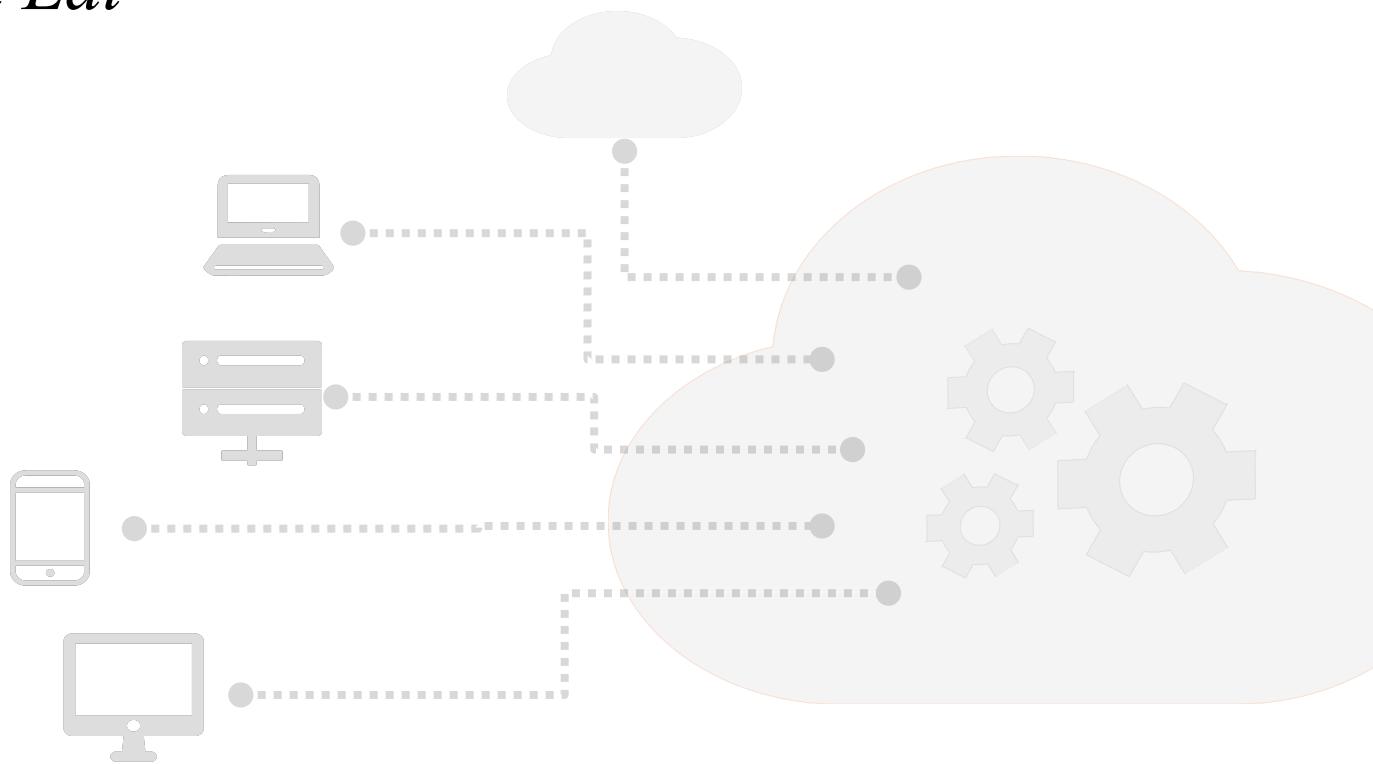


I ILLINOIS

CS 598: Systems for GenAI

Instructor: Fan Lai

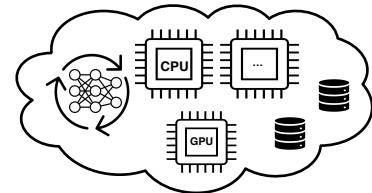


About Fan

- **Assistant Professor in CS**
 - PhD'23: "Minimalist Systems for Pervasive Machine Learning"

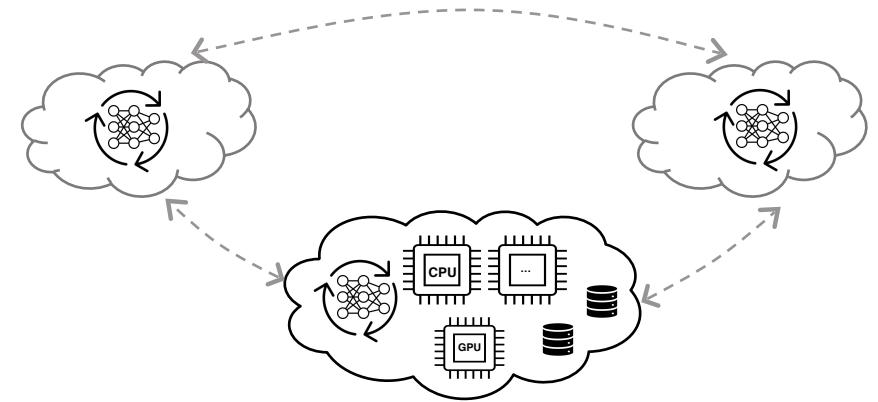
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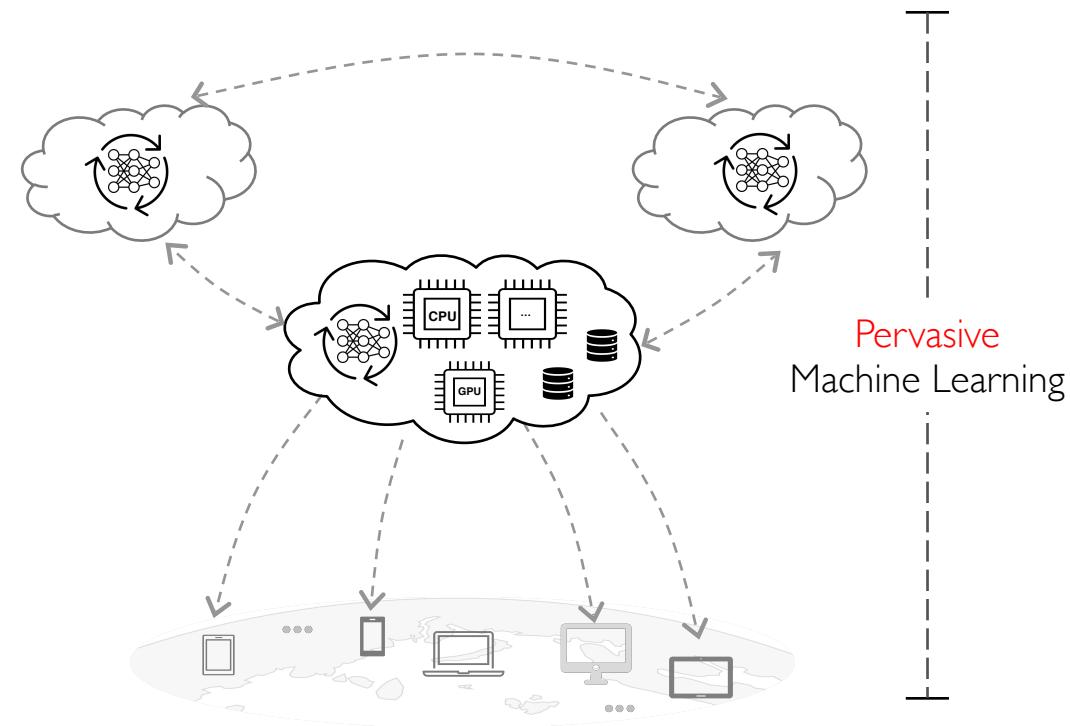
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- PhD'23: "Minimalist Systems for Pervasive Machine Learning"

- **Industry:**

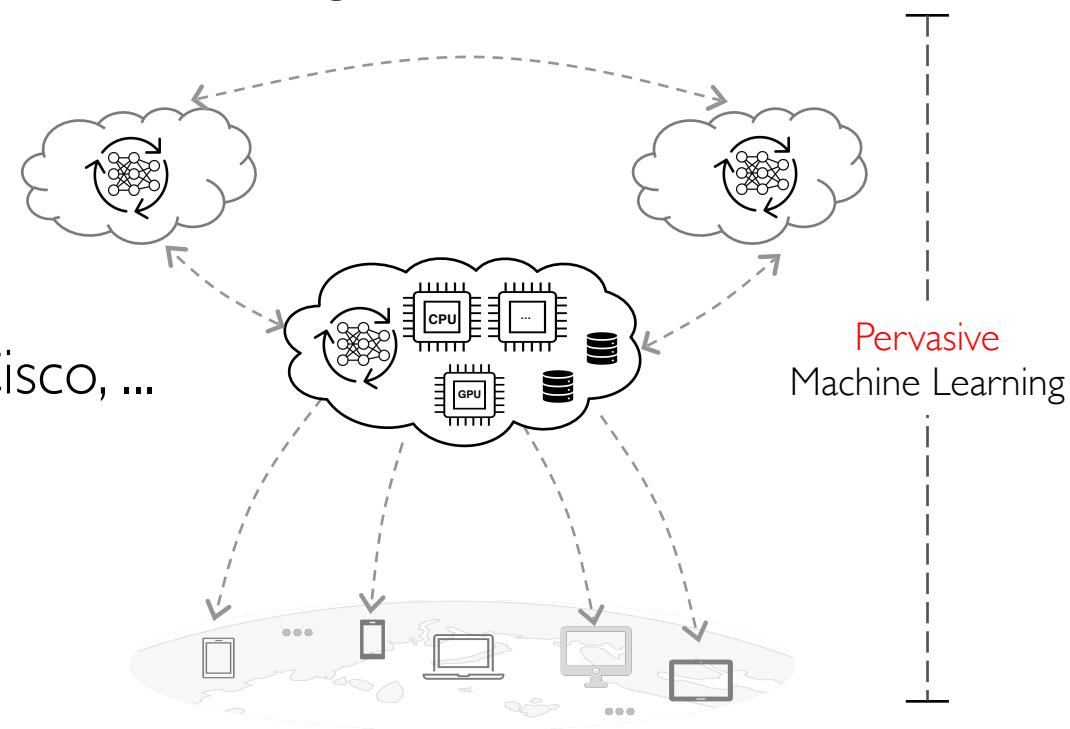
- Visiting Faculty@Google (2023-present)

- Meta AI (2022-2023)

- MLSys adoptions at Google, Meta, LinkedIn, Cisco, ...

- **Office hours**

- SC 3128, M 11 AM – 12 PM



About Chengsong Zhang (TA)

- **2rd-year Master's student**
 - Research on image generation
- **Created several Stable Diffusion WebUI Extensions**
 - Segment Anything (Github 3.3k stars)
 - AnimateDIFF extension (Github 3k stars)
- **Office hours from next week**
 - [Zoom](#), W 11:00 AM - 12:00 PM



Status and Prerequisites

- As of today: ~50 registered
 - If you are not planning to take the class, please drop ASAP

Status and Prerequisites

- **As of today: ~50 registered**
 - If you are not planning to take the class, please **drop ASAP**
- **Systems Courses: OS/databases/distributed systems/networking**
 - Equivalent courses are acceptable as well
- **ML/AI course is helpful but not required**
- **Good programming skills** (e.g., PyTorch, TensorFlow, ...)
 - Build systems for course project

Course Schedule

- Webpage: <https://github.com/fanlai0990/cs598>
- Discussion, Questions: Please Use [Piazza](#)
- In-person lectures, discussion
- Feel free to drop us email too :)

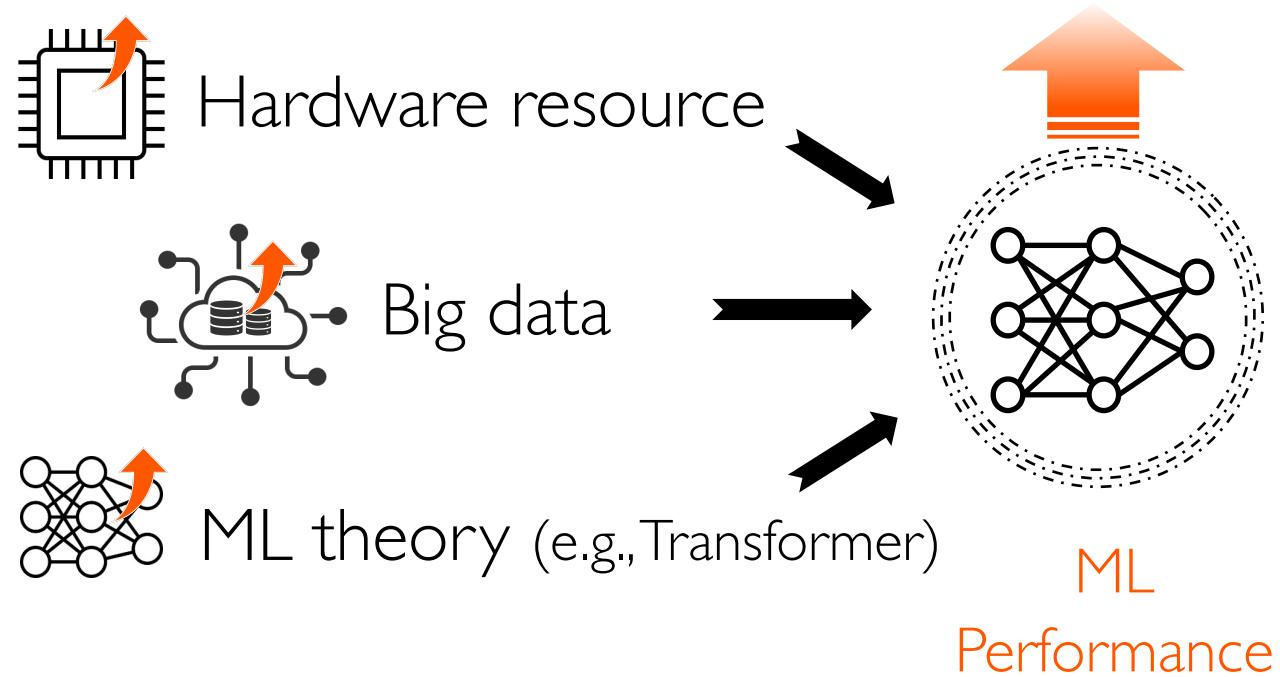
Agenda

- **What will you learn in this course?**
 - GenAI, systems, networks, ...
- **What will you do in this course?**
 - Participation, presentation, research project, ...

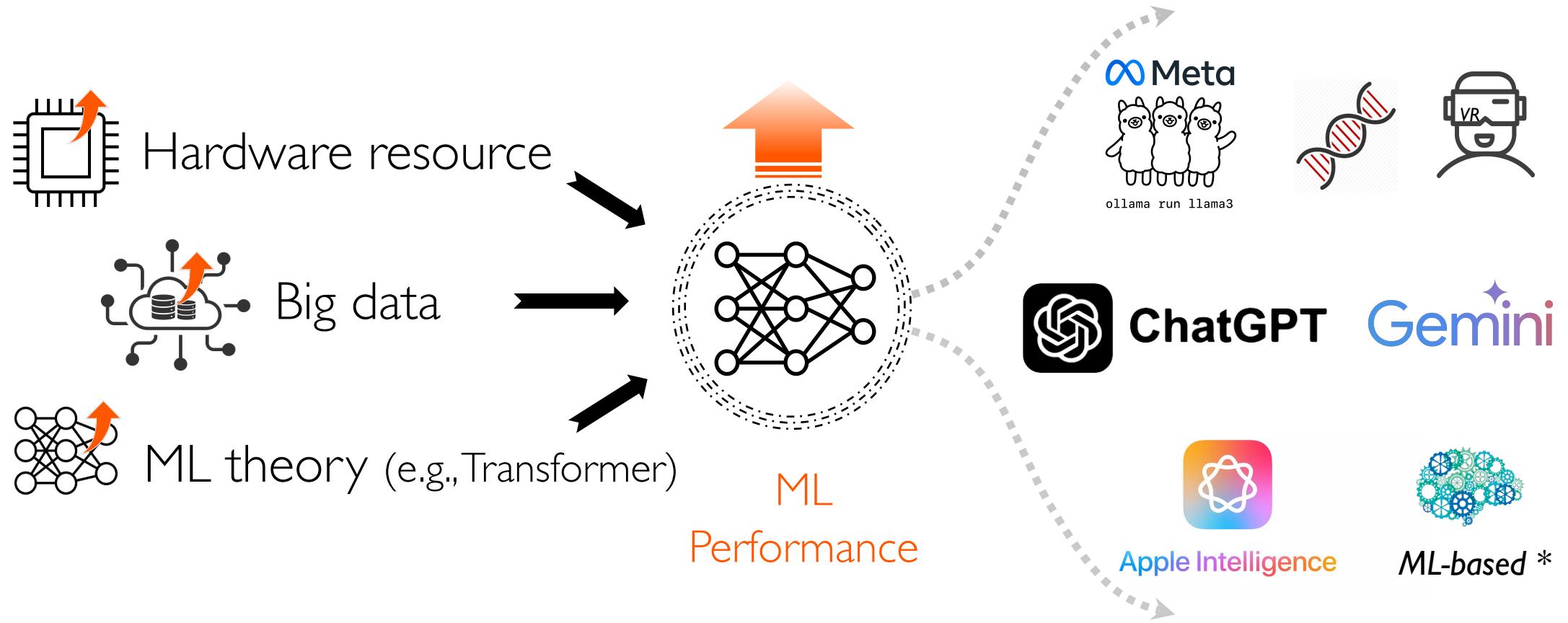


What Do We Talk About When We Talk About “**Systems** for GenAI”

Cloud Enabled Last Leap in Machine Learning (ML)

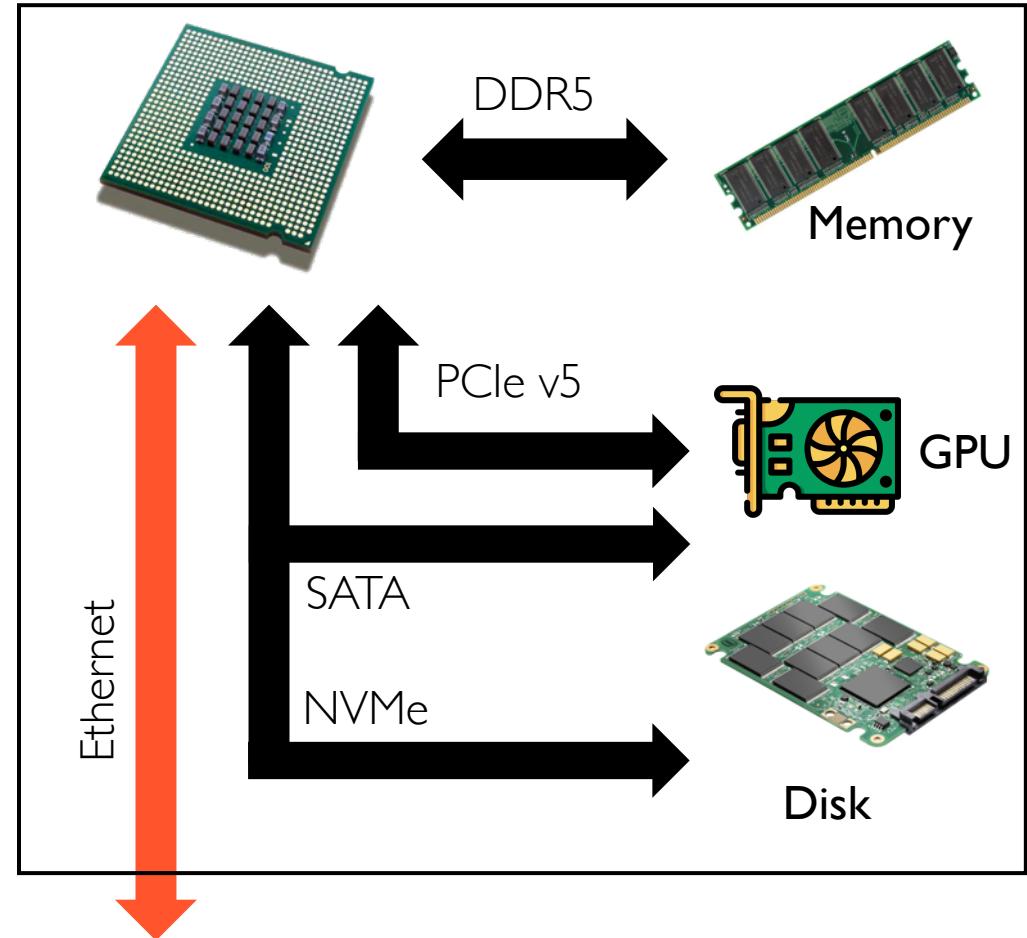


Cloud Enabled Last Leap in Machine Learning (ML)



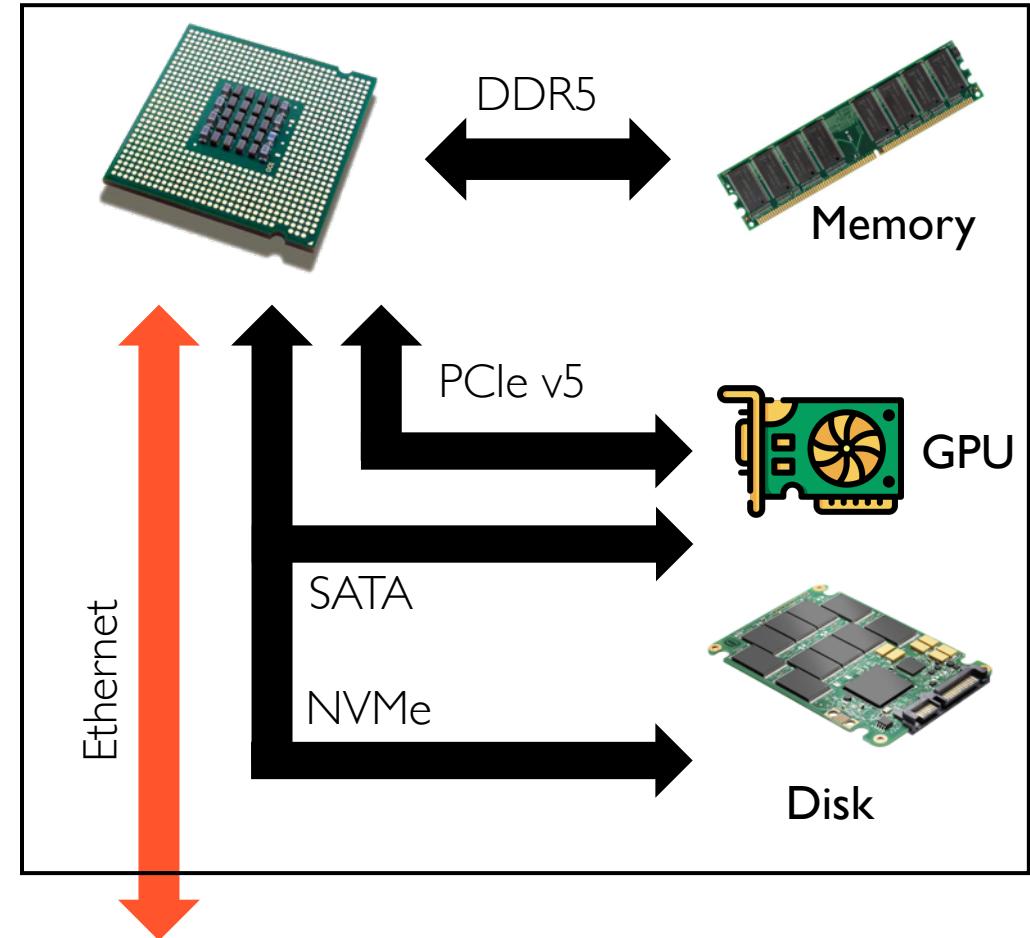
What's in a (Simplified) AI Server?

- Interconnected compute and storage resources



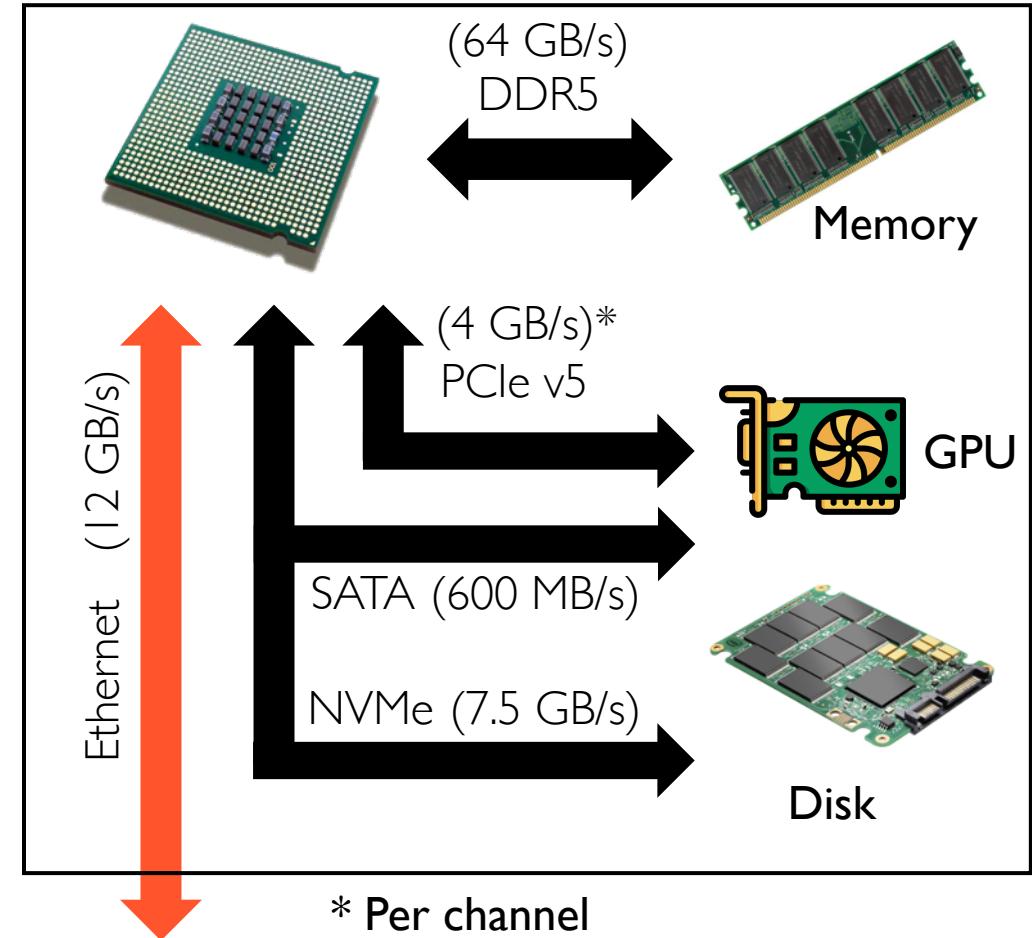
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 - Different bandwidth and latency constraints



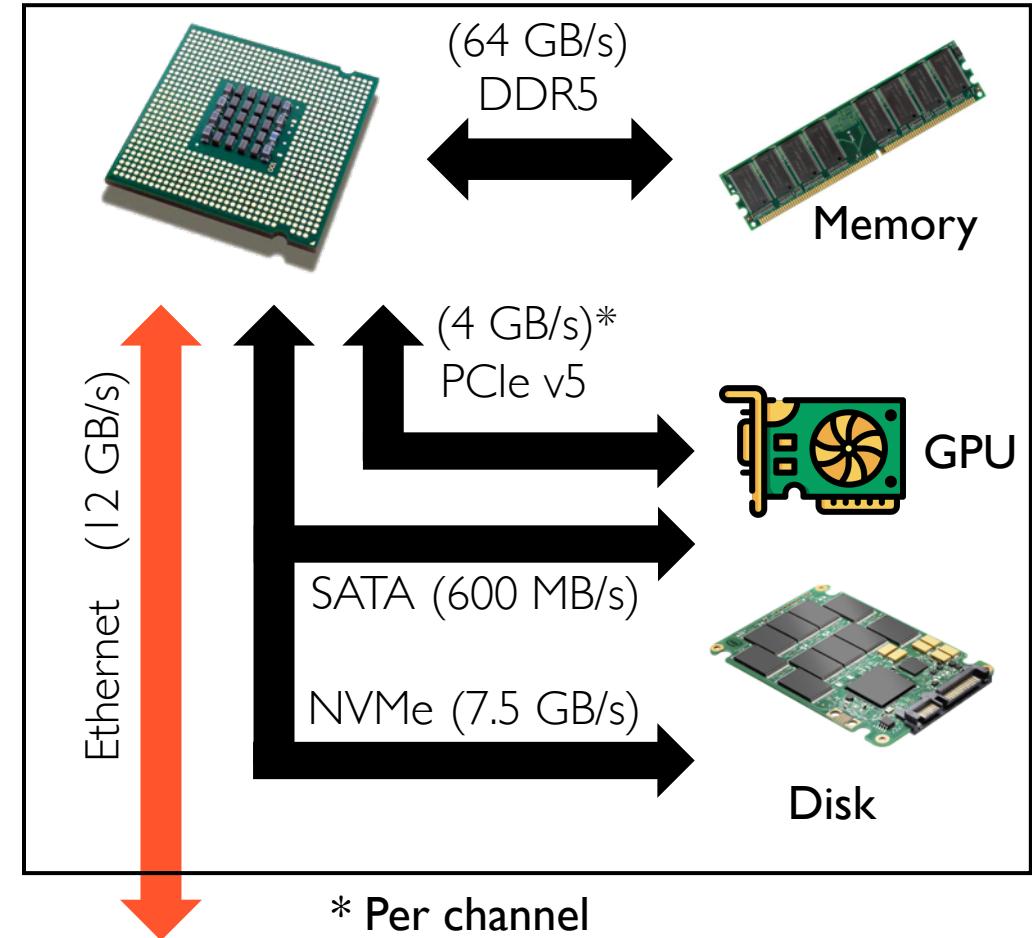
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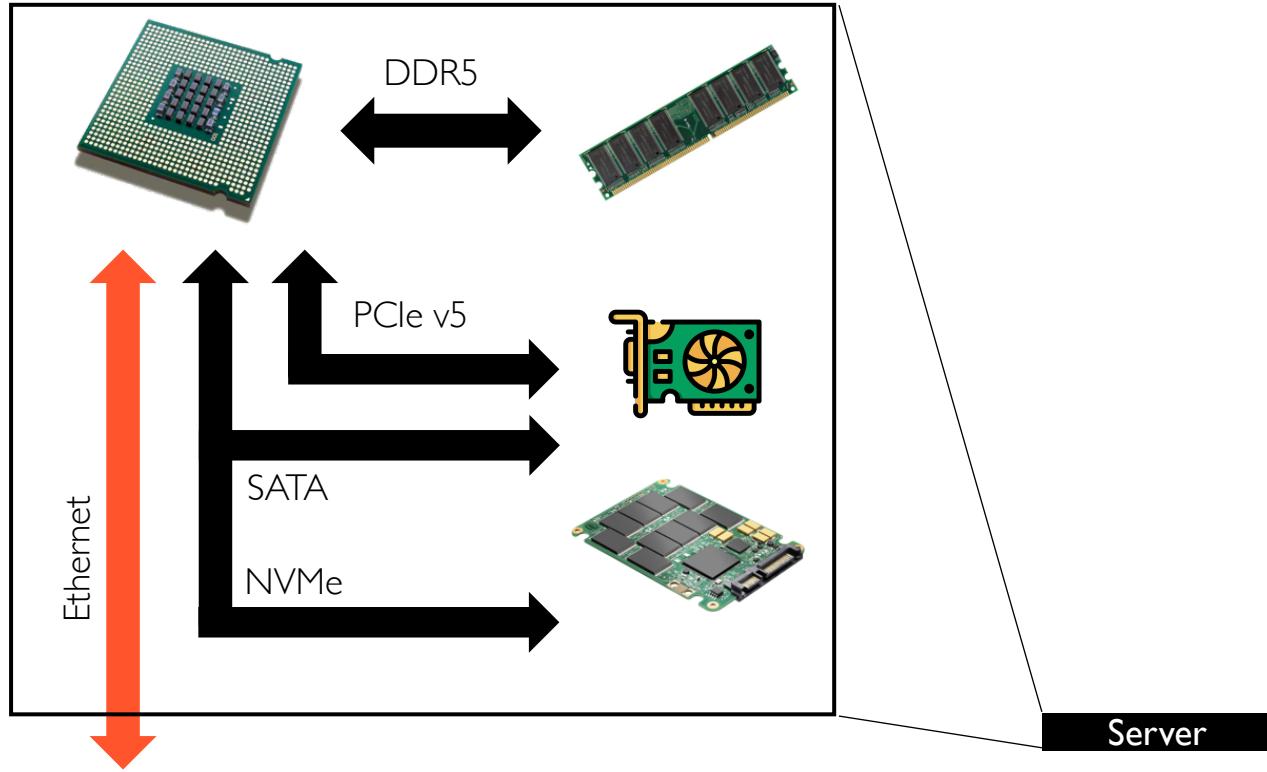


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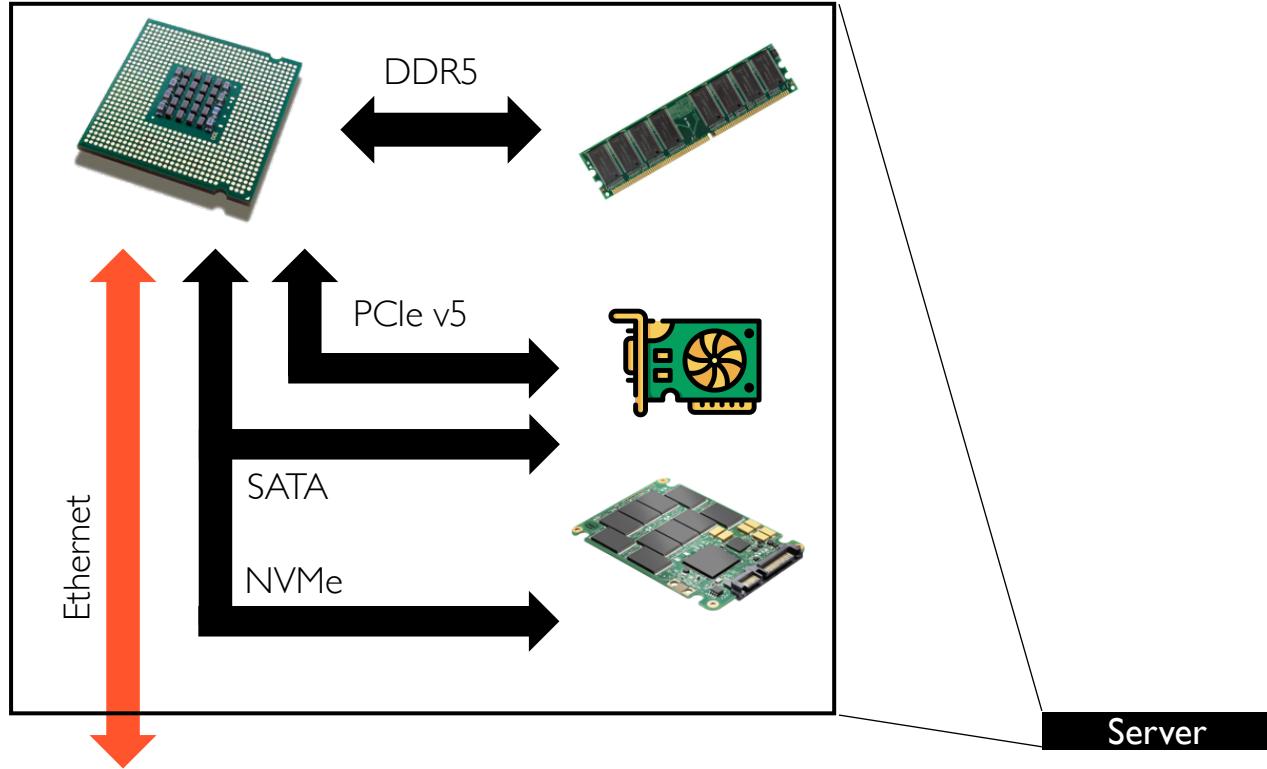
- **Interconnected compute and storage resources**
 - Different bandwidth and latency constraints
- **Simplified diagram**
 - Doesn't include faster networks such as RDMA, dedicated GPU interconnects such as NVLink



Cloud Datacenter: Scale-Out Servers

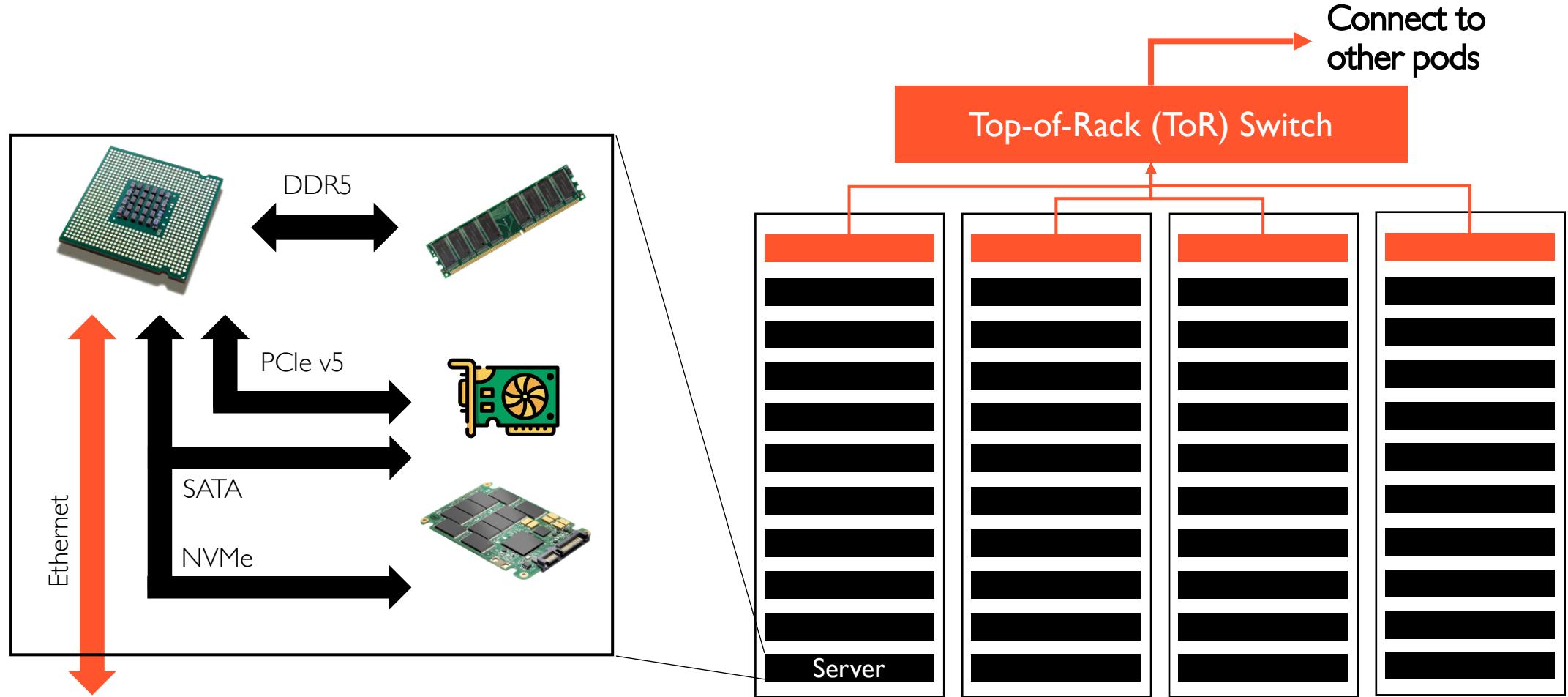


Cloud Datacenter: Scale-Out Servers



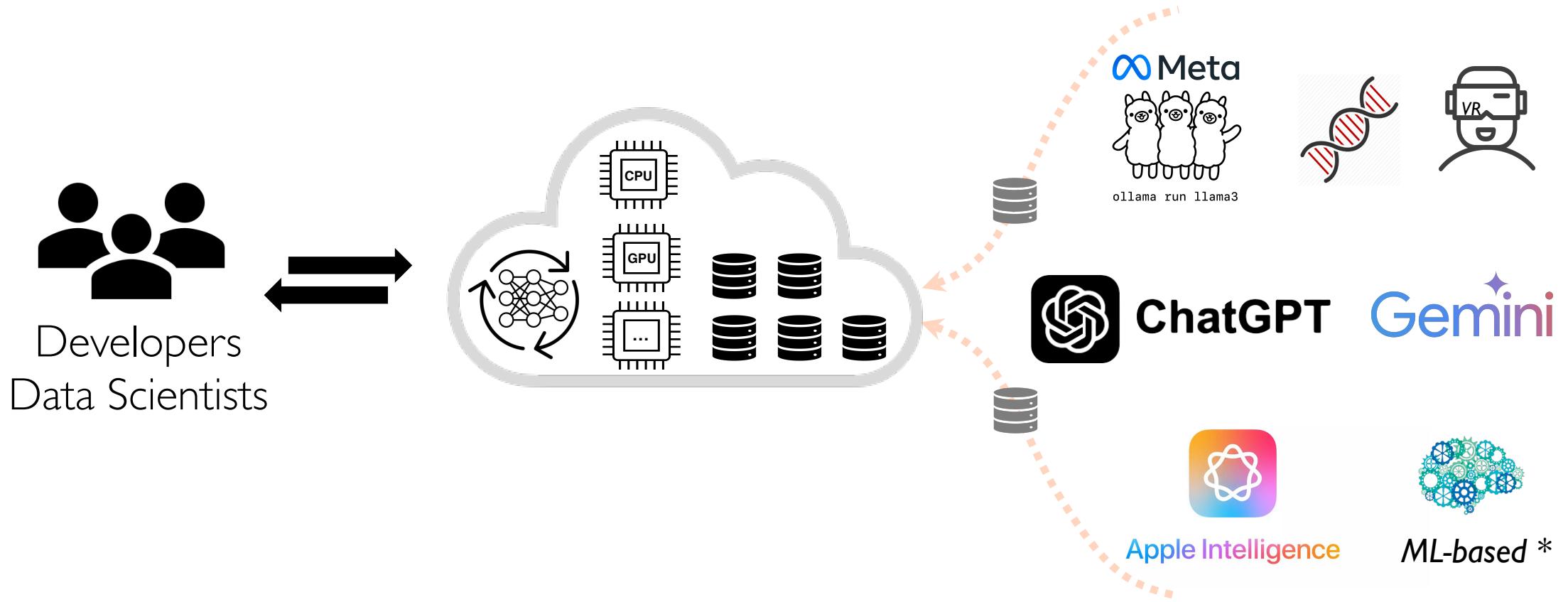
Meta's AI datacenter houses 16K of its 24K GPUs for training the latest Llama 3 model

Cloud Datacenter: Scale-Out Servers

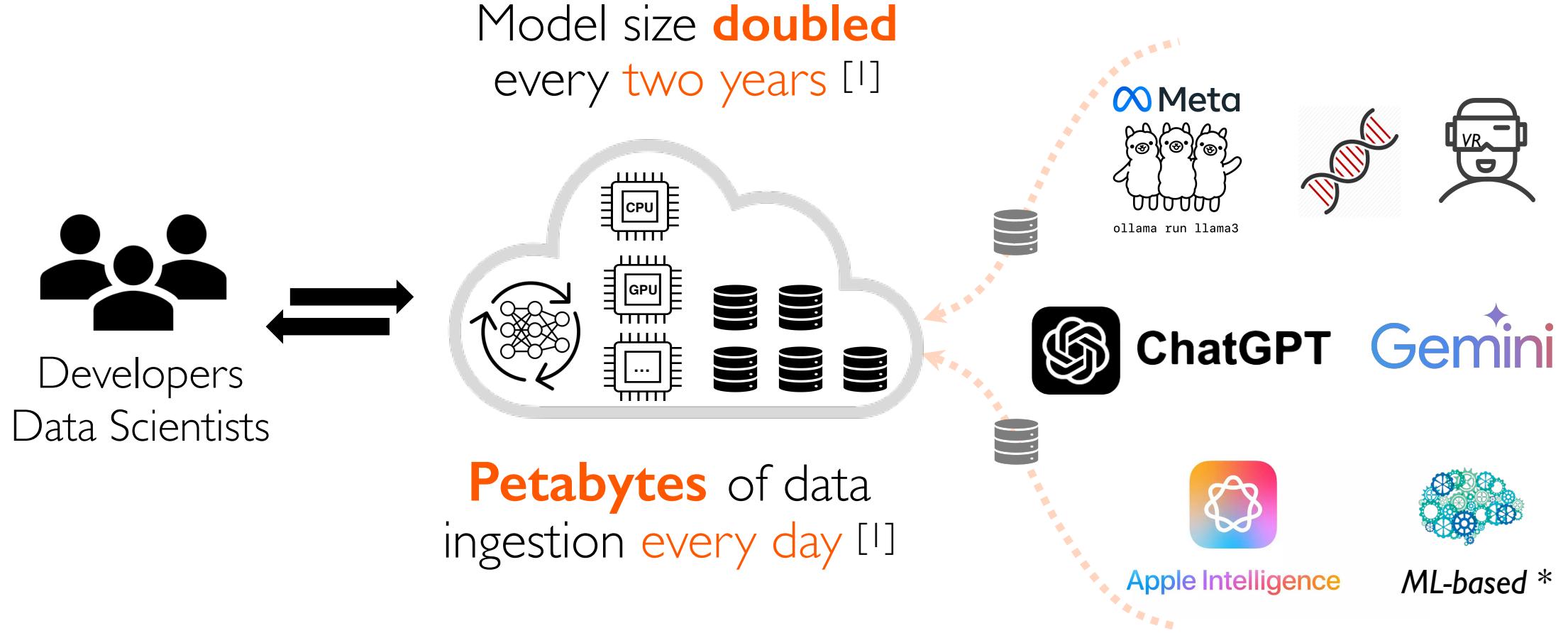


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Cloud Faces Skyrocketing GenAI Workloads



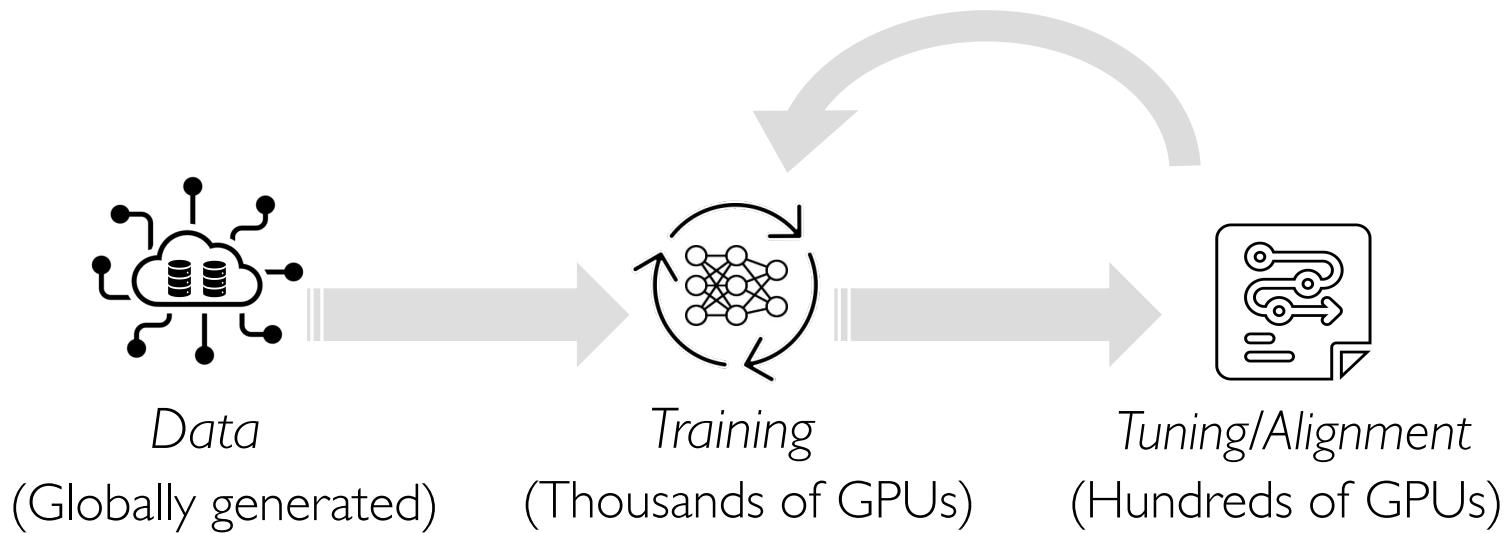
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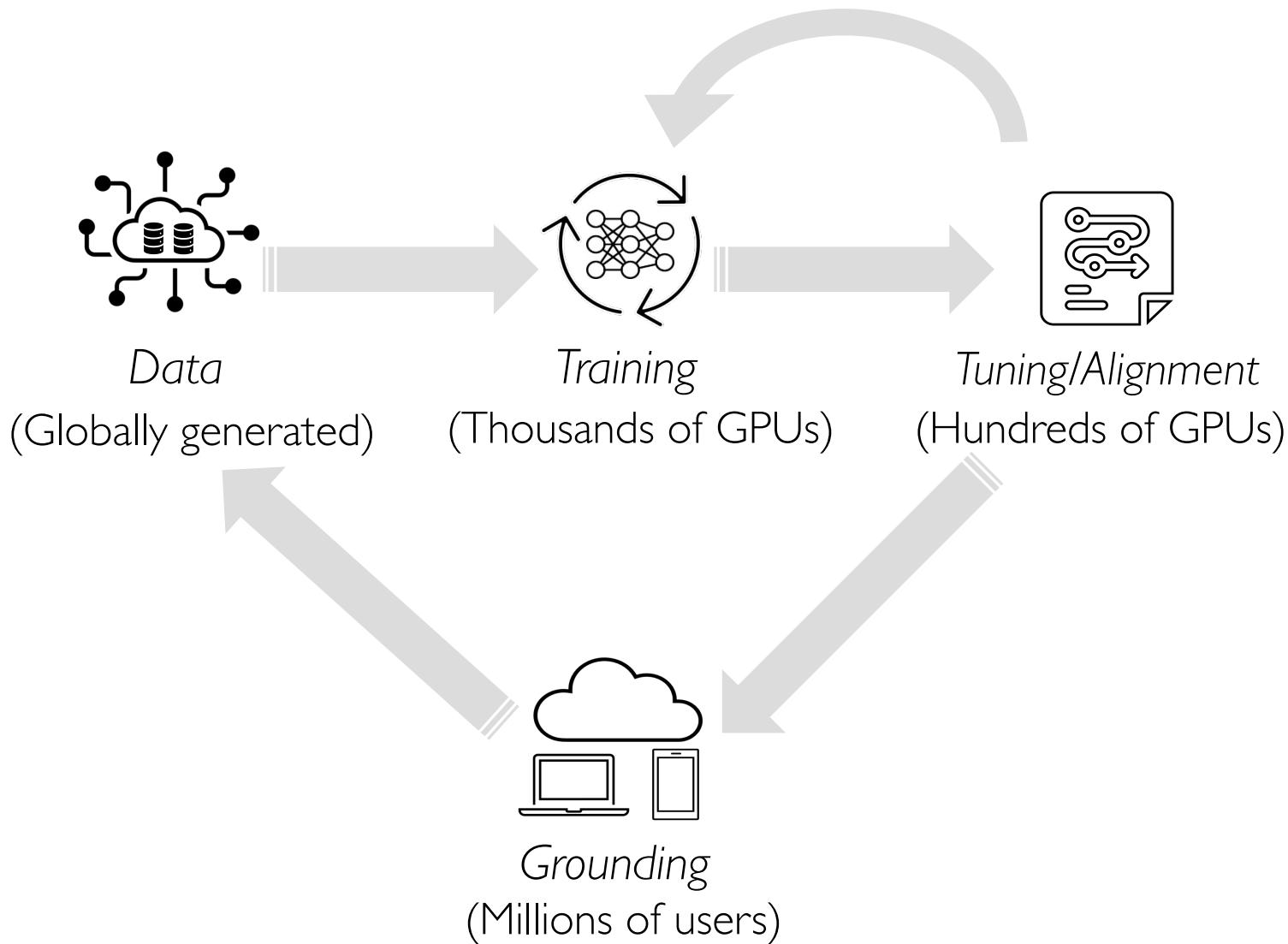
[!] "Sustainable AI: Environment Implications, Challenges and Opportunities", Meta, MLSys'22

GenAI Lifecycle Demands Great Systems Support

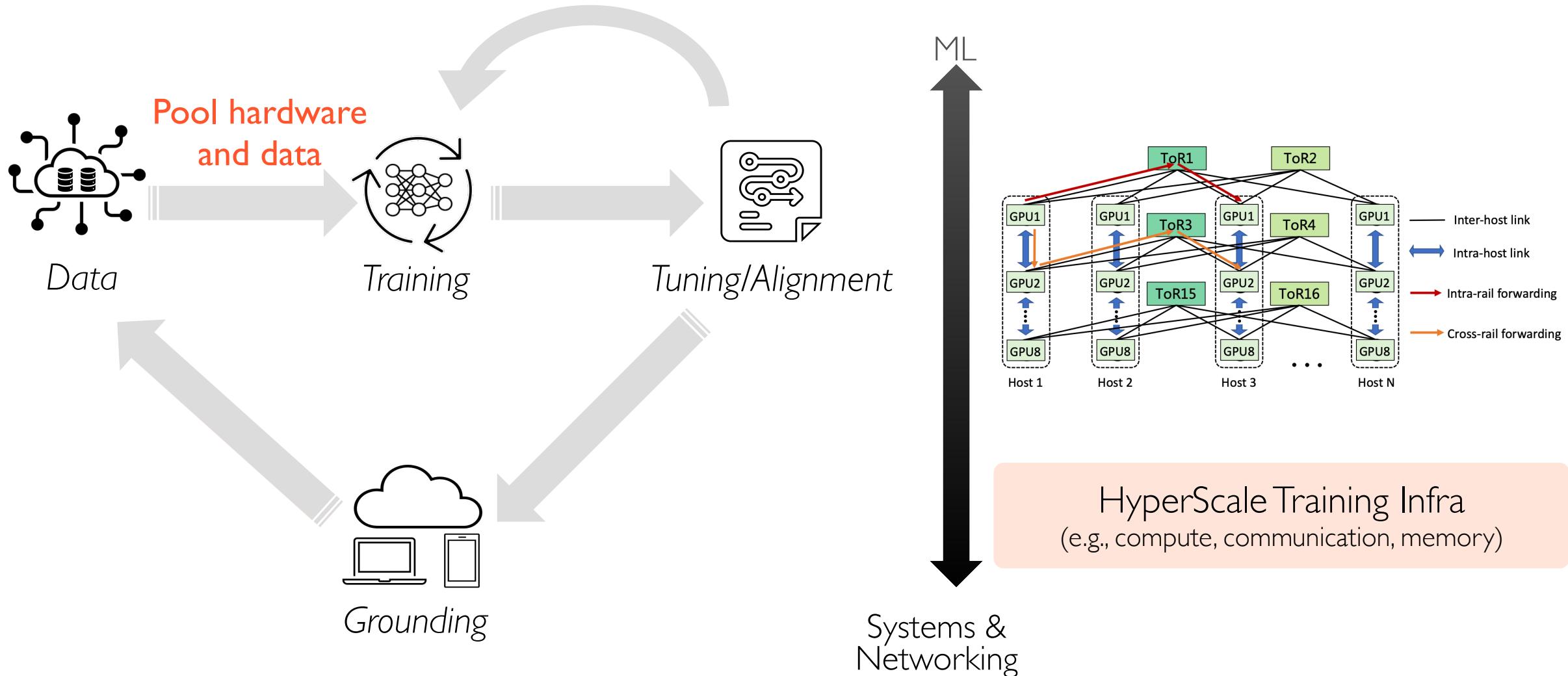
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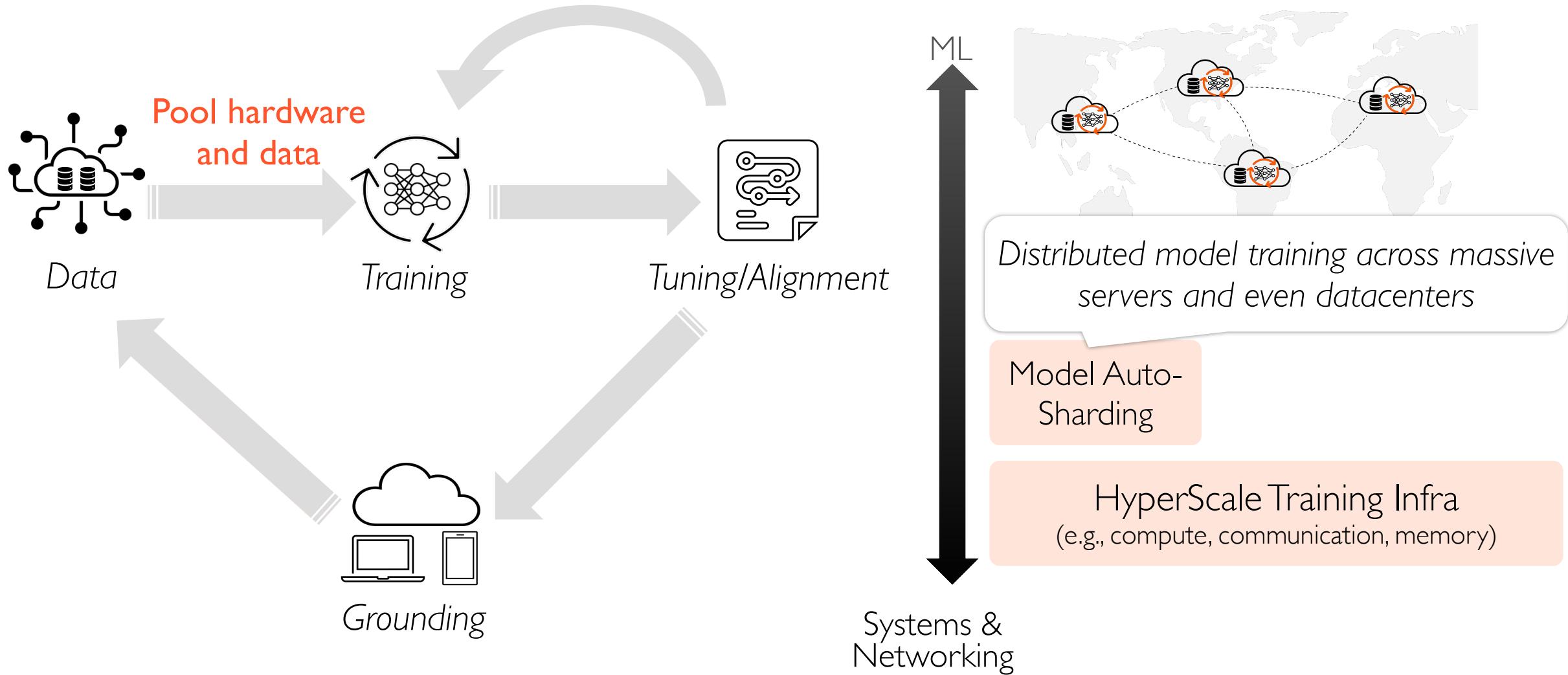
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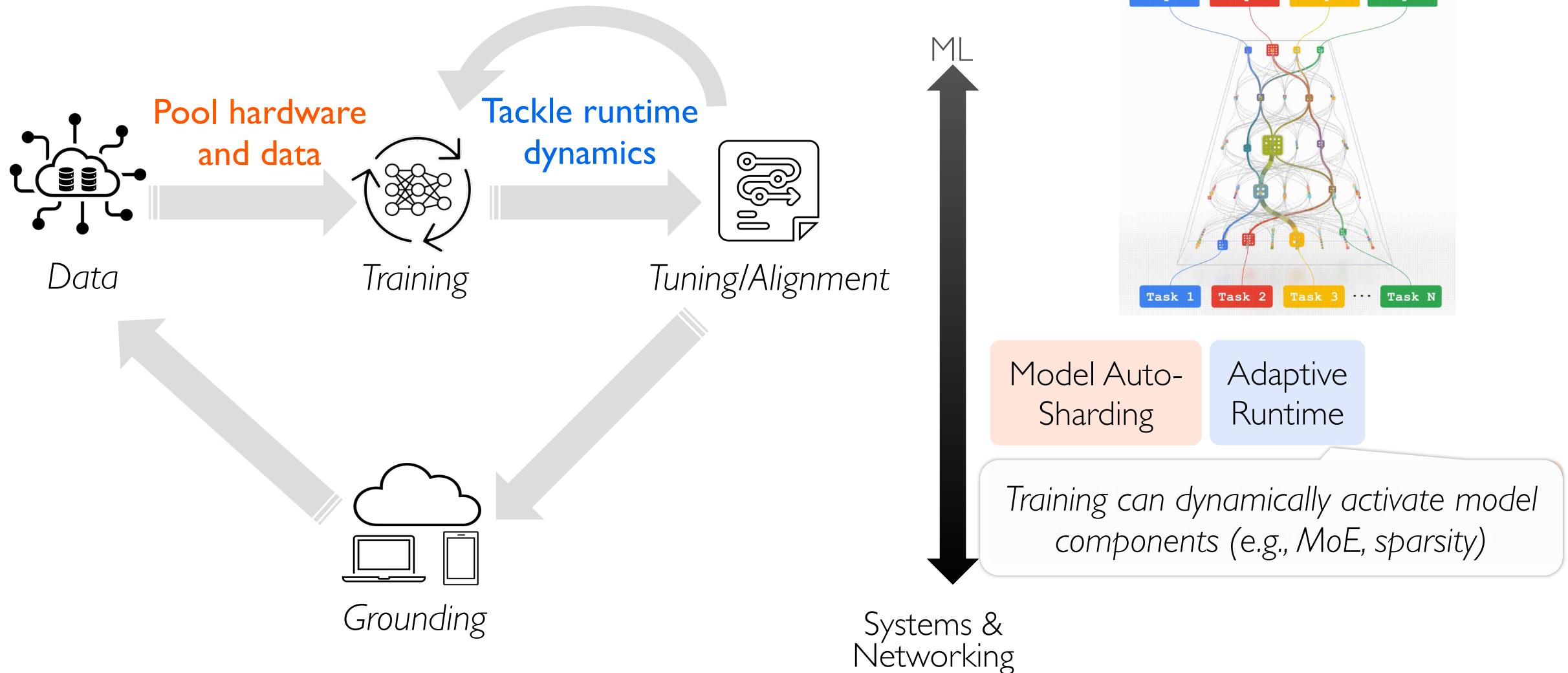
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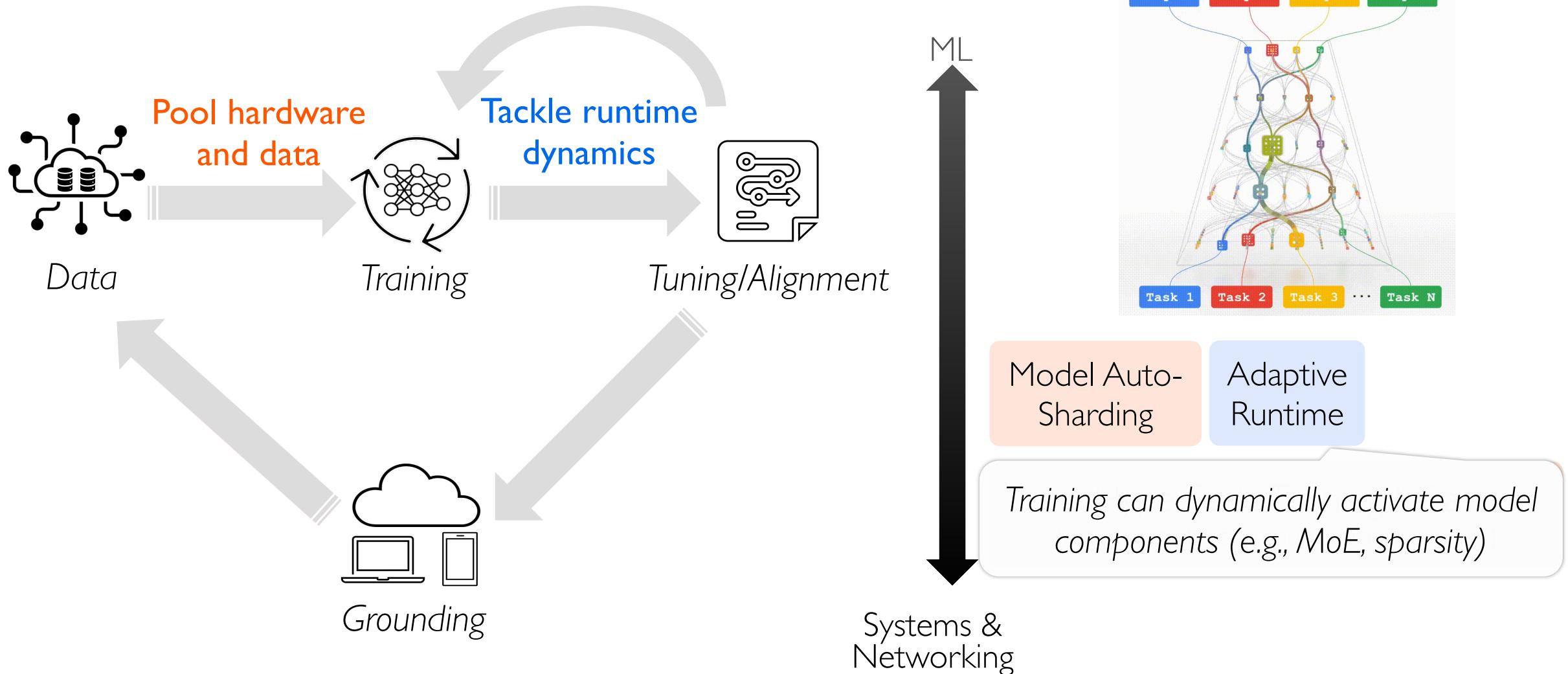
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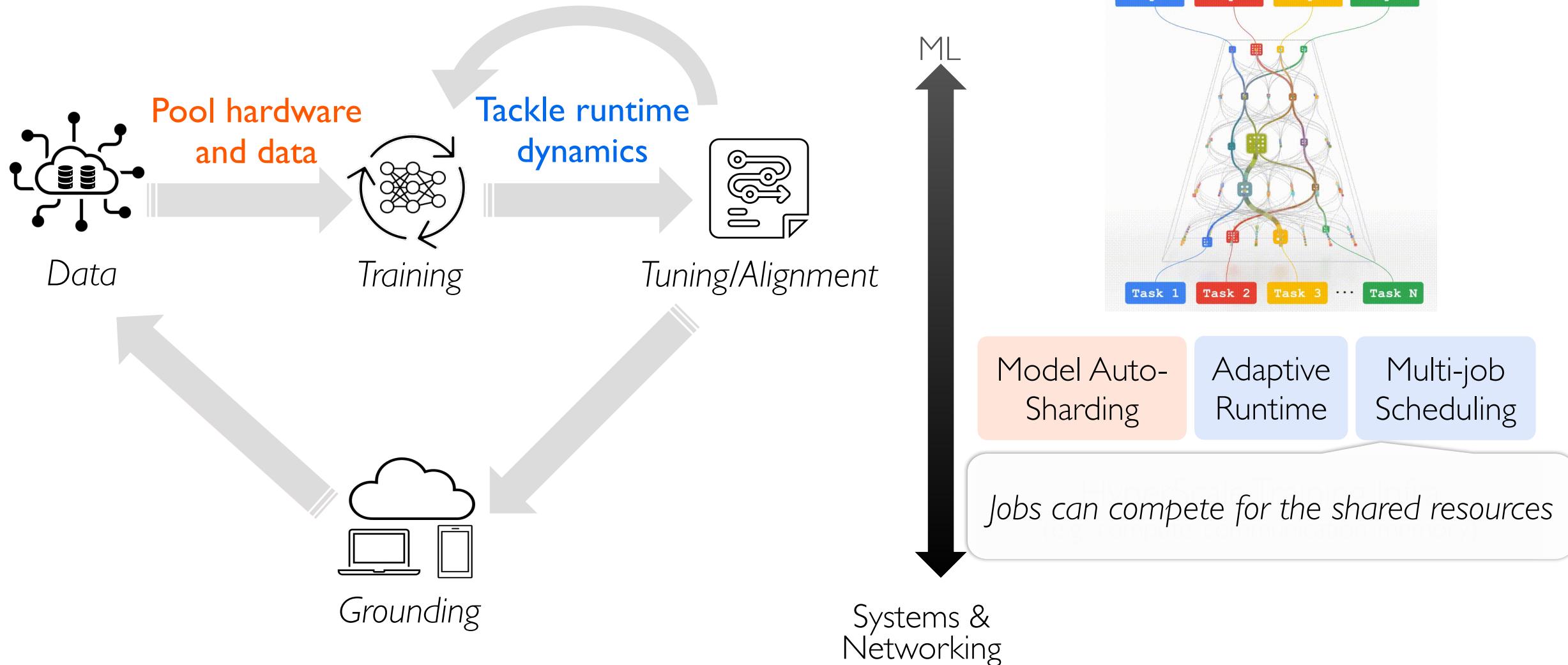
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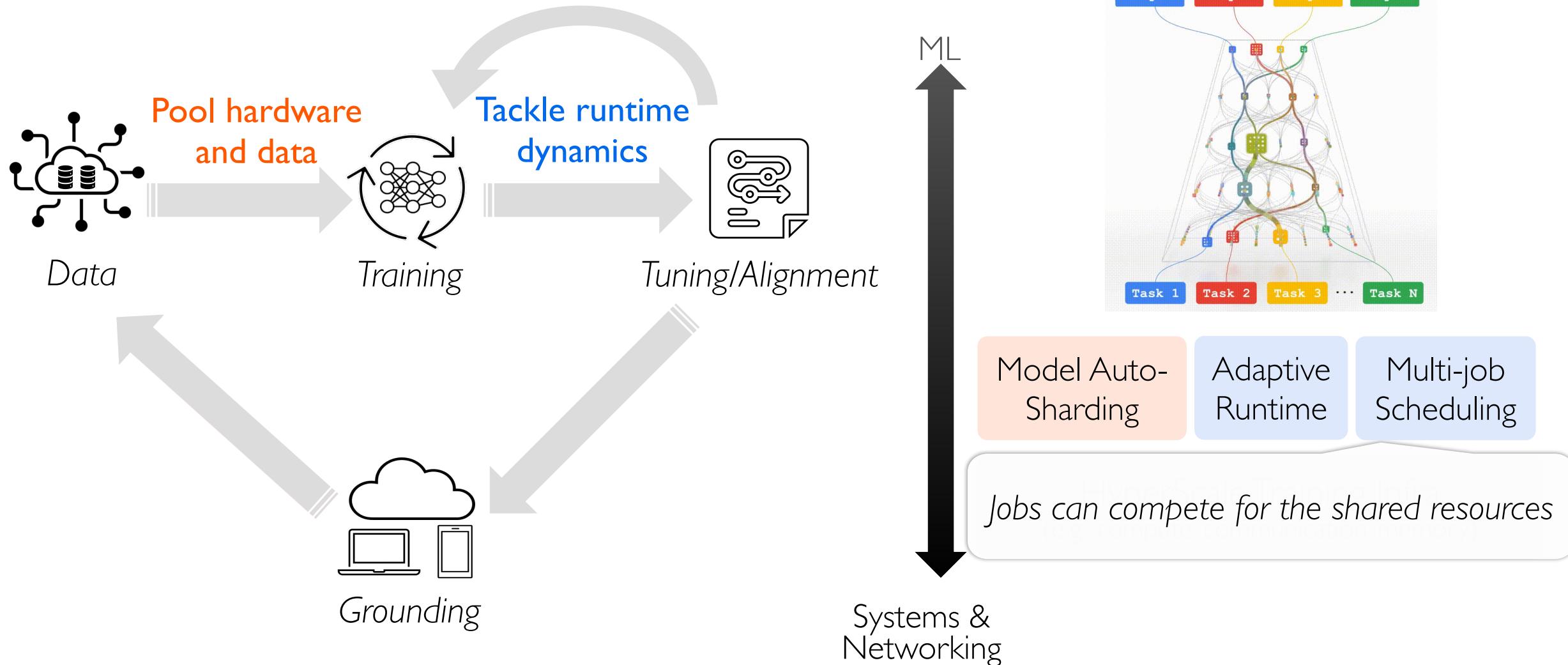
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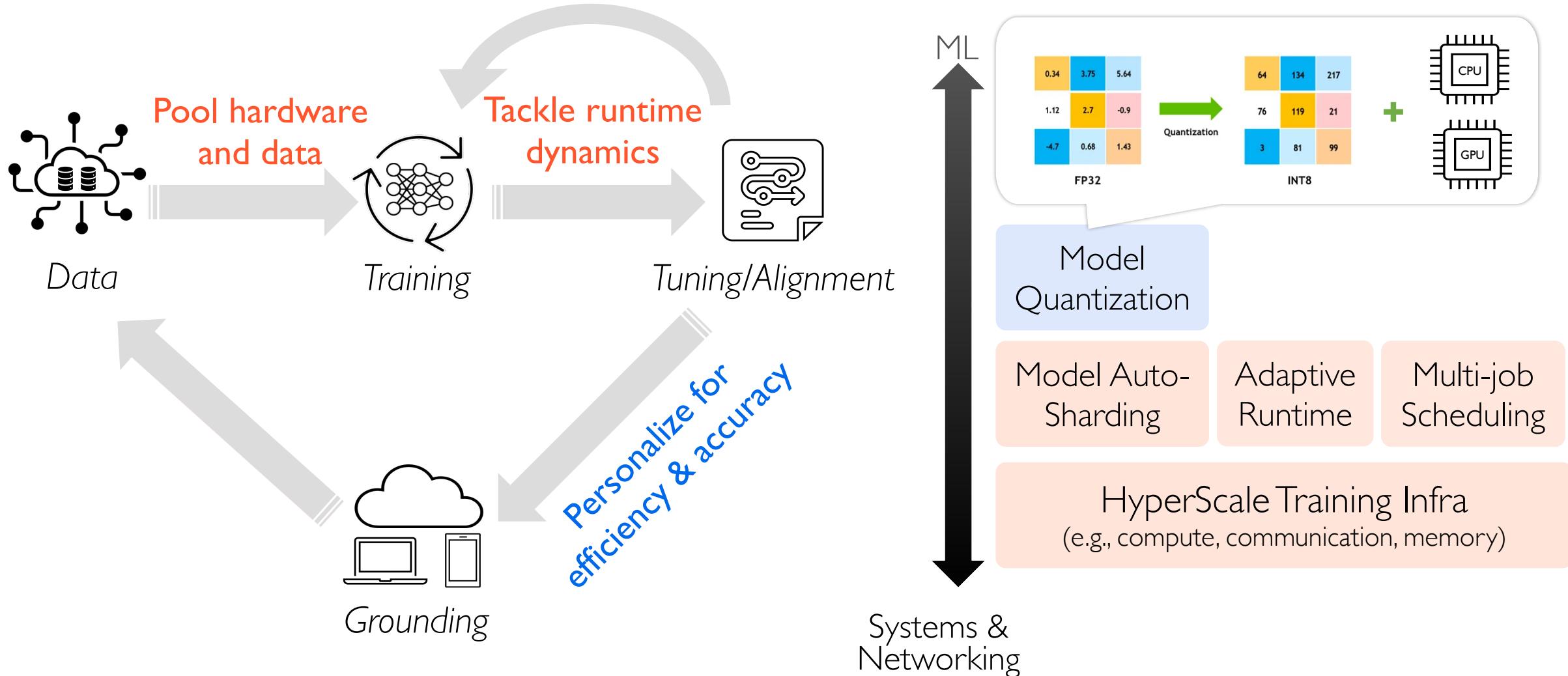
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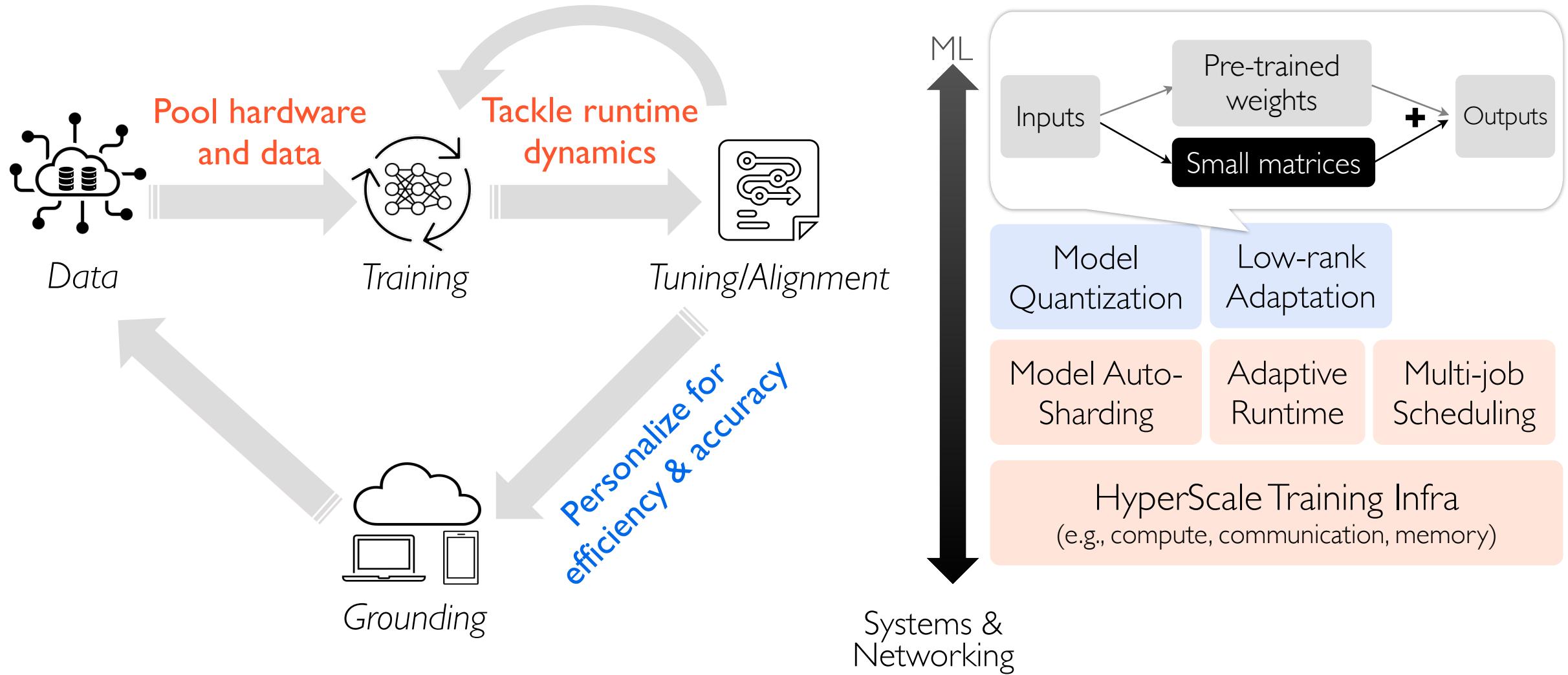
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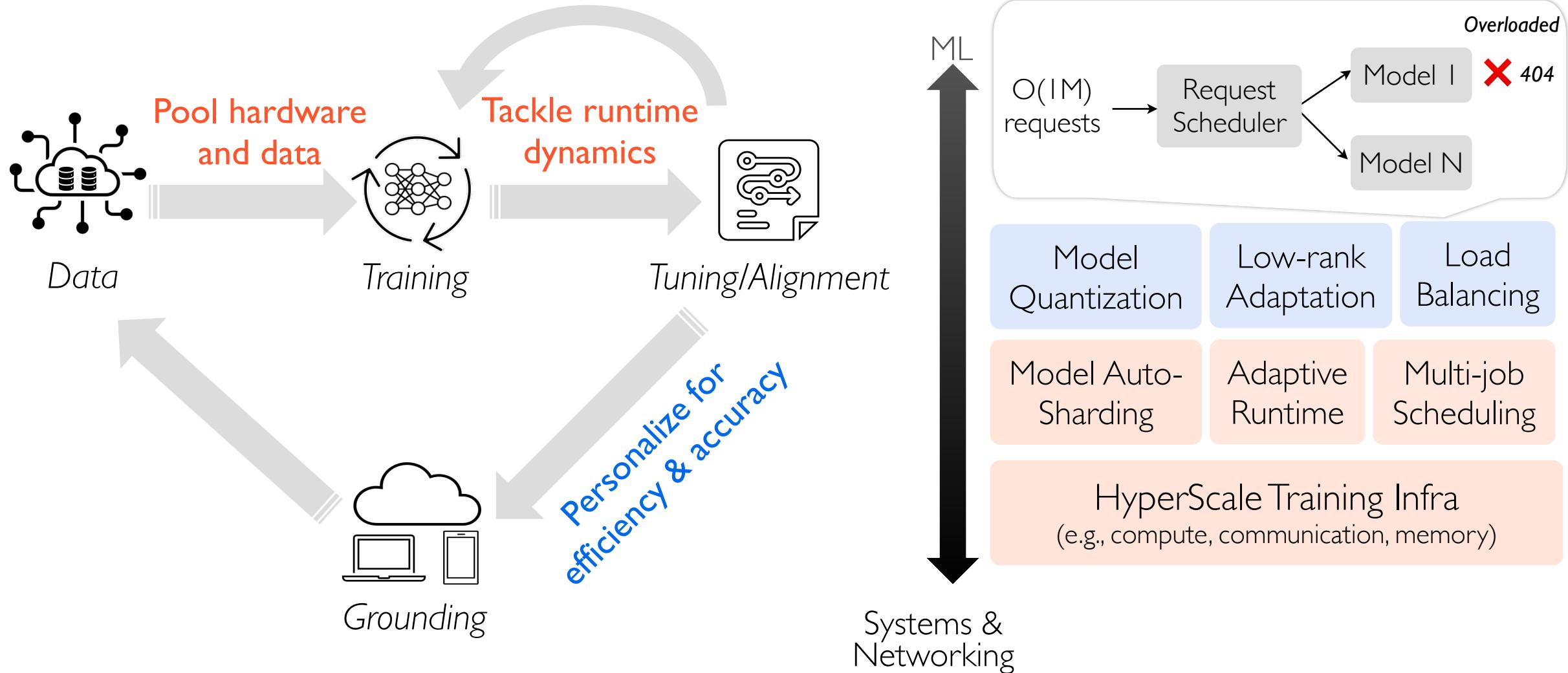
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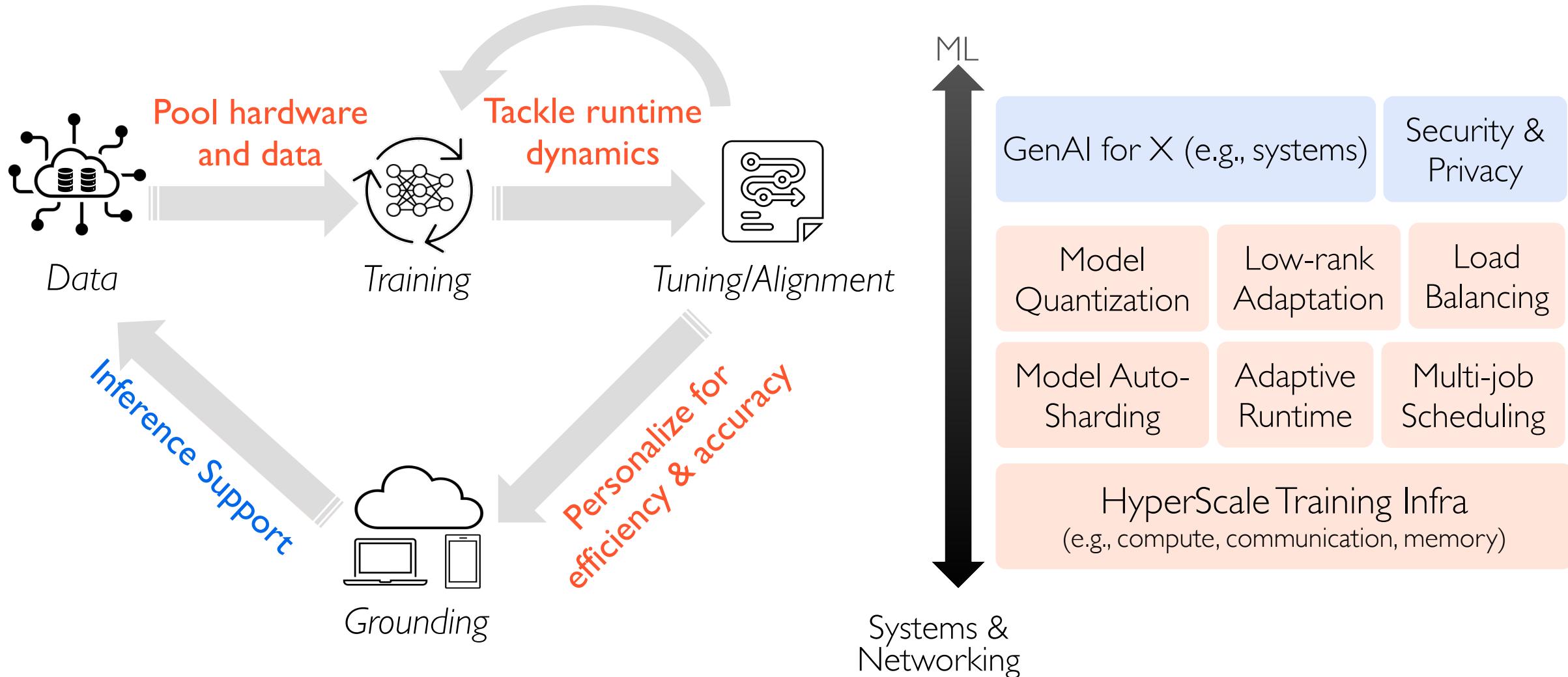
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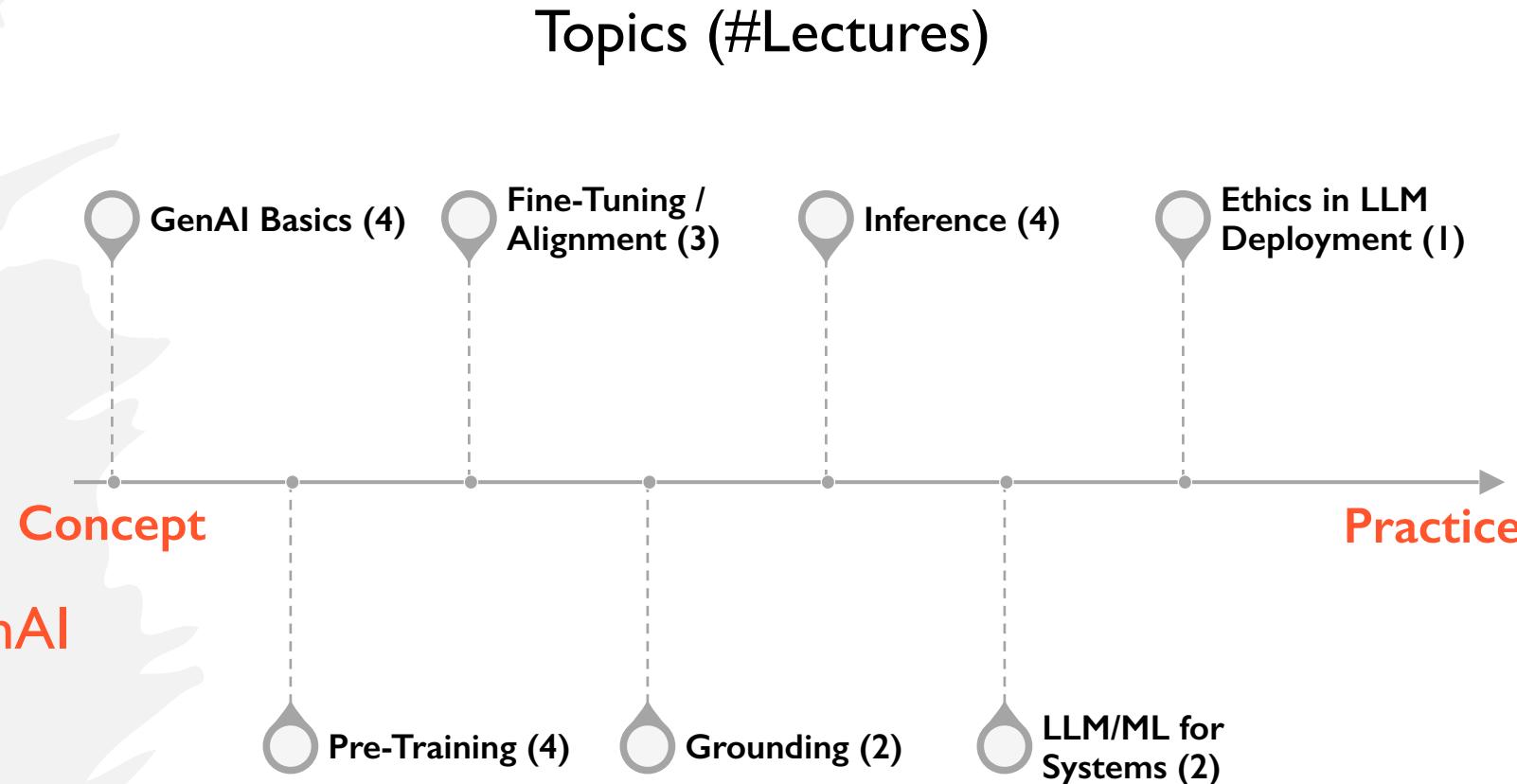


What will you learn in this course?

-- How to **Support Practical GenAI**

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Learning Outcomes

After completing this course you should be able to

- Articulate and critique latest GenAI Sys
- Be prepared to perform new research
- Communicate your research findings

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Learning Outcomes

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- Articulate and critique latest GenAI Sys
- Be prepared to perform new research
- Communicate your research findings

This is a **Research Seminar Course**.
The more **active** the better.

Agenda

- What will you learn in this course?
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- What will you do in this course?
 - Participation, presentation, research project, ...

Course Requirements (Tentative)

Participation	10%	Paper reading; Up to two absences
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ALL activities will be done in groups *except* for your own participation

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Paper Summary	15%	Two summaries
Paper Presentation & Discussion	15%	One Presentation

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Course Requirements (Tentative)

Participation	10%	Paper reading; Up to two absences
Paper Summary	15%	Two summaries
Paper Presentation & Discussion	15%	One Presentation
Project Presentations	20%	Mid-term + Final Poster
Project Report	40%	One Final Report

ALL activities will be done in groups *except* for your own participation

Form Groups ASAP

- Use [Piazza](#) to find potential group members
- Group size should be 3
 - May allow a few smaller groups if/when students drop out
- Submit at <https://forms.gle/cmoy5Hi9JLRmtcbq9>
 - By Sept 5th the latest, but **right now** is better

Participation

- **Reading: 39 papers/articles across**
 - Primarily from systems venues like SOSP, OSDI, NSDI, EuroSys, and MLSys
 - Some from traditional AI/ML venues but still with systems-y flavor

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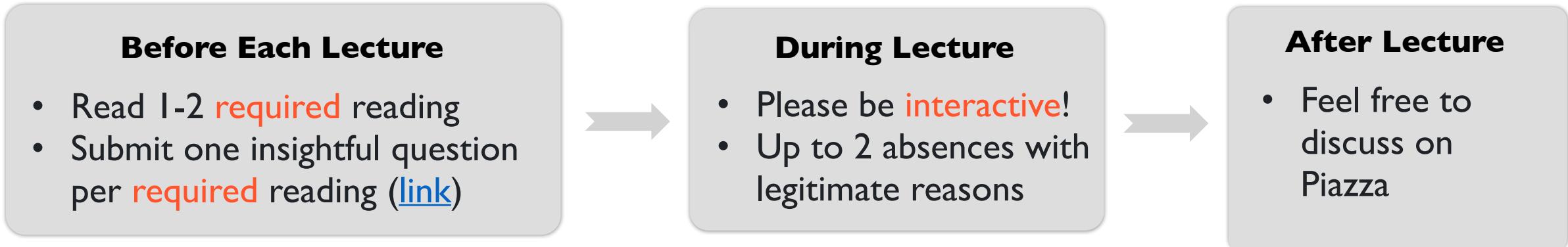
Before Each Lecture

- Read 1-2 **required** reading
- Submit one insightful question per **required** reading ([link](#))

Pre-Training	
Sept 18	The Llama 3 Herd of Models (Sec 1-4, Required) Gemini: A Family of Highly Capable Multimodal Models

Participation

- **Reading: 39 papers/articles across**
 - Primarily from systems venues like SOSP, OSDI, NSDI, EuroSys, and MLSys
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Paper Presentation

- **This is a seminar-style course**
 - Each group presents ~1 lectures covering required papers
 - Include a few slides to **skim through companion papers**
- **The entire class will be dedicated to the assigned paper(s)**
 - Aim for **40-min** presentation w/o interruption, but there will be **intermittent discussions**
 - No more than 55 minutes in total
- **Lead the discussion ([details](#))**
 - Go through the required paper in details, along with its strengths and weaknesses

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Share slides (in *.ppt format) to cs598-aisys-staff@lists.cs.illinois.edu **24 hrs before** the class

Paper Summaries

- ~2 summaries per-group, covering required and companion papers
- Each summary must follow the template and address the following
 - What is the problem and why is it important?
 - What is the hypothesis of the work?
 - What is the proposed solution, and what key insight guides their solution?
 - What is one (or more) drawback/limitation, and how will you improve it?
- Summary should include the gist of class discussion

Share summary (in *.pdf) to cs598-aisys-staff@lists.cs.illinois.edu within 24 hrs of presentation

Panel Discussion (right after presentation)

- **The Authors (assigned)**
 - ‘Companion’ group that **writes summary** and answer questions from ‘Reviewers’
- **The Reviewers (assigned)**
 - ‘Reviewer’ group that **writes summary** and poses challenging **research** questions
- **Rest of the Class & Presenters**
 - Ask questions directly too

Each group will be assigned to these slots at least once; 1 presentation & 2 summaries (only! 😊)

Summary of Your Role

Presenter Group

- Share slides **24 hrs** before class
- Maximum **55-minute** presentation
- Respond to questions on Piazza
- Share your final slides after class

Authors (Companion) Group

- Share summary within **24 hrs** after class presentation
- Respond to Reviewers' questions

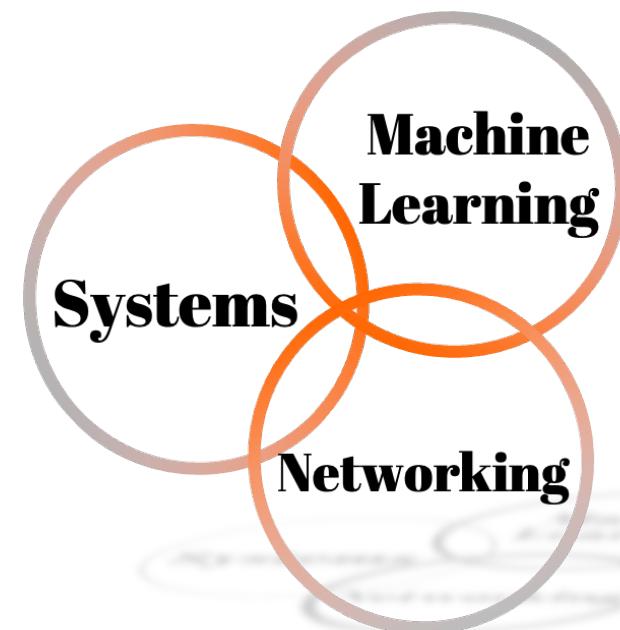
Reviewers Group

- Share summary within **24 hrs** after class presentation
- Pose challenging **research** questions

Audience Group

- Read **required** papers
- Submit one insightful question per required reading **before each lecture**

Systems for GenAI Projects



Research-Oriented Course!

- The final project accounts for **60%** of total grades
- What can and cannot be a project?
 - Just surveys are not allowed
 - Measurements of new environments or of existing solutions in new environments are acceptable
 - Proposing new research problems or addressing existing ones is **highly preferred!**

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- An ideal project should answer the questions you asked during paper reviews and points you cared about for presentations

How to Approach it?

1. Find a problem and motivate why this is worth solving
2. Quickly survey background and related work
 - Might require you to go back to the first step
3. Form/update your hypothesis
4. Test your hypothesis
 - Go back to 3 until you are happy
5. Present your findings on poster and in writing
 - Discuss known limitations

Draft Proposal (Sept 26)

- Two pages, plus as many pages as needed for references, **must** include
 - *Problem*: What is the problem?
 - *Motivation*: Why is it important?
 - *Solution overview*: Any initial thoughts?
 - *Evaluation plan*: How would you evaluate it?
- Submit as a group, including your group information (form a group ASAP)
- Approved by the instructor and agreed upon by you
 - Forms the basis of expectation

Mid-Semester Checkpoint (Oct 21, 23)

- **In-class short presentation over two days**
 - This is to make sure you are receiving feedback and making progress
- **Must include**
 - What is the problem?
 - Why is it important?
 - What are the most related work?
 - What's your hypothesis so far?
 - How are/will you evaluate it?

Poster & Paper (Dec 7, 19)

- **Poster session (Dec 7)**
- **Final report (7-8 pages excluding references):**
 - Extended from mid-term writeup
 - Should be written like the papers you've read
 - As if you'd submit it to a workshop with ~3 more months of work or to a conference after ~6 more months of work
 - [How to Write a Great Research Paper](#) by Simon Peyton Jones

Project Ideas

- **Some potential project ideas (will share more on Piazza soon)**
 - Multi-tier memory, including CXL and RDMA, for long-context LLMs
 - Energy-efficient GenAI serving on end-user devices
 - Systems support for reinforcement learning from human feedback
 - Making chatbots real by allowing them to cut in
 - Repurposing spatiotemporal redundancy in video generation
 - ...
- **Any of your crazy ideas!**

Any Questions?

Date	Milestone	Details
09/05/24	Form Group	Find 3 like-minded teammates
09/26/24	Submit Proposal	Send your proposal by email to receive feedback either via email or in-person or both
10/21/24 10/23/24	Mid-Semester Presentations	Define and motivate a problem, overview, related work, and form initial hypothesis/idea
12/04/24 12/07/24	In-Class or Poster Presentations	Present your research findings
12/19/24	Research paper	Submit a report like the papers you read

NO extensions! Delayed submission will receive NO CREDIT

Thank you!

Form Groups of 3; submit by *Sept 5*

Reviewers Group

- Write one paper summary
- Participate in panel discuss.

Authors (Companion) Group

- Write one paper summary
- Participate in panel discuss.