacity and plan for expansion.

> Infra Requirements...

3. Networking infrastructure

Networking is another key component of AI infrastructure. Deep learning algorithms are highly dependent on communications, and networks will need to keep stride with demand as AI efforts expand. That's why scalability must be a high priority, and that will require a high-bandwidth, low-latency network. The best choice for expansive service is a global infrastructure provider who can ensure the service wrap and technology stack are consistent in all regions.

4. Security

AI can involve handling sensitive data such as patient records, financial information, and personal data. Having this data breached will be a disaster for any organization. Also, the infusion of bad data could cause the AI system to make incorrect inferences, leading to flawed decisions. The AI infrastructure must be secured from end to end with state-of-the-art technology.

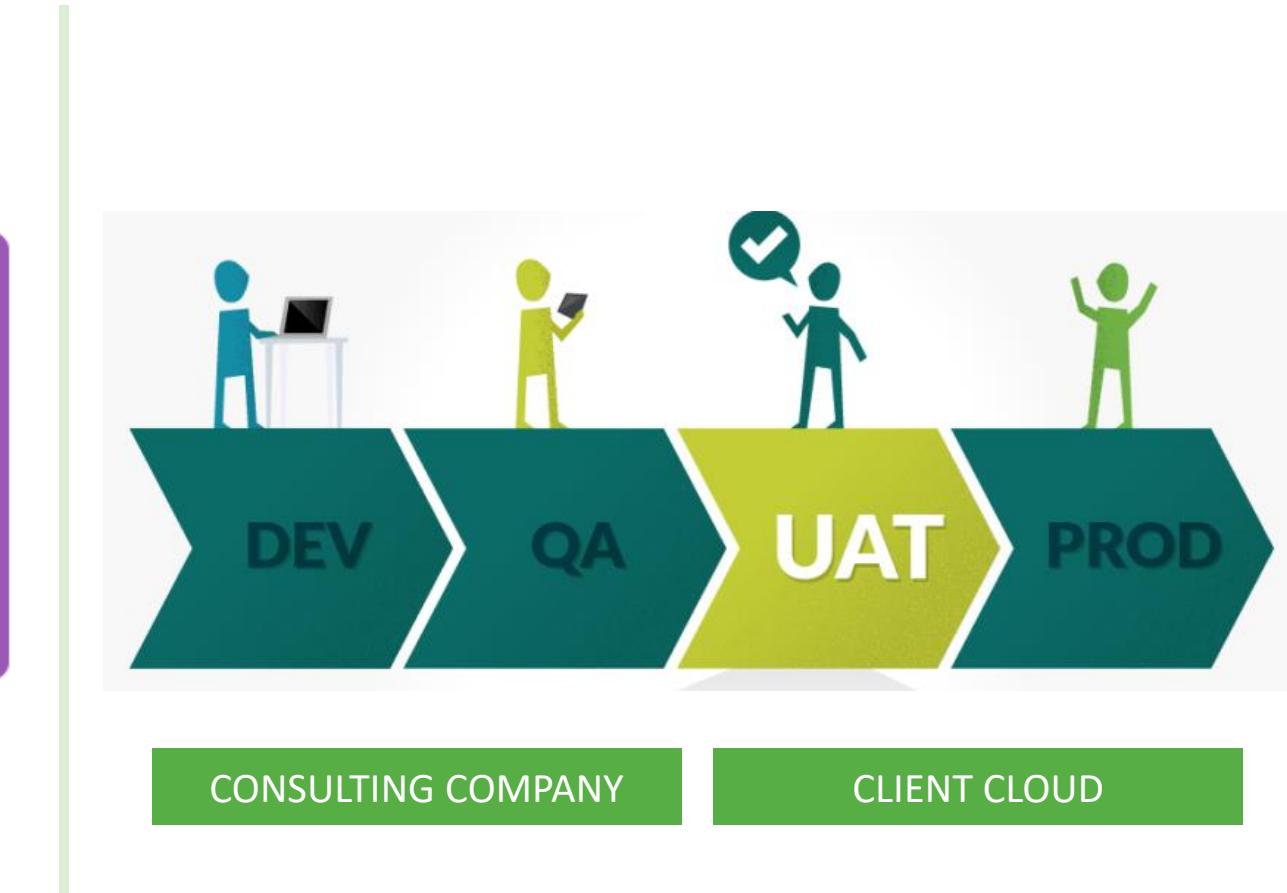
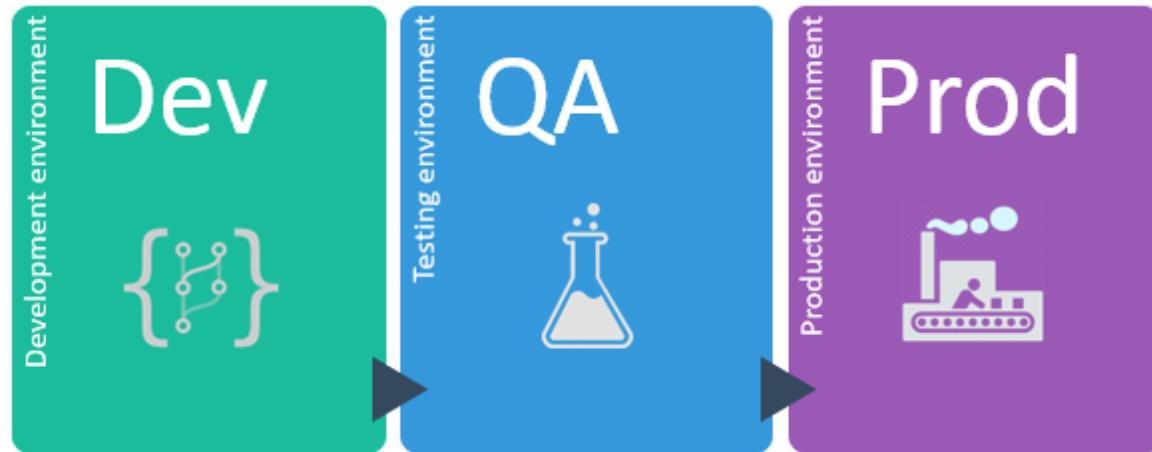
> Infra Requirements...

5. Cost-effective solutions

As AI models become more complex, they become more expensive to run, so getting extra performance from your infrastructure is pivotal to corralling costs. Over the next few years, we can expect continued growth in companies using AI, placing heavier burdens on the network, servers, and storage infrastructures to enable the use of this technology.

By making careful choices and identifying providers who can offer cost-effective dedicated servers, there is an opportunity to boost performance. This will enable companies to continue investing in AI without an increase in budget.

> Infra Requirements | Environments



Practice #1

Image Classifier



> #1 Image Classifier Assignment

INSTRUCTIONS:

Record a video with 10-15 minutes explaining how to use Image Classifier and your discoveries.

- In the Image Classifier select 3 or more different categories of images
- Tag each image
- Train your model
- Validate the results
- Evaluate the results
- Analyze all the steps you performed and think how should be the behavior (processes) of an enterprise solution with the same purpose. What are the differences?

In your video explain how and why you performed each step and explain the final result.

EVALUATION:

Mark: 5 points

- Ensure that you recorded yourself using the tool
- Ensure that you showed all the performed steps
- Ensure that you analyse the results
- Explain what kind of ML you are using in this exercise and why

Will be considered: Your results, explanations, level of details, clarity to explain and presentation / video quality (preparation).

Due date: Week 3 class

> Image Classifier | Practice

Microsoft

Cognitive Services

Custom Vision

<https://www.customvision.ai/>

Visual Intelligence Made Easy

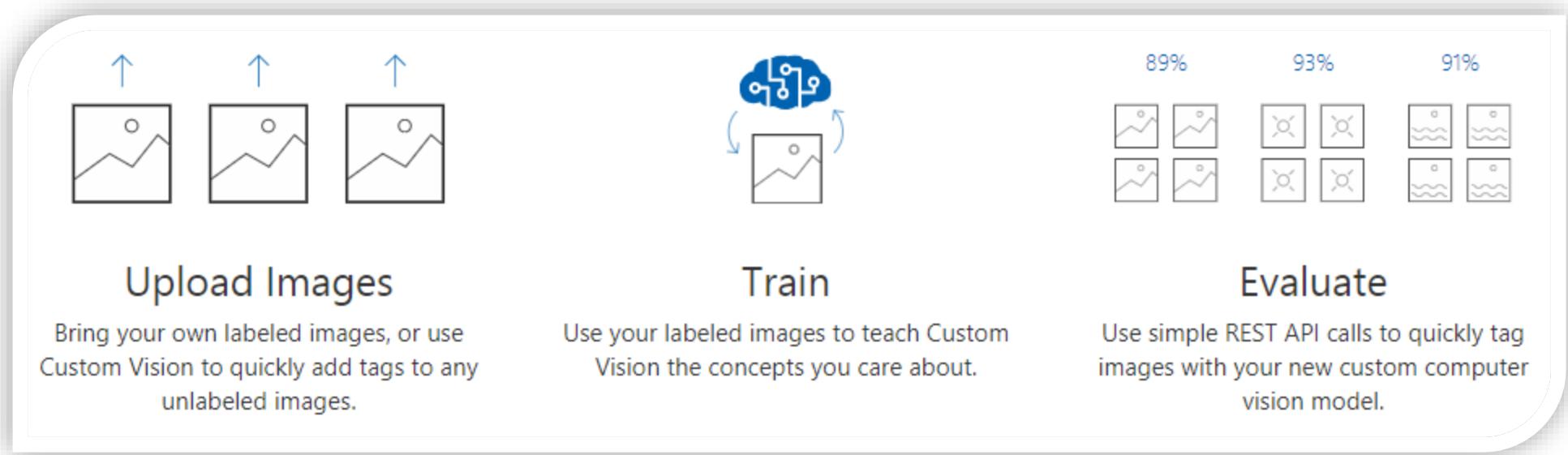
Easily customize your own state-of-the-art computer vision models that fit perfectly with your unique use case. Just bring a few examples of labeled images and let Custom Vision do the hard work.

SIGN IN

This is an example for
academic purposes

> Image Classifier | Practice

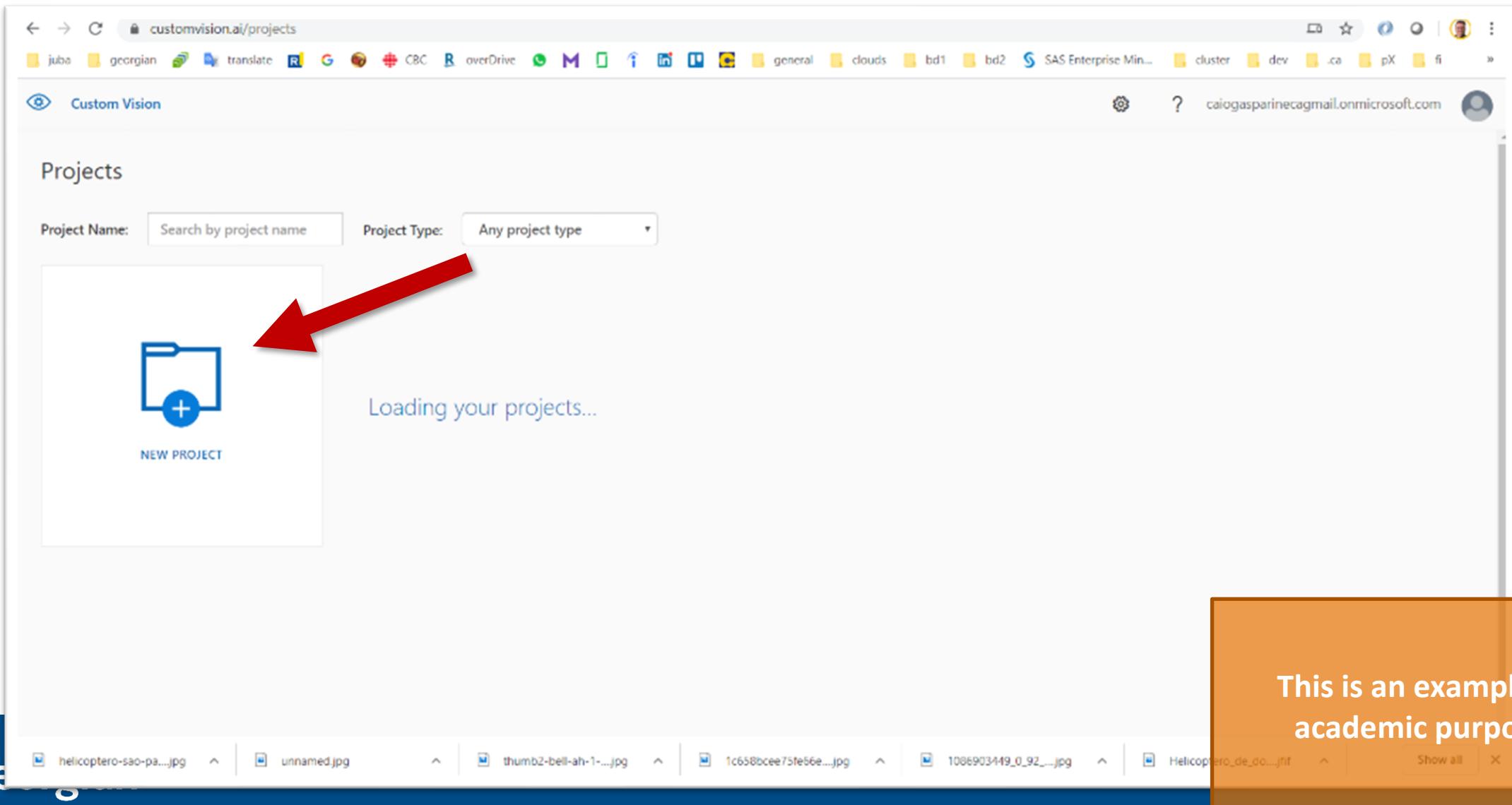
HOW IT WORKS?



This is an example for academic purposes

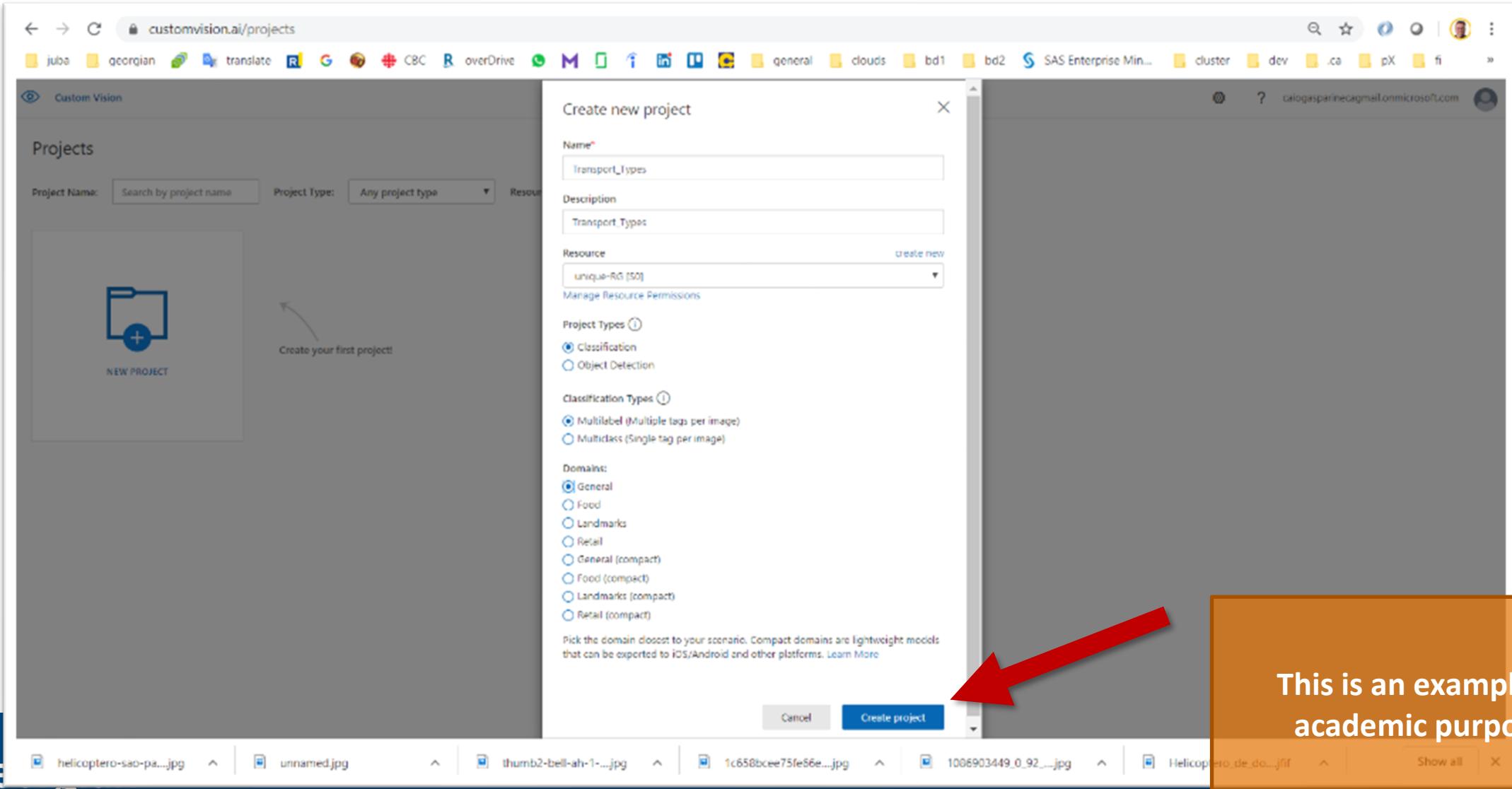
> Image Classifier | Practice

FIRST STEP - START A NEW PROJECT



> Image Classifier | Practice

SET THE PARAMETERS FOR THE NEW PROJECT



The screenshot shows the 'Create new project' dialog box from the Custom Vision service. The 'Name' field contains 'Transport.Types'. The 'Description' field contains 'Transport.Types'. The 'Resource' dropdown is set to 'unique-RG [50]'. Under 'Project Types', 'Classification' is selected. Under 'Classification Types', 'Multilabel (Multiple tags per image)' is selected. Under 'Domains', 'General' is selected. A note at the bottom states: 'Pick the domain closest to your scenario. Compact domains are lightweight models that can be exported to iOS/Android and other platforms. Learn More'. At the bottom right of the dialog is a 'Create project' button, which is highlighted by a large red arrow.

This is an example for academic purposes

> Image Classifier | Practice

SELECT THE IMAGES TO TRAIN YOUR MODEL



This is an example for
academic purposes

> Image Classifier | Practice

This is an example for academic purposes

TAG EACH IMAGE WITH A LABEL

Screenshot of the Microsoft Custom Vision Service interface for tagging images.

The main interface shows a list of training images categorized under "Transport_types". The "Tags" sidebar on the left lists categories: Tagged (ships) and Untagged (airplanes, helicopters, trains). A red arrow points to the "ships" tag.

The "Image upload" dialog box is open, showing a preview of the selected images and a text input field for adding tags. A second red arrow points to this input field. The dialog also displays the message "7 images will be added..." and a "Upload 7 files" button.

The bottom navigation bar shows the following file names: helicoptero-sao-pa...jpg, unnamed.jpg, thumb2-bell-ah-1....jpg, 1c658bcee75e66e...jpg, 1086903449_0_92....jpg.

> Image Classifier | Practice

TRAIN YOUR MODEL WITH THE IMAGES AND TAGS

The screenshot shows the Microsoft Custom Vision AI interface for training a model. A modal window titled "Choose Training Type" is open in the center, containing two options: "Quick Training" (selected) and "Advanced Training". A large red arrow points from the bottom right towards the "Train" button at the bottom of the modal. The background shows a grid of images related to transport types, with several cruise ships and trains visible. The interface includes a sidebar for filtering and tagging images, and a navigation bar at the top.

This is an example for academic purposes

Georgian

> Image Classifier | Practice

CHECK THE RESULTS AND ACCURACY OF YOUR MODEL

The screenshot shows the Microsoft Custom Vision Performance page for a project titled "Transport Types". The page displays the results of "Iteration 1", which was trained 1 minute ago using a General domain. The classification type is Multilabel (Multiple tags per image). The performance metrics shown are:

Metric	Value
Precision	100.0%
Recall	87.5%
AP	100.0%

Below these metrics, a section titled "Performance Per Tag" lists the following data:

Tag	Precision	Recall	AP	Image count
transport	100.0%	100.0%	100.0%	29
trains	100.0%	100.0%	100.0%	7
ships	100.0%	50.0%	100.0%	7
helicopters	100.0%	50.0%	100.0%	7
airplanes	100.0%	100.0%	100.0%	7

At the bottom of the page, there is a navigation bar with several image thumbnails.

This is an example for academic purposes

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Georgian

END OF DAY 3