Seminar in Computer Architecture

Lecture 1a: Intro & Logistics

Prof. Onur Mutlu

ETH Zürich

Spring 2022

24 February 2022

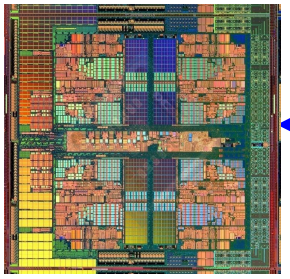
Brief Self Introduction

- Onur Mutlu
  - Full Professor @ ETH Zurich ITET (INFK), since Sept 2015
  - Strecker Professor @ Carnegie Mellon University ECE (CS), 2009-2016, 2016-…
  - Started the Comp Arch Research Group @ Microsoft Research, 2006-2009
  - Worked @ Google, VMware, Microsoft Research, Intel, AMD
  - PhD in Computer Engineering from University of Texas at Austin in 2006
  - BS in Computer Engineering & Psychology from University of Michigan in 2000
  - https://people.inf.ethz.ch/omutlu/ omutlu@gmail.com

- Research and Teaching in:
  - **Computer architecture, systems, hardware security, bioinformatics**
  - Memory and storage systems
  - Robust & dependable hardware systems: security, safety, predictability, reliability
  - Hardware/software cooperation
  - New computing paradigms; architectures with emerging technologies/devices
  - Architectures for bioinformatics, genomics, health, medicine, AI/ML
  - …

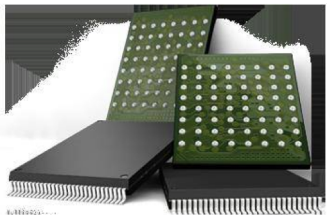
Current Research Mission

Computer architecture, HW/SW, systems, bioinformatics, security

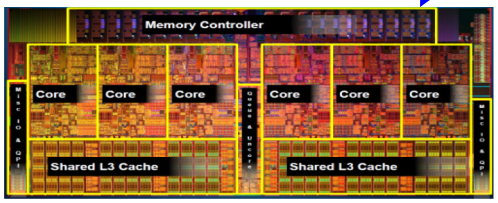


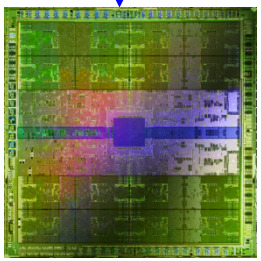
Heterogeneous Processors and Accelerators

Hybrid Main Memory



Persistent Memory/Storage





Graphics and Vision Processing

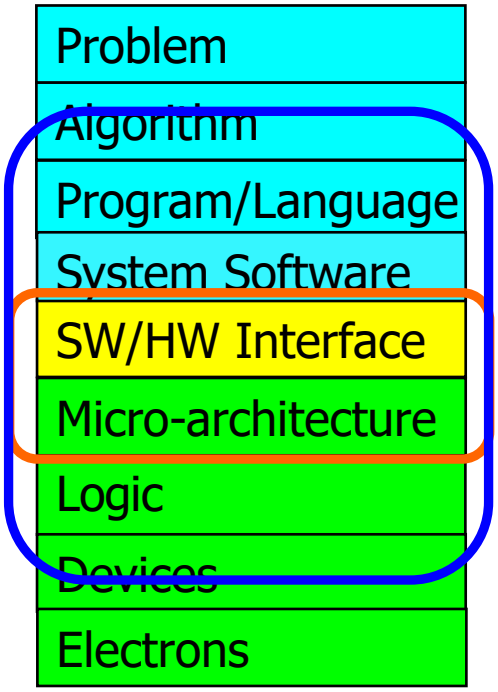
Build fundamentally better architectures

Four Key Current Directions

- Fundamentally Secure/Reliable/Safe Architectures
- Fundamentally Energy-Efficient Architectures
  - Memory-centric (Data-centric) Architectures
- Fundamentally Low-Latency and Predictable Architectures
- Architectures for AI/ML, Genomics, Medicine, Health

The Transformation Hierarchy

Computer Architecture (expanded view)



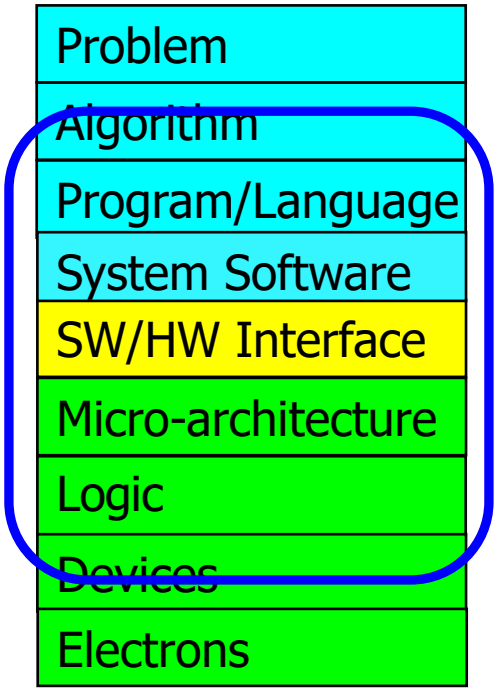
Computer Architecture (narrow view)

Axiom

To achieve the highest energy efficiency and performance:

we must take the expanded view

of Computer Architecture

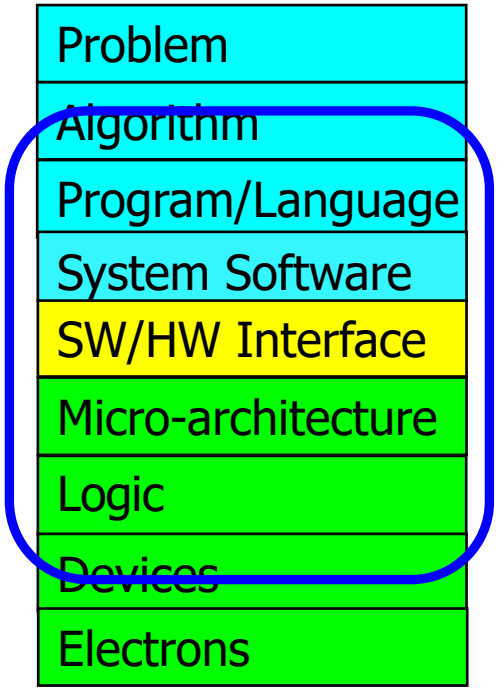


Co-design across the hierarchy: Algorithms to devices

Specialize as much as possible within the design goals

Current Research Mission & Major Topics

Build fundamentally better architectures



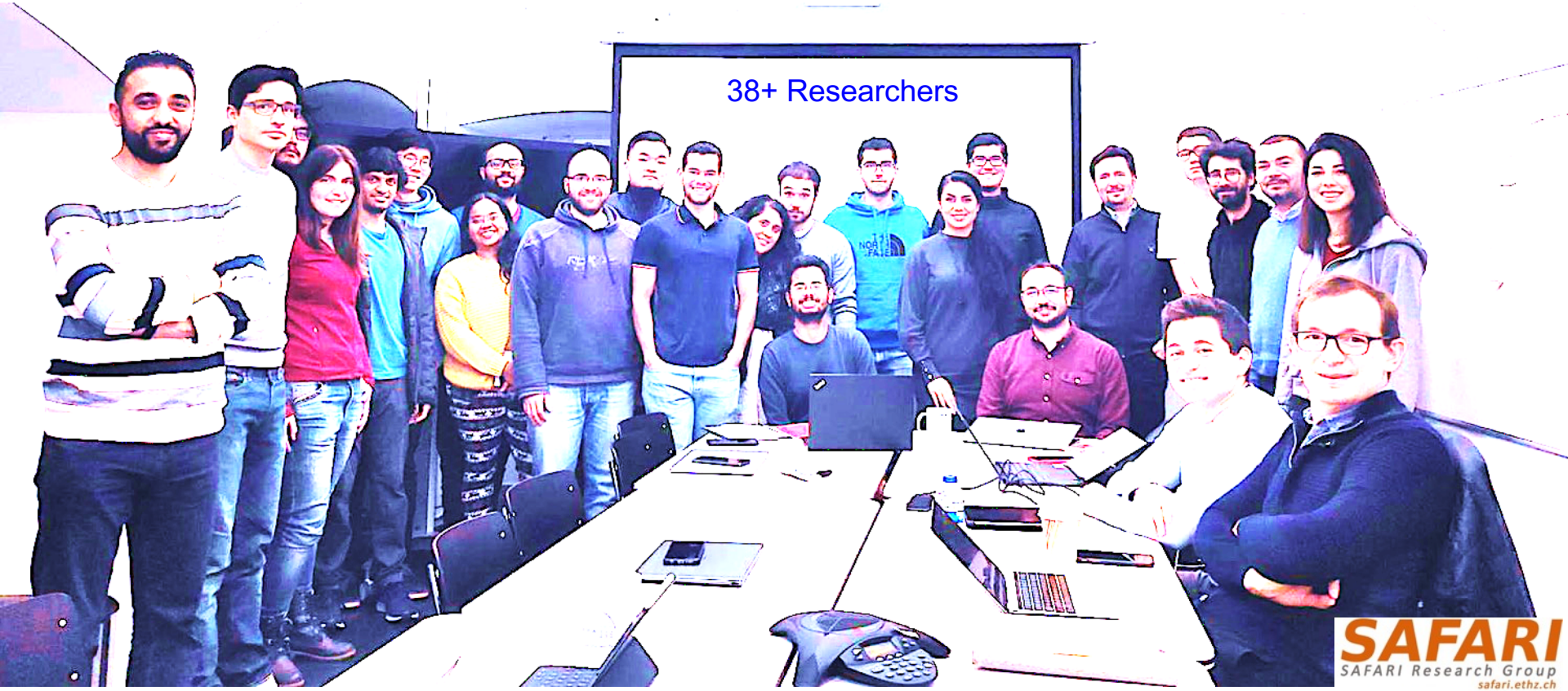
Broad research spanning apps, systems, logic with architecture at the center

- Data-centric arch. for low energy & high perf.
  - Proc. in Mem/DRAM, NVM, unified mem/storage
- Low-latency & predictable architectures
  - Low-latency, low-energy yet low-cost memory
  - QoS-aware and predictable memory systems
- Fundamentally secure/reliable/safe arch.
  - Tolerating all bit flips; patchable HW; secure mem
- Architectures for ML/AI/Genomics/Graph/Med
  - Algorithm/arch./logic co-design; full heterogeneity
- Data-driven and data-aware architectures
  - ML/AI-driven architectural controllers and design
  - Expressive memory and expressive systems

Onur Mutlu's SAFARI Research Group

Computer architecture, HW/SW, systems, bioinformatics, security, memory

https://safari.ethz.ch/safari-newsletter-january-2021/



Think BIG, Aim HIGH!

SAFARI

https://safari.ethz.ch

SAFARI Newsletter January 2021 Edition

- https://safari.ethz.ch/safari-newsletter-january-2021/

SAFARI
SAFARI Research Group

Newsletter
January 2021

Think Big, Aim High, and Have a Wonderful 2021!

Dear SAFARI friends,

Happy New Year! We are excited to share our group highlights with you in this second edition of the SAFARI newsletter (You can find the first edition from April 2020 **here**). 2020 has

SAFARI Newsletter December 2021 Edition

- https://safari.ethz.ch/safari-newsletter-december-2021/

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Think Big, Aim High

ETH zürich

View in your browser
December 2021

SAFARI PhD and Post-Doc Alumni

- https://safari.ethz.ch/safari-alumni/

- Minesh Patel (ETH Zurich), MICRO 2020 and DSN 2020 Best Paper Awards; ISCA Hall of Fame 2021
- Damla Senol Cali (Bionano Genomics), SRC TECHCON 2019 Best Student Presentation Award
- Nastaran Hajinazar (ETH Zurich)
- Gagandeep Singh (ETH Zurich), FPL 2020 Best Paper Award Finalist
- Amirali Boroumand (Stanford Univ → Google), SRC TECHCON 2018 Best Student Presentation Award
- Jeremie Kim (ETH Zurich), EDAA Outstanding Dissertation Award 2020; IEEE Micro Top Picks 2019; ISCA/MICRO HoF 2021
- Nandita Vijaykumar (Univ. of Toronto, Assistant Professor), ISCA Hall of Fame 2021
- Kevin Hsieh (Microsoft Research, Senior Researcher)
- Justin Meza (Facebook), HiPEAC 2015 Best Student Presentation Award; ICCD 2012 Best Paper Award
- Mohammed Alser (ETH Zurich), IEEE Turkey Best PhD Thesis Award 2018
- Yixin Luo (Google), HPCA 2015 Best Paper Session
- Kevin Chang (Facebook), SRC TECHCON 2016 Best Student Presentation Award
- Rachata Ausavarungnirun (KMUNTB, Assistant Professor), NOCS 2015 and NOCS 2012 Best Paper Award Finalist
- Gennady Pekhimenko (Univ. of Toronto, Assistant Professor), ISCA Hall of Fame 2021; ASPLOS 2015 SRC Winner
- Vivek Seshadri (Microsoft Research)
- Donghyuk Lee (NVIDIA Research, Senior Researcher), HPCA Hall of Fame 2018
- Yoongu Kim (Software Robotics → Google), TCAD'19 Top Pick Award; IEEE Micro Top Picks'10; HPCA'10 Best Paper Session
- Lavanya Subramanian (Intel Labs → Facebook)

- Samira Khan (Univ. of Virginia, Assistant Professor), HPCA 2014 Best Paper Session
- Saugata Ghose (Univ. of Illinois, Assistant Professor), DFRWS-EU 2017 Best Paper Award
- Jawad Haj-Yahya (Huawei Research Zurich, Principal Researcher)

SAFARI Research Group: Introduction and Research

- Onur Mutlu,
  "SAFARI Research Group: Introduction & Research"
  Invited Talk at the ETH Future Computing Laboratory
  Huawei Day, Virtual, 19 October 2021.
  [Slides (pptx) (pdf)]
  [Talk Video (15 minutes)]

Short Video on SAFARI Research Group

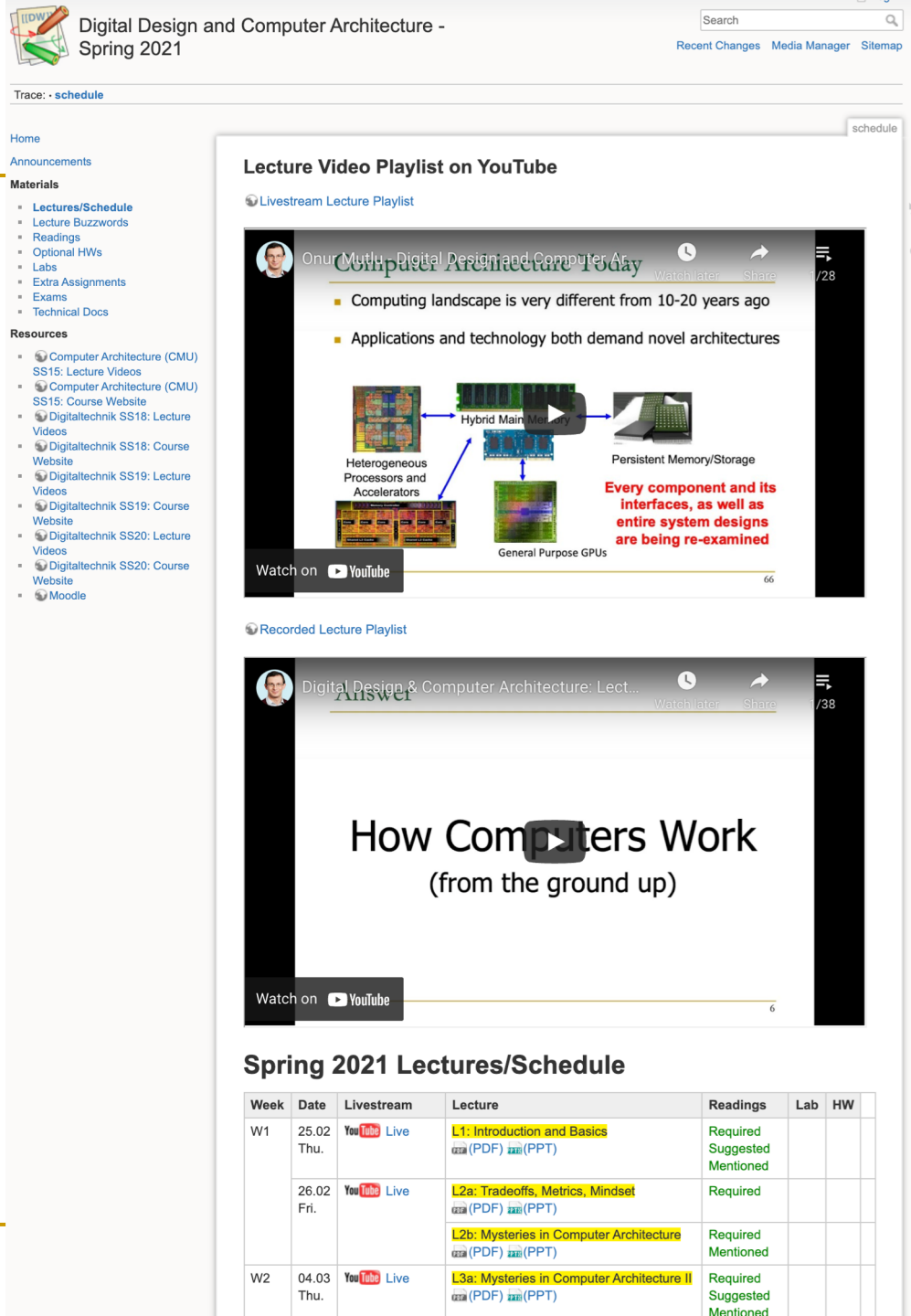
https://www.youtube.com/watch?v=mSr1QQmYuX0

Our Major Courses & Lectures

- **First Computer Architecture & Digital Design Course**
  - Digital Design and Computer Architecture
  - Spring 2021 Livestream Edition: https://www.youtube.com/watch?v=LbC0EZY8yw4&list=PL5Q2soXY2Zi_uej3aY39YB5pfW4SJ7LlN
- **Advanced Computer Architecture Course**
  - Computer Architecture
  - Fall 2021 Livestream Edition: https://www.youtube.com/watch?v=4yfkM_5EFgo&list=PL5Q2soXY2Zi-Mnk1PxjEIG32HAGILkTOF
- **Seminar in Computer Architecture**
  - https://www.youtube.com/watch?v=4TcP297mdsI&list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4

DDCA (Spring 2021)

- https://safari.ethz.ch/digitaltechnik/spring2021/doku.php?id=schedule
- https://www.youtube.com/watch?v=LbC0EZY8yw4&list=PL5Q2soXY2Zi_uej3aY39YB5pfW4SJ7LlN
- Bachelor's course
  - 2nd semester at ETH Zurich
  - Rigorous introduction into "How Computers Work"
  - Digital Design/Logic
  - Computer Architecture
  - 10 FPGA Lab Assignments

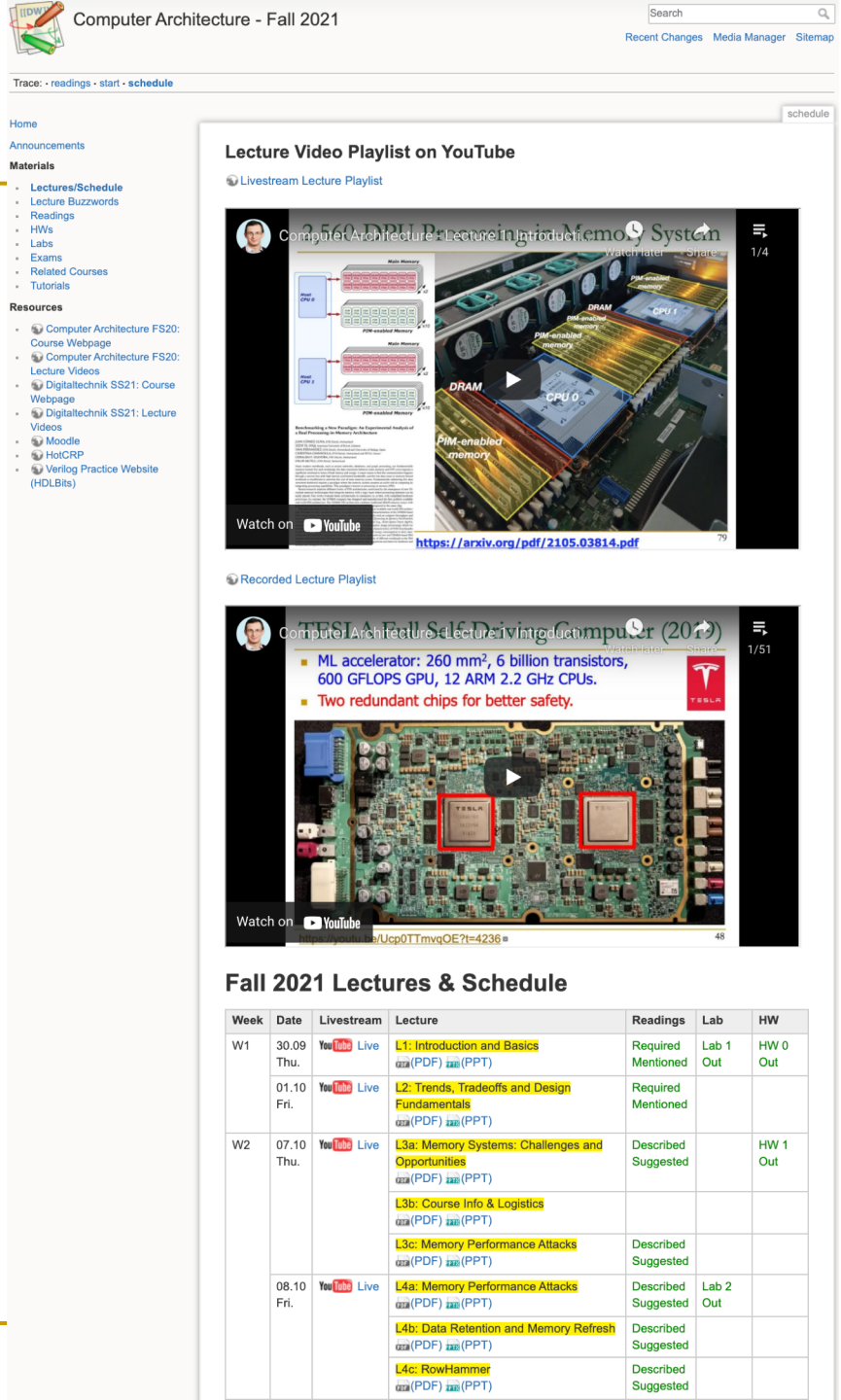


Comp Arch (Fall 2021)

- https://safari.ethz.ch/architecture/fall2021/doku.php?id=schedule

- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=4yfkM_5EFgo&list=PL5Q2soXY2Zi-Mnk1PxjEIG32HAGILkTOF

- Master's level course
  - Taken by Bachelor's/Masters/PhD students
  - Cutting-edge research topics + fundamentals in Computer Architecture
  - 5 Simulator-based Lab Assignments
  - Potential research exploration
  - Many research readings

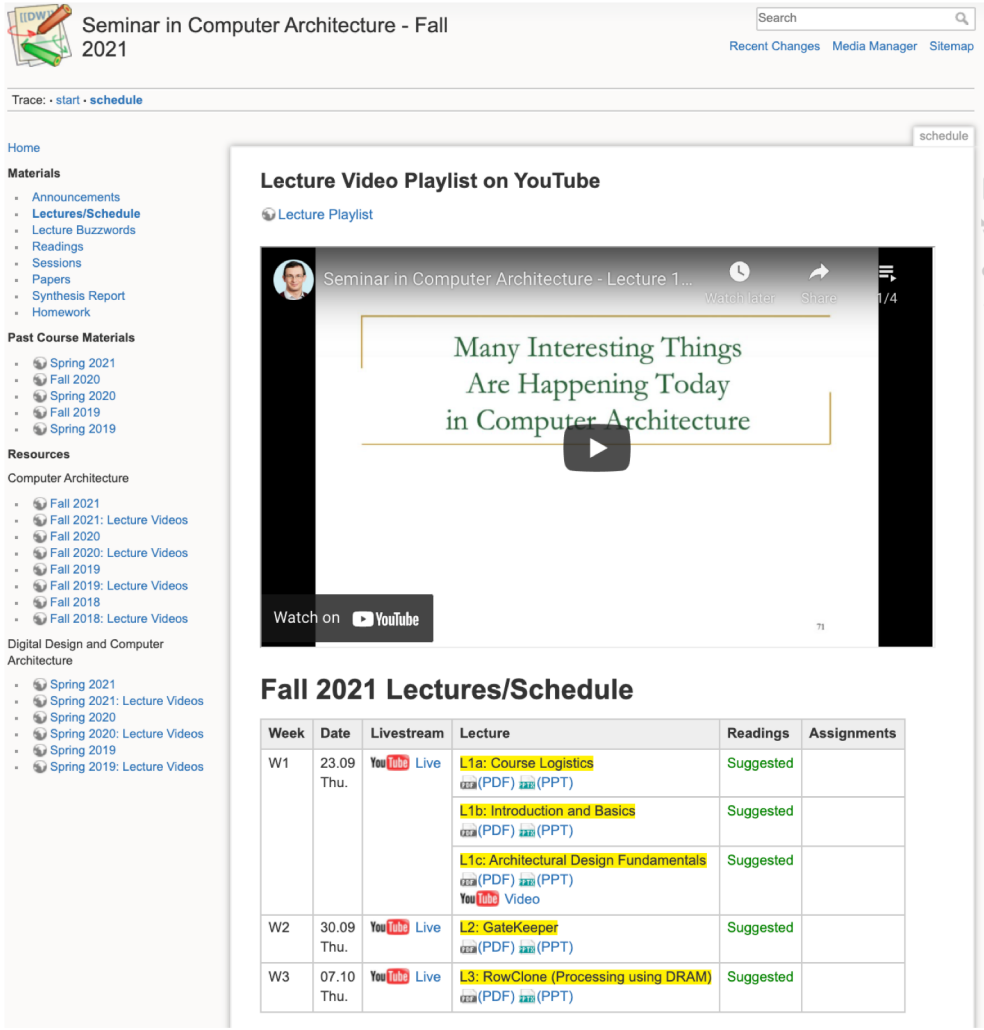


Seminar in Comp Arch (Fall 2021)

- https://safari.ethz.ch/architecture_seminar/fall2021/doku.php?id=schedule

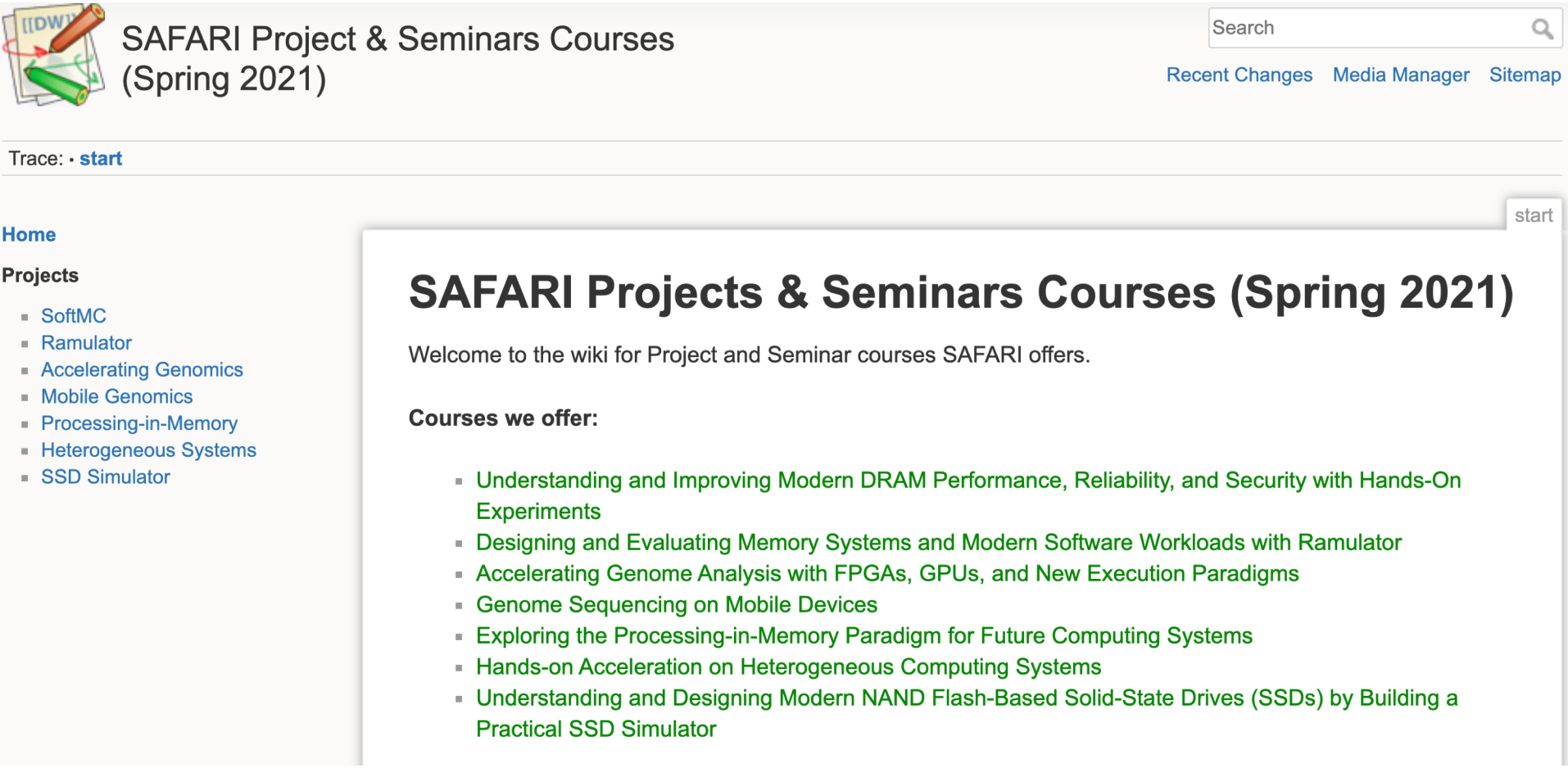
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=4TcP297mdsI&list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4

- Critical analysis course
  - Taken by Bachelor's/Masters/PhD students
  - Cutting-edge research topics + fundamentals in Computer Architecture
  - 20+ research papers, presentations, analyses



Hands-On Project Courses

- https://safari.ethz.ch/projects_and_seminars/doku.php

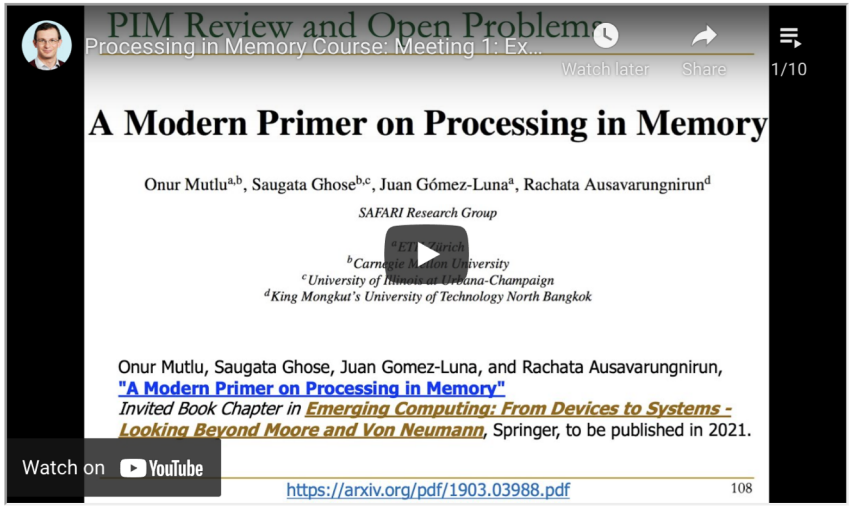


PIM Course (Fall 2021)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=processing_in_memory
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=9e4Chnwdovo&list=PL5Q2soXY2Zi-841fUYYUK9EsXKhQKRPyX
- Project course
  - Taken by Bachelor's/Master's students
  - Processing-in-Memory lectures
  - Hands-on research exploration
  - Many research readings

Lecture Video Playlist on YouTube

Lecture Playlist

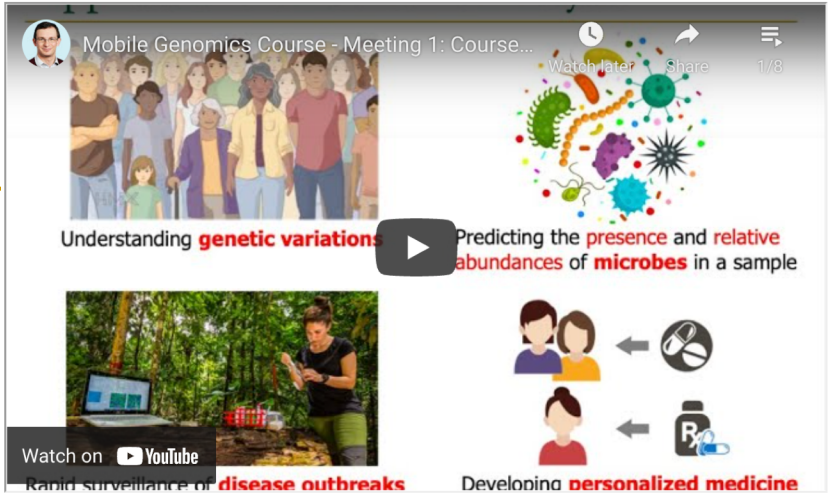


Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	05.10 Tue.	YouTube Live	M1: P&S PIM Course Presentation (PDF) (PPT)	Required Materials Recommended Materials	HW 0 Out
W2	12.10 Tue.	YouTube Live	M2: Real-World PIM Architectures (PDF) (PPT)		
W3	19.10 Tue.	YouTube Live	M3: Real-World PIM Architectures II (PDF) (PPT)		
W4	26.10 Tue.	YouTube Live	M4: Real-World PIM Architectures III (PDF) (PPT)		
W5	02.11 Tue.	YouTube Live	M5: Real-World PIM Architectures IV (PDF) (PPT)		
W6	09.11 Tue.	YouTube Live	M6: End-to-End Framework for Processing-using-Memory (PDF) (PPT)		
W7	16.11 Tue.	YouTube Live	M7: How to Evaluate Data Movement Bottlenecks (PDF) (PPT)		
W8	23.11 Tue.	YouTube Live	M8: Programming PIM Architectures (PDF) (PPT)		
W9	30.11 Tue.	YouTube Live	M9: Benchmarking and Workload Suitability on PIM (PDF) (PPT)		
W10	07.12 Tue.	YouTube Live	M10: Bit-Serial SIMD Processing using DRAM (PDF) (PPT)		

Genomics (Fall 2021)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=bioinformatics
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=MnogTeMjY8k&list=PL5Q2soXY2Zi8sngH-TrNZnDhDkPq55J9J
- Project course
  - Taken by Bachelor's/Master's students
  - Genomics lectures
  - Hands-on research exploration
  - Many research readings

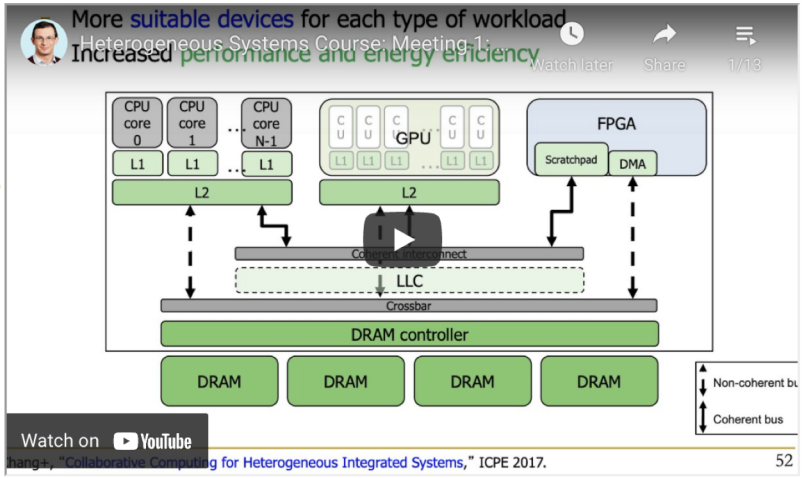


Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	5.10 Tue.	YouTube Live	M1: P&S Accelerating Genomics Course Introduction & Project Proposals (PDF) (PPT) YouTube Video	Required Materials Recommended Materials	
W2	20.10 Wed.	YouTube Live	M2: Introduction to Sequencing (PDF) (PPT)		
W3	27.10 Wed.	YouTube Live	M3: Read Mapping (PDF) (PPT)		
W4	3.11 Wed.	YouTube Live	M4: GateKeeper (PDF) (PPT)		
W5	10.11 Wed.	YouTube Live	M5: MAGNET & Shouji (PDF) (PPT)		
W6	17.11 Wed.		M6.1: SneakySnake (PDF) (PPT) Video		
			M6.2: GRIM-Filter (PDF) (PPT) YouTube Video		
W7	24.11 Wed.		M7: GenASM (PDF) (PPT) YouTube Video		
W8	01.12 Wed.	YouTube Live	M8: Genome Assembly (PDF) (PPT)		
W9	13.12 Mon.	YouTube Live	M9: GRIM-Filter (PDF) (PPT)		
W10	15.12 Wed.	YouTube Live	M10: Genomic Data Sharing Under Differential Privacy (PDF) (PPT)		

Hetero. Systems (Fall'21)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=heterogeneous_systems
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=QY_bjwzsfMM&list=PL5Q2soXY2Zi_OwkTgEyA6tk3UsoPBH737
- Project course
  - Taken by Bachelor's/Master's students
  - GPU and Parallelism lectures
  - Hands-on research exploration
  - Many research readings



Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	07.10 Thu.	Live	M1: P&S Course Presentation (PDF) (PPT)	Required Materials Recommended Materials	HW 0 Out
W2	14.10 Thu.	Live	M2: SIMD Processing and GPUs (PDF) (PPT)		
W3	21.10 Thu.	Live	M3: GPU Software Hierarchy (PDF) (PPT)		
W4	28.10 Thu.	Live	M4: GPU Memory Hierarchy (PDF) (PPT)		
W5	04.11 Thu.	Live	M5: GPU Performance Considerations (PDF) (PPT)		
W6	11.11 Thu.	Live	M6: Parallel Patterns: Reduction (PDF) (PPT)		
W7	18.11 Thu.	Live	M7: Parallel Patterns: Histogram (PDF) (PPT)		
W8	25.11 Thu.	Live	M8: Parallel Patterns: Convolution (PDF) (PPT)		
W9	02.12 Thu.	Live	M9: Parallel Patterns: Prefix Sum (Scan) (PDF) (PPT)		
W10	09.12 Thu.	Live	M10: Parallel Patterns: Sparse Matrices (PDF) (PPT)		
W11	16.12 Thu.	Live	M11: Parallel Patterns: Graph Search (PDF) (PPT)		
W12	22.12 Thu.	Live	M12: Dynamic Parallelism (PDF) (PPT)		
W13	06.01 Thu.	Live	M13: Collaborative Computing (PDF) (PPT)		

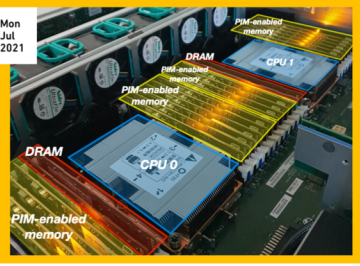
SAFARI Live Seminars (I)

SAFARI Live Seminars in Computer Architecture

Dr. Juan Gómez Luna, ETH Zurich

Understanding a Modern Processing-in-Memory Architecture: Benchmarking and Experimental Characterization

12 Mon Jul 2021

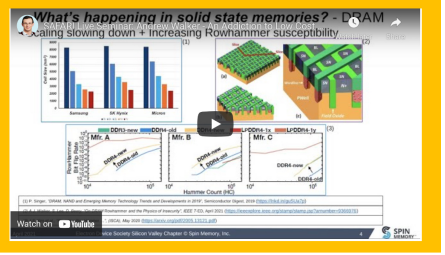


SAFARI Live Seminars in Computer Architecture

Dr. Andrew Walker, Schiltron Corporation & Nexgen Power Systems

An Addiction to Low Cost Per Memory Bit – How to Recognize it and What to Do About it

19 Mo Jul 2021

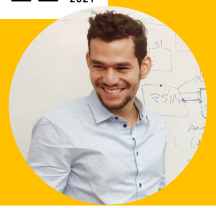


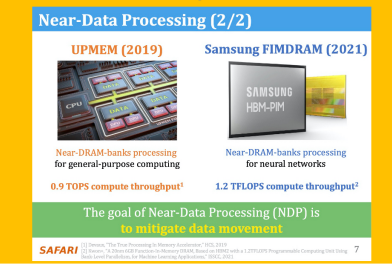
SAFARI Live Seminars in Computer Architecture

Geraldo F. Oliveira, ETH Zurich

DAMOV: A New Methodology and Benchmark Suite for Evaluating Data Movement Bottlenecks

22 Do Jul 2021



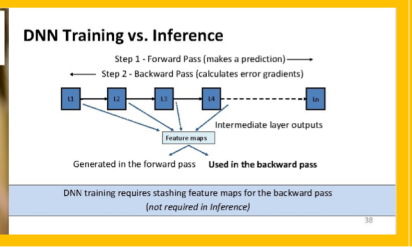


SAFARI Live Seminars in Computer Architecture

Gennady Pekhimenko, University of Toronto

Efficient DNN Training at Scale: from Algorithms to Hardware

5 Do Aug 2021

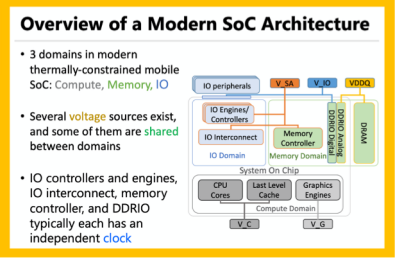


SAFARI Live Seminars in Computer Architecture

Jawad Haj-Yahya, Huawei Research Center Zurich

Power Management Mechanisms in Modern Microprocessors and Their Security Implications

16 Mo Aug 2021

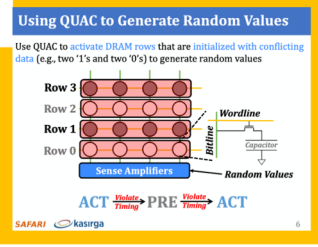


SAFARI Live Seminars in Computer Architecture

Ataberk Olgun, TOBB & ETH Zurich

QUAC-TRNG: High-Throughput True Random Number Generation Using Quadruple Row Activation in Commodity DRAM Chips

15 Mi Sep 2021

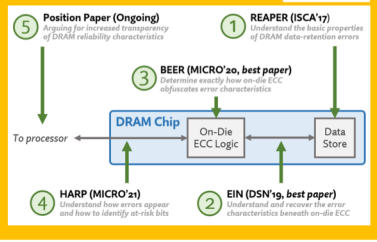


SAFARI Live Seminars in Computer Architecture

Minesh Patel, ETH Zurich

Enabling Effective Error Mitigation in Memory Chips That Use On-Die ECCs

21 Tues Sep 2021

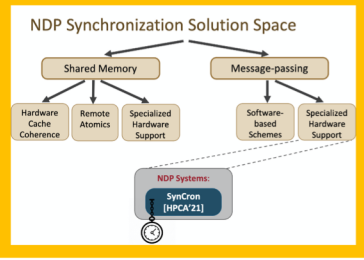


SAFARI Live Seminars in Computer Architecture

Christina Giannoula, National Technical University of Athens

Efficient Synchronization Support for Near-Data-Processing Architectures

27 Mo Sep 2021

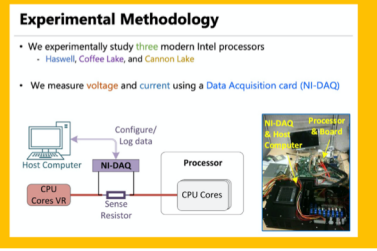


SAFARI Live Seminars in Computer Architecture

Jawad Haj-Yahya, Huawei Research Center Zurich

Security Implications of Power Management Mechanisms In Modern Processors, Current Studies and Future Trends

4 Mo Okt 2021



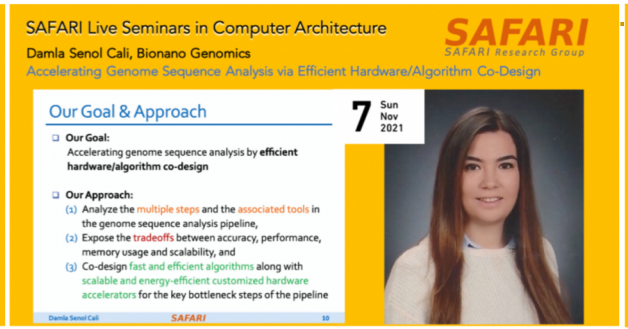
SAFARI

https://safari.ethz.ch/safari-seminar-series/

SAFARI Live Seminars (II)

SAFARI Live Seminar: Nastaran Hajinazar 27 Oct 2021

Posted on October 1, 2021 by ewent



SAFARI Live Seminar: Damla Senol Cali 07 Nov 2021

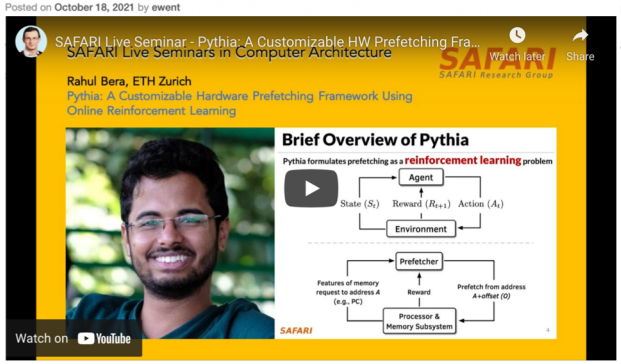
Posted on October 18, 2021 by ewent

SAFARI Live Seminar: Gennady Pekhimenko 08 Nov 2021

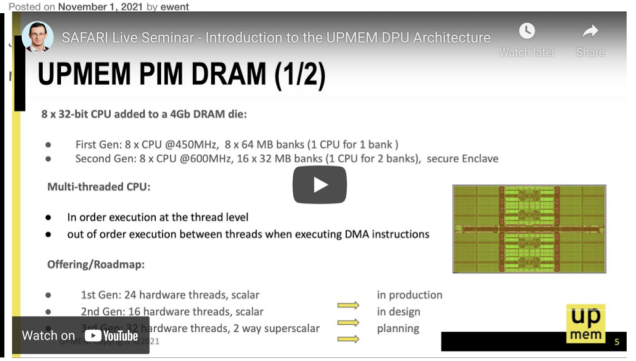
Posted on November 1, 2021 by ewent

SAFARI Live Seminar: Serghei Mangul 11 Nov 2021

Posted on November 5, 2021 by ewent



SAFARI Live Seminar: Rahul Bera 20 Dec 2021

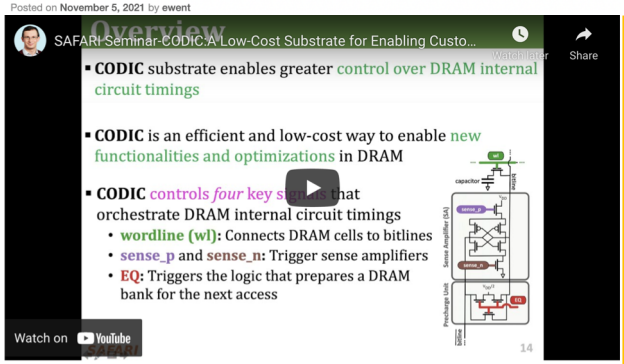


SAFARI Live Seminar: Fabrice Devaux, 2 Feb 2022

Posted on January 15, 2022 by ewent

Join us for our joint SAFARI Live Seminar & EFCL Seminar with Fabrice Devaux, UPMEM

Wednesday, February 2 2022 at 11:00 am Zurich time (CET)



SAFARI Live Seminar: Lois Orosa, 10 Feb 2022

Posted on January 16, 2022 by ewent

Join us for our next SAFARI Live Seminar with Lois Orosa.

Thursday, February 10 at 5:00 pm Zurich time (CET)

Posted on January 19, 2022 by ewent

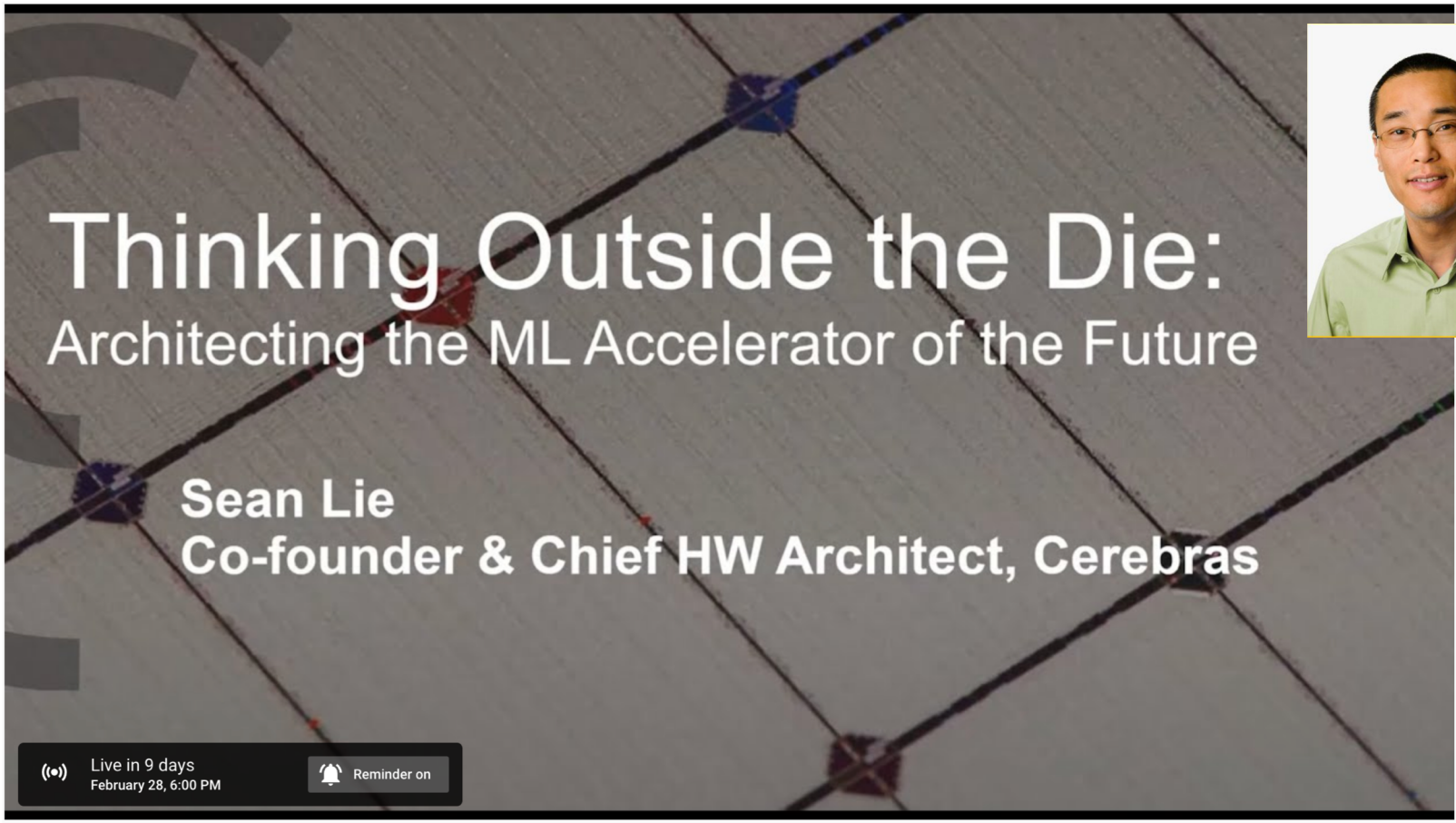
Join us for our SAFARI Live Seminar with Sean Lie, Cerebras Systems

Monday, February 28 2022 at 6:00 pm Zurich time (CET)

https://www.youtube.com/watch?v=D8Hjy2iU9l4&list=PL5Q2soXY2Zi_tOTAYm--dYByNPL7JhwR9&index=1

Upcoming SAFARI Live Seminar (Feb 28)

https://www.youtube.com/watch?v=x2-qB0J7KHw



Some Basic Principles We Follow

Principle: Teaching and Research

...

Teaching drives Research

Research drives Teaching

...

Principle: Insight and Ideas

Focus on Insight

Encourage New Ideas

Principle: Learning and Scholarship

Focus on

learning and scholarship

Principle: Environment of Freedom

Create an environment that values free & critical exploration, openness, collaboration, hard work, creativity

Principle: Learning and Scholarship

The quality of your work defines your impact

Principle: Good Mindset, Goals & Focus

You can make a
good impact
on the world

Suggestion: Principle: Passion

Follow Your Passion

(Do not get derailed by naysayers)

Principle: Build Infrastructure

Build Infrastructure to Enable Your Passion

Principle: Work Hard

Work Hard to
Enable Your Passion

Suggestion: Principle: Resilience & Focus

Be Resilient & Focused

Make It Happen

Principle: Good Mindset, Goals & Focus

You can make a
good impact
on the world

Research & Teaching: Some Overview Talks

https://www.youtube.com/onurmutlulectures

- Future Computing Architectures
  - https://www.youtube.com/watch?v=kgiZlSOcGFM&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=1
- Enabling In-Memory Computation
  - https://www.youtube.com/watch?v=njX_14584Jw&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=16
- Accelerating Genome Analysis
  - https://www.youtube.com/watch?v=r7sn41lH-4A&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=41
- Rethinking Memory System Design
  - https://www.youtube.com/watch?v=F7xZLNMIY1E&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=3
- Intelligent Architectures for Intelligent Machines
  - https://www.youtube.com/watch?v=c6_LgzuNdkw&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=25
- The Story of RowHammer
  - https://www.youtube.com/watch?v=sgd7PHQQ1AI&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=39

An Interview on Research and Education

- **Computing Research and Education** (@ ISCA 2019)
  - https://www.youtube.com/watch?v=8ffSEKZhmvo&list=PL5Q2soXY2Zi_4oP9LdL3cc8G6NIjD2Ydz

- **Maurice Wilkes Award Speech** (10 minutes)
  - https://www.youtube.com/watch?v=tcQ3zZ3JpuA&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=15

More Thoughts and Suggestions

- Onur Mutlu,
  "Some Reflections (on DRAM)"
  *Award Speech for ACM SIGARCH Maurice Wilkes Award, at the **ISCA** Awards Ceremony*, Phoenix, AZ, USA, 25 June 2019.
  [Slides (pptx) (pdf)]
  [Video of Award Acceptance Speech (Youtube; 10 minutes) (Youku; 13 minutes)]
  [Video of Interview after Award Acceptance (Youtube; 1 hour 6 minutes) (Youku; 1 hour 6 minutes)]
  [News Article on "ACM SIGARCH Maurice Wilkes Award goes to Prof. Onur Mutlu"]

- Onur Mutlu,
  "How to Build an Impactful Research Group"
  *57th Design Automation Conference Early Career Workshop (**DAC**)*, Virtual, 19 July 2020.
  [Slides (pptx) (pdf)]

More Thoughts and Suggestions (II)

- Onur Mutlu,
  "Computer Architecture: Why Is It So Important and Exciting Today?"
  Invited Lecture at *Izmir Institute of Technology (**IYTE**)* , Virtual, 16 October 2020.
  [Slides (pptx) (pdf)]
  [Talk Video (2 hours 12 minutes)]

- Onur Mutlu,
  "Applying to Graduate School & Doing Impactful Research"
  *Invited Panel Talk at the 3rd Undergraduate Mentoring Workshop, held with the 48th International Symposium on Computer Architecture (**ISCA**)*, Virtual, 18 June 2021.
  [Slides (pptx) (pdf)]
  [Talk Video (50 minutes)]

A Talk on Impactful Growth

Arch. Mentoring Workshop @ISCA'21 - Applying to Grad School & Doing Impactful Research - Onur Mutlu

1,563 views • Premiered Jun 16, 2021

74 1 SHARE SAVE ...

Onur Mutlu Lectures
17.2K subscribers

ANALYTICS EDIT VIDEO

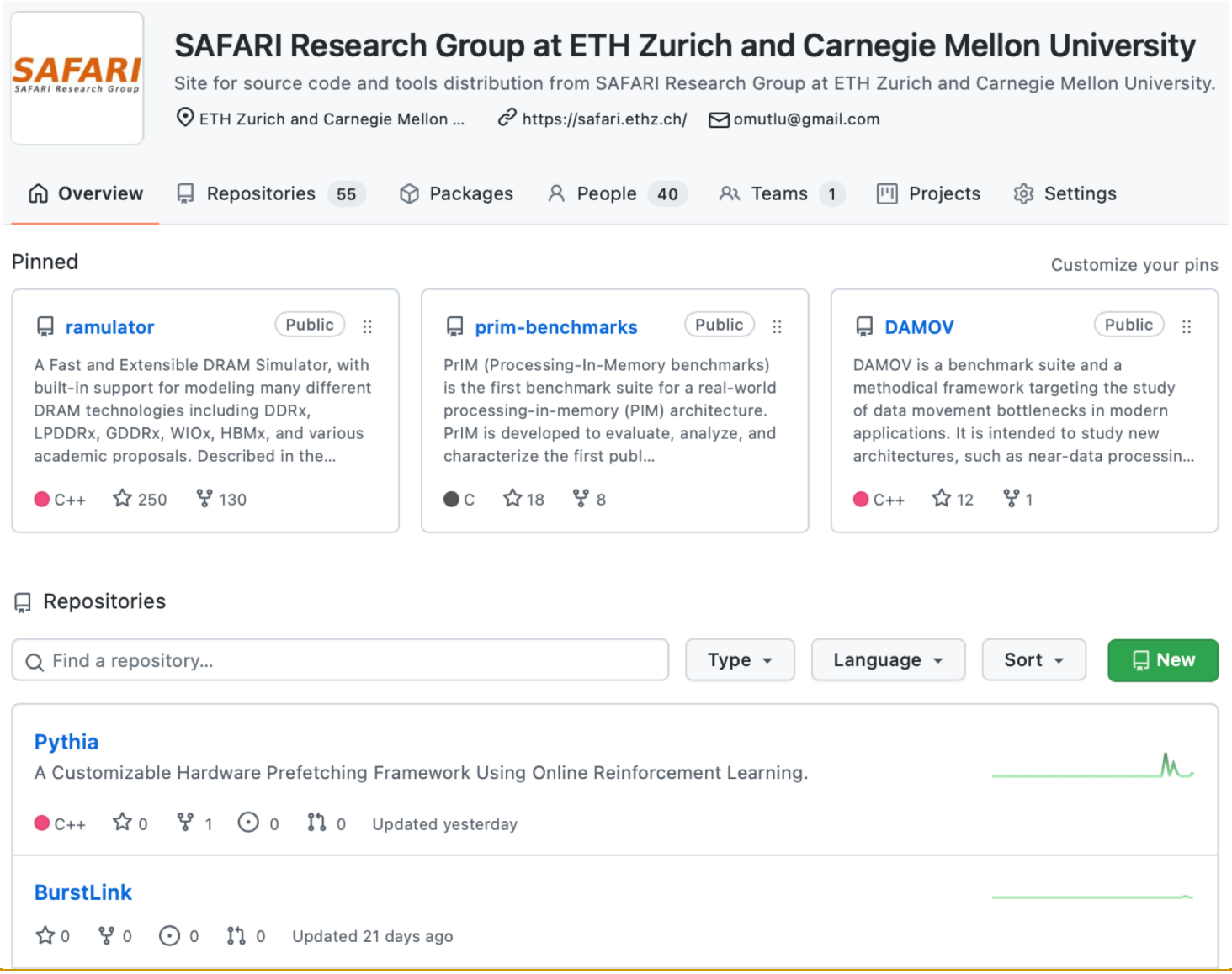
Panel talk at Undergraduate Architecture Mentoring Workshop at ISCA 2021
(https://sites.google.com/wisc.edu/uar...)

https://www.youtube.com/watch?v=83tlorht7Mc&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=54

An Interview on Computing Futures

https://www.youtube.com/watch?v=8ffSEKZhmvo

Open Source Artifacts: SAFARI GitHub



https://github.com/CMU-SAFARI/

Papers, Courses, Talks, Videos, Artifacts

- All are available at

  https://people.inf.ethz.ch/omutlu/projects.htm

  https://www.youtube.com/onurmutlulectures

  https://github.com/CMU-SAFARI/

Suggested Reading on Mindset & More

Richard Hamming

``You and Your Research''

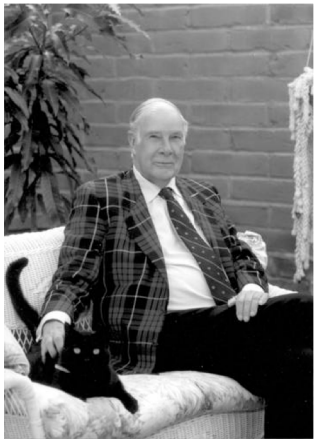
Transcription of the
Bell Communications Research Colloquium Seminar
7 March 1986

https://safari.ethz.ch/architecture/fall2021/lib/exe/fetch.php?media=youandyourresearch.pdf

Required Reading on Mindset & More

If you really want to be a first-class scientist you need to know yourself, your weaknesses, your strengths, and your bad faults, like my egotism. How can you convert a fault to an asset? How can you convert a situation where you haven't got enough manpower to move into a direction when that's exactly what you need to do? I say again that I have seen, as I studied the history, the successful scientist changed the viewpoint and what was a defect became an asset.

In summary, I claim that some of the reasons why so many people who have greatness within their grasp don't succeed are: they don't work on important problems, they don't become emotionally involved, they don't try and change what is difficult to some other situation which is easily done but is still important, and they keep giving themselves alibis why they don't. They keep saying that it is a matter of luck. I've told you how easy it is; furthermore I've told you how to reform. Therefore, go forth and become great scientists!



https://safari.ethz.ch/architecture/fall2021/lib/exe/fetch.php?media=youandyourresearch.pdf

The Role of This Course

Computer Architecture

- is the science and art of designing computing platforms (hardware, interface, system SW, and programming model)

- to achieve a set of design goals
  - E.g., highest performance on earth on workloads X, Y, Z
  - E.g., longest battery life at a form factor that fits in your pocket with cost < $$$ CHF
  - E.g., best average performance across all known workloads at the best performance/cost ratio
  - …

  - Designing a supercomputer is different from designing a smartphone → But, many fundamental principles are similar

Seminar in Computer Architecture

- We will cover **fundamental** and **cutting-edge** research papers in computer architecture

- Multiple components that are aimed at improving students'
  - technical skills in computer architecture
  - critical thinking and analysis
  - technical presentation of concepts and papers
    - in both spoken and written forms
  - familiarity with key research directions

Key Goal

(Learn how to)

rigorously

analyze, present, discuss

papers and ideas

in computer architecture

Steps to Achieve the Key Goal

- Steps for the Presenter
  - Read
  - Absorb, read more (other related works)
  - Critically analyze; think; synthesize
  - Prepare a clear and rigorous talk
  - Present
  - Answer questions
  - Analyze and synthesize (in meeting, after, and at course end)

- Steps for the Participants
  - Discuss
  - Ask questions
  - Analyze and synthesize (in meeting, after, and at course end)

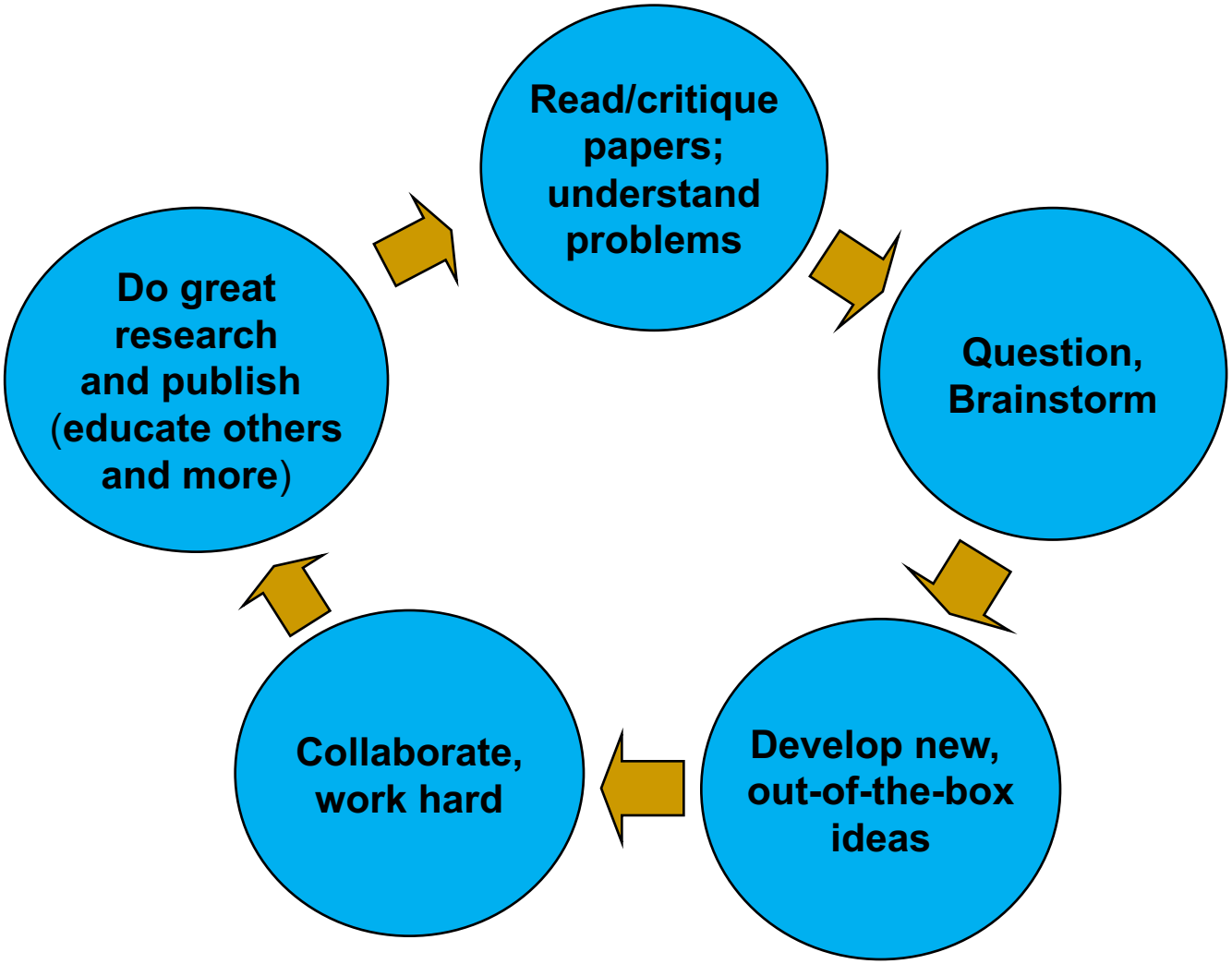
Topics of Papers and Discussion

- hardware security;
- architectural acceleration mechanisms for key applications like machine learning, graph processing, and bioinformatics;
- memory systems;
- interconnects;
- processing inside memory;
- various fundamental and emerging ideas/paradigms in computer architecture;
- hardware/software co-design and cooperation;
- fault tolerance;
- energy efficiency;
- heterogeneous and parallel systems;
- new execution models, etc.

Recap: Some Goals of This Course

- Teach/enable/empower you to:
  - Think critically
  - Think broadly
  - Learn how to understand, analyze, and present papers and ideas
  - Get familiar with key first steps in research
  - Get familiar with key research directions

The Virtuous Cycle of Scientific Progress



Course Info and Logistics

Course Info: Who Are We?

- Onur Mutlu
  - Full Professor @ ETH Zurich ITET (INFK), since Sept 2015
  - Strecker Professor @ Carnegie Mellon University ECE (CS), 2009-2016, 2016-…
  - Started the Comp Arch Research Group @ Microsoft Research, 2006-2009
  - Worked @ Google, VMware, Microsoft Research, Intel, AMD
  - PhD in Computer Engineering from University of Texas at Austin in 2006
  - BS in Computer Engineering & Psychology from University of Michigan in 2000
  - https://people.inf.ethz.ch/omutlu/ omutlu@gmail.com

- Research and Teaching in:
  - **Computer architecture, systems, hardware security, bioinformatics**
  - Memory and storage systems
  - Robust & dependable hardware systems: security, safety, predictability, reliability
  - Hardware/software cooperation
  - New computing paradigms; architectures with emerging technologies/devices
  - Architectures for bioinformatics, genomics, health, medicine, AI/ML
  - …

Lecturers

Mohammed Alser

Senior Researcher and Lecturer

Bioinformatics | Computational Genomics | Hardware/Software Cooperation | Specialized/Heterogeneous Computing Systems | Processing-in-Memory

@mealser

Juan Gómez Luna

Senior Researcher and Lecturer

Processing-In-Memory | Heterogeneous computing | Memory Systems | Bioinformatics | Medical imaging

Course Info: Who Are We?

- **Teaching Assistants**
  - Dr. Mohammad Sadr,
  - Dr. Jisung Park,
  - Dr. Gagandeep Singh,
  - Hasan Hassan,
  - Abdullah Giray Yaglikci,
  - Can Firtina,
  - Geraldo Francisco De Oliveira Junior,
  - Rahul Bera,
  - Konstantinos Kanellopoulos,
  - Nika Mansouri Ghiasi,
  - Rakesh Nadig
  - Ataberk Olgun
  - Joel Lindegger
  - Haocong Luo,
  - João Dinis Ferreira,
  - Roberto Starc

- Get to know them and their research as they will be your mentors
  https://safari.ethz.ch/group-members/

Course Requirements and Expectations

- Attendance required for all meetings
- Each student presents one paper
  - Prepare for presentation with engagement from the mentor
  - Full presentation + questions + discussion
- Non-presenters participate during the meeting
  - Ask questions, contribute thoughts/ideas
  - Better if you read/skim the paper beforehand
- Non-presenters take an online short quiz after each session
  - 5 MCQs for each presentation (1 Full day to submit)
- Everyone comments on papers in the online review system
  - After presentation
- Write synthesis report at the end of semester
  - (sample synthesis report online)

Course Website

- https://safari.ethz.ch/architecture_seminar/spring2022
- All course materials to be posted
- Plus other useful information for the course
- Check frequently for announcements and due dates

Moodle

- https://moodle-app2.let.ethz.ch/course/view.php?id=16853

- Check frequently for:
  - Announcements and due dates
  - Quizzes
  - Paper discussion
  - Assignment submissions

Homework 0

- Due March 3
  - https://safari.ethz.ch/architecture_seminar/spring2022
- Information about yourself
- All future grading is predicated on homework 0
- If it is not submitted on time, we cannot schedule you for a presentation.

Paper Review Preferences

- Due TBD
- Check the website and Moodle for instructions
- If it is not submitted on time, we cannot schedule you for a presentation.

How to Deliver a Good Talk

Anatomy of a Good Paper Review (Talk)

- 0: Title, Authors, Venue
- 1: Summary
  - What is the problem the paper is trying to solve?
  - What are the key ideas of the paper? Key insights?
  - What are the key mechanisms? What is the implementation?
  - What are the key results? Key conclusions?
- 2: Strengths (most important ones)
  - Does the paper solve the problem well? Is it well written? …
- 3: Weaknesses (most important ones)
  - This is where you should think critically. Every paper/idea has a weakness. This does not mean the paper is necessarily bad. It means there is room for improvement and future research can accomplish this.
- 4: Thoughts/Ideas: Can you do better? Present your ideas.
- 5: Takeaways: What you learned/enjoyed/disliked? Why?
- 6: Discussion starters and questions.
- Review should be short and concise (20 minutes or < one page)

Suggested Paper Discussion Format

- Problem & Goal
- Key Ideas/solution
- Novelty
- Mechanisms & Implementation
- Major Results
- Takeaways/Conclusions

~20-25 minute Summary

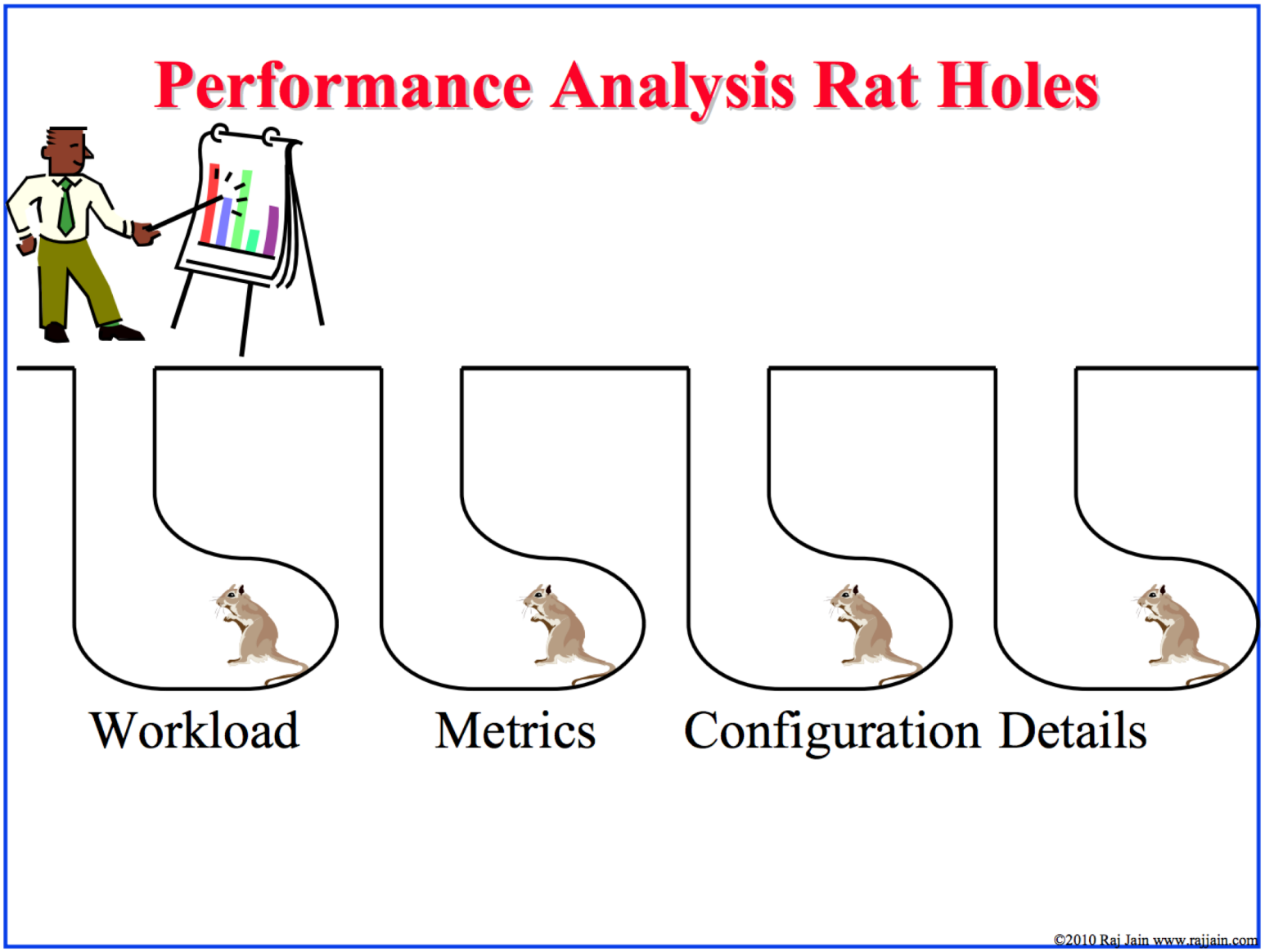
- Strengths
- Weaknesses
- Alternatives
- New ideas/problems
- Brainstorming and Discussion

~10 min Critique plus ~15 min Discussion

More Advice on Paper Review/Talk

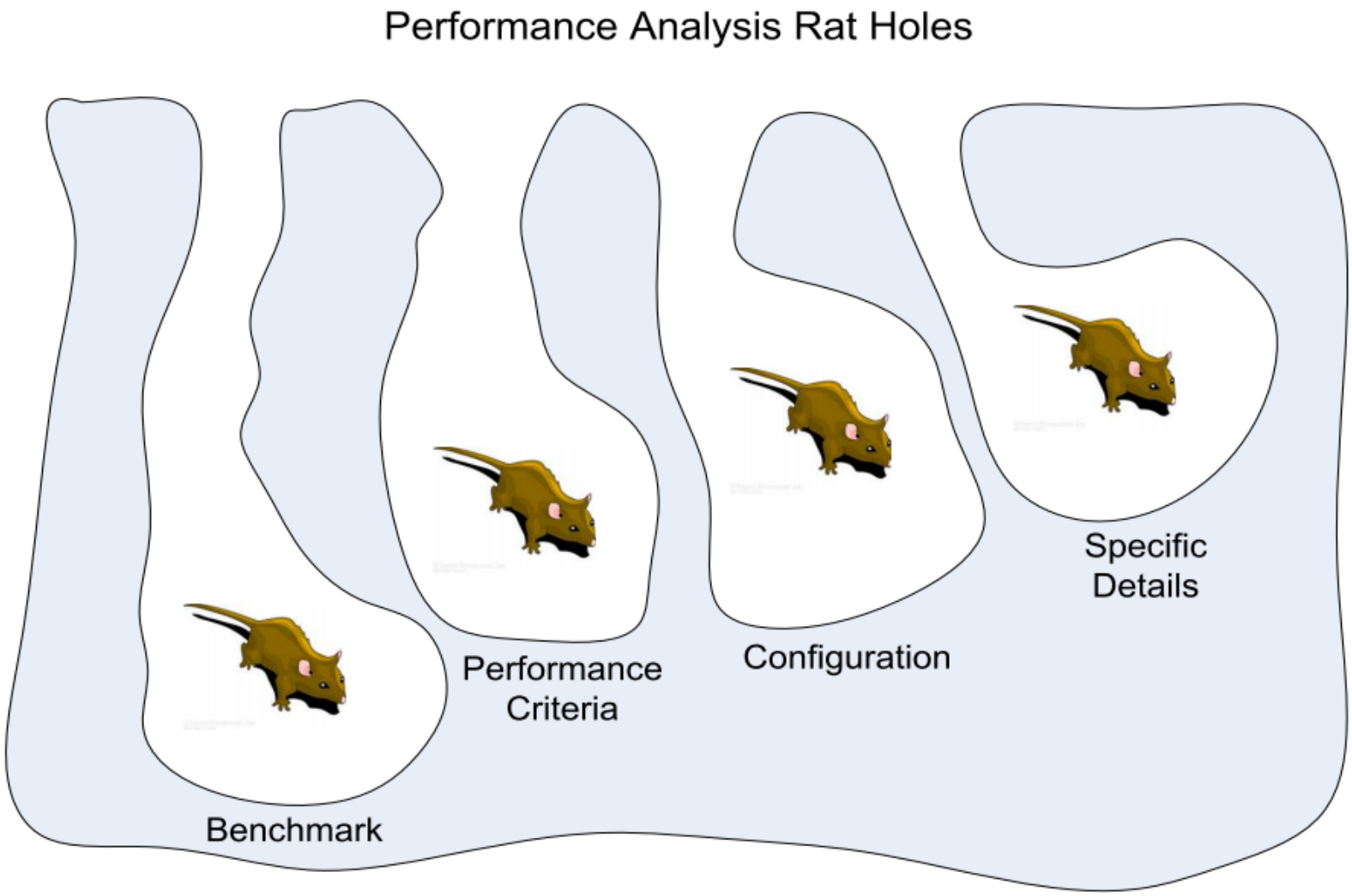
- When doing the paper reviews and analyses, be very critical
- Always think about better ways of solving the problem or related problems
  - Question the problem as well
  - Read background papers (both past and future)
- This is how things progress in science and engineering (or anywhere), and how you can make big leaps
  - By critical analysis
- A few sample text reviews provided online

Try to Avoid Rat Hole Discussions



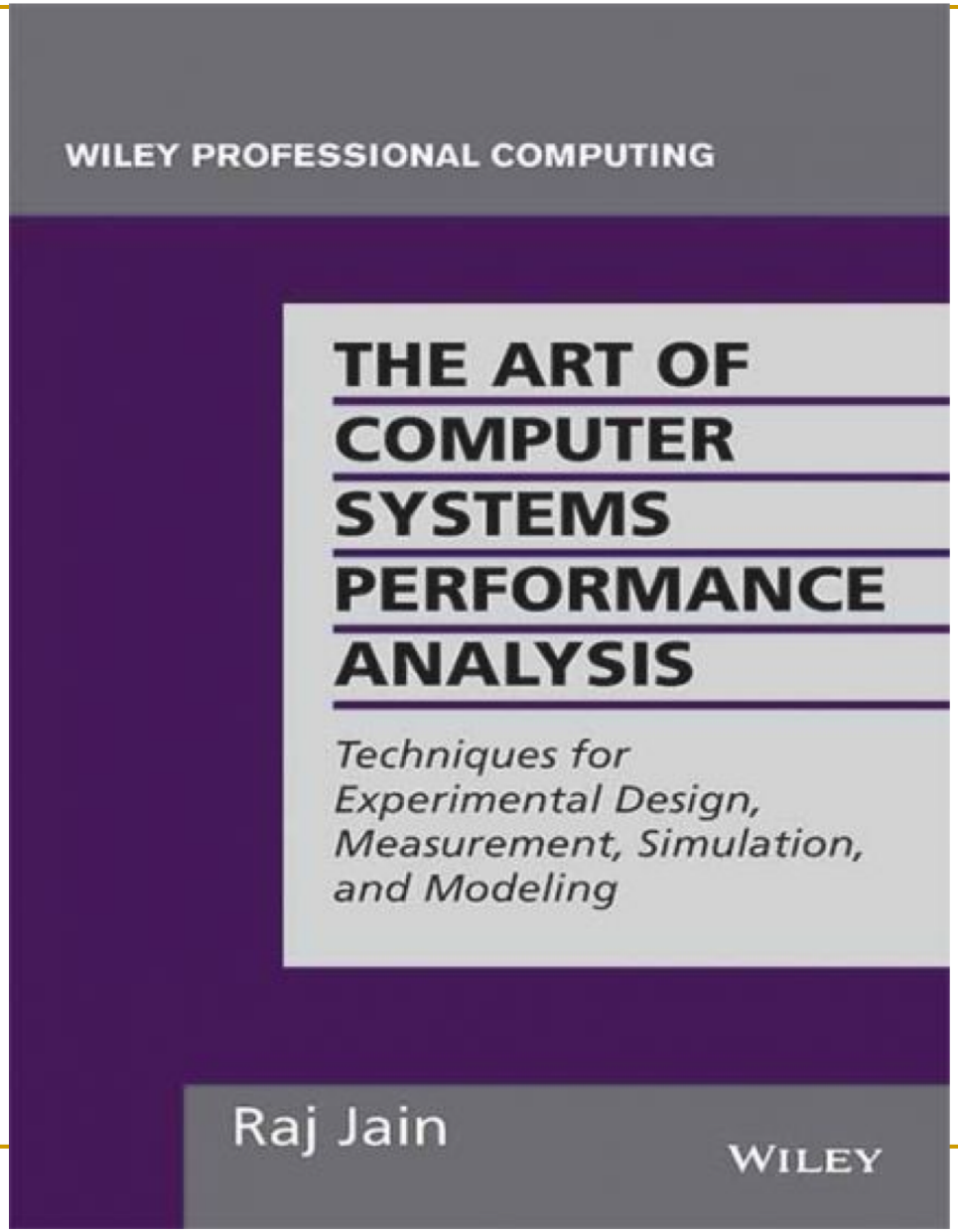
Source: https://www.cse.wustl.edu/~jain/iucee/ftp/k_10adp.pdf

Try to Avoid Rat Hole Discussions



Source: P. Jarupunphol, "Using Buddhist Insights to Analyse the Cause of System Project Failures," Ph.D. Thesis, 2013

Aside: A Recommended Book



Raj Jain, "The Art of Computer Systems Performance Analysis," Wiley, 1991.

10.8 DECISION MAKER'S GAMES

Even if the performance analysis is correctly done and presented, it may not be enough to persuade your audience—the decision makers—to follow your recommendations. The list shown in Box 10.2 is a compilation of reasons for rejection heard at various performance analysis presentations. You can use the list by presenting it immediately and pointing out that the reason for rejection is not new and that the analysis deserves more consideration. Also, the list is helpful in getting the competing proposals rejected!

There is no clear end of an analysis. Any analysis can be rejected simply on the grounds that the problem needs more analysis. This is the first reason listed in Box 10.2. The second most common reason for rejection of an analysis and for endless debate is the workload. Since workloads are always based on the past measurements, their applicability to the current or future environment can always be questioned. Actually workload is one of the four areas of discussion that lead a performance presentation into an endless debate. These "rat holes" and their relative sizes in terms of time consumed are shown in Figure 10.26. Presenting this cartoon at the beginning of a presentation helps to avoid these areas.

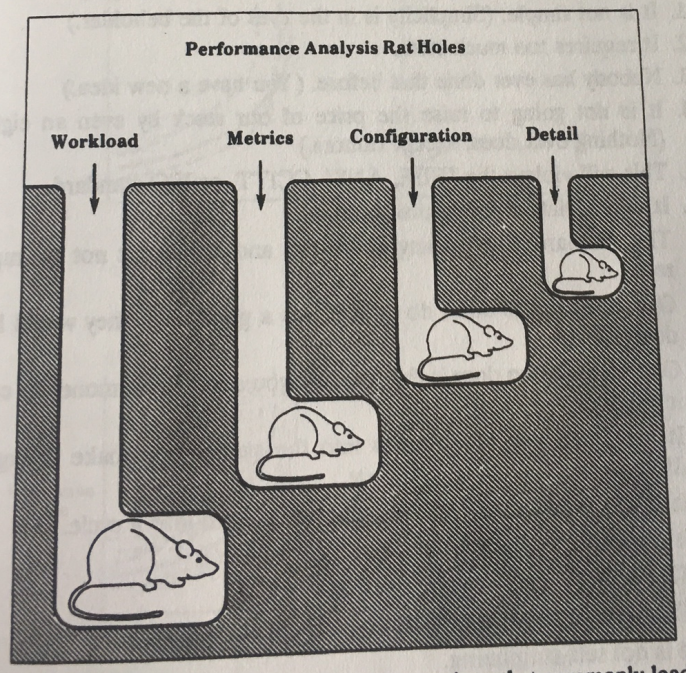
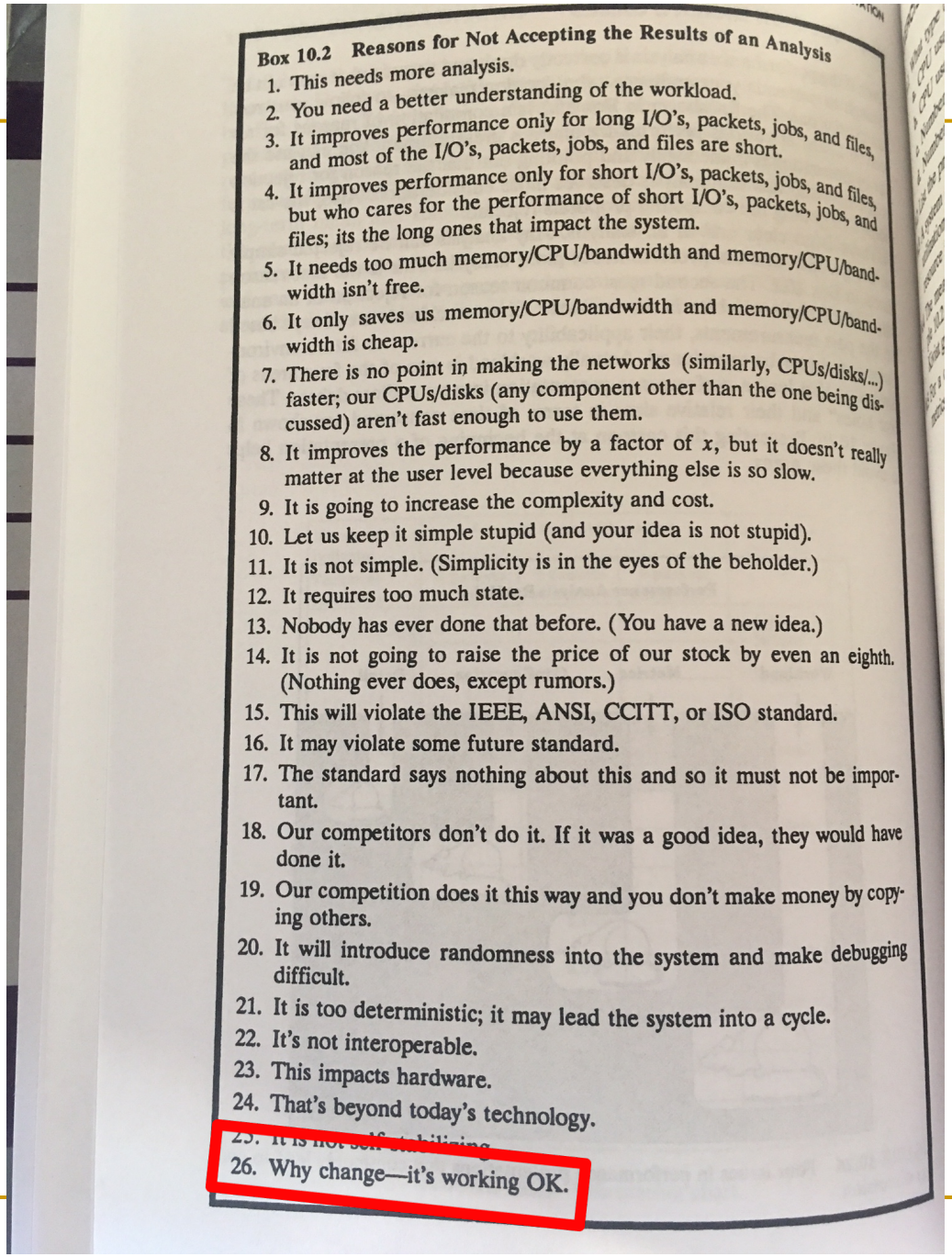


FIGURE 10.26 Four issues in performance presentations that commonly lead to endless discussion.

Raj Jain, "The Art of Computer Systems Performance Analysis," Wiley, 1991.



Box 10.2 Reasons for Not Accepting the Results of an Analysis

1. This needs more analysis.
2. You need a better understanding of the workload.
3. It improves performance only for long I/O's, packets, jobs, and files, and most of the I/O's, packets, jobs, and files are short.
4. It improves performance only for short I/O's, packets, jobs, and files, but who cares for the performance of short I/O's, packets, jobs, and files; its the long ones that impact the system.
5. It needs too much memory/CPU/bandwidth and memory/CPU/bandwidth isn't free.
6. It only saves us memory/CPU/bandwidth and memory/CPU/bandwidth is cheap.
7. There is no point in making the networks (similarly, CPUs/disks/...) faster; our CPUs/disks (any component other than the one being discussed) aren't fast enough to use them.
8. It improves the performance by a factor of x, but it doesn't really matter at the user level because everything else is so slow.
9. It is going to increase the complexity and cost.
10. Let us keep it simple stupid (and your idea is not stupid).
11. It is not simple. (Simplicity is in the eyes of the beholder.)
12. It requires too much state.
13. Nobody has ever done that before. (You have a new idea.)
14. It is not going to raise the price of our stock by even an eighth. (Nothing ever does, except rumors.)
15. This will violate the IEEE, ANSI, CCITT, or ISO standard.
16. It may violate some future standard.
17. The standard says nothing about this and so it must not be important.
18. Our competitors don't do it. If it was a good idea, they would have done it.
19. Our competition does it this way and you don't make money by copying others.
20. It will introduce randomness into the system and make debugging difficult.
21. It is too deterministic; it may lead the system into a cycle.
22. It's not interoperable.
23. This impacts hardware.
24. That's beyond today's technology.
25. It is not self-stabilizing.
26. Why change—it's working OK.

Raj Jain, "The Art of Computer Systems Performance Analysis," Wiley, 1991.

More Advice on Talks

- Kayvon Fatahalian, "Tips for Giving Clear Talks"
  - http://graphics.stanford.edu/~kayvonf/misc/cleartalktips.pdf
  - Many useful and simple principles here

"Every sentence matters"

"The audience prefers not to think" (about things you can just tell them)

"Surprises are bad": say why before what
(indicate why you are saying something before you say it)

Explain every figure, graph, or equation

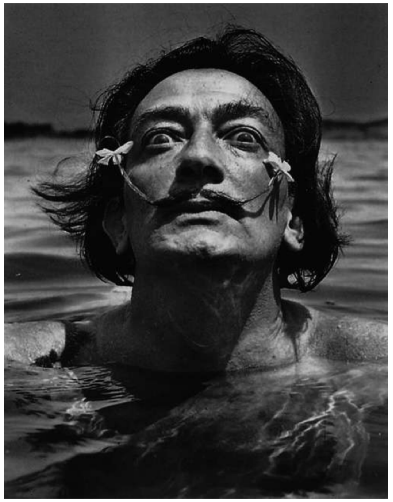
When improving the talk, the audience is always right

Who Painted This Painting?

Salvador Dali @ 1924

Source: http://www.museoreinasofia.es/en/collection/artwork/retrato-luis-bunuel-portrait-luis-bunuel http://salvadordaliprints.org/biography/

What About This?



Salvador Dali @ 1937

Source: http://salvadordaliprints.org/the-burning-giraffe/ https://www.dalipaintings.com/

Takeaway

Learn the basic principles

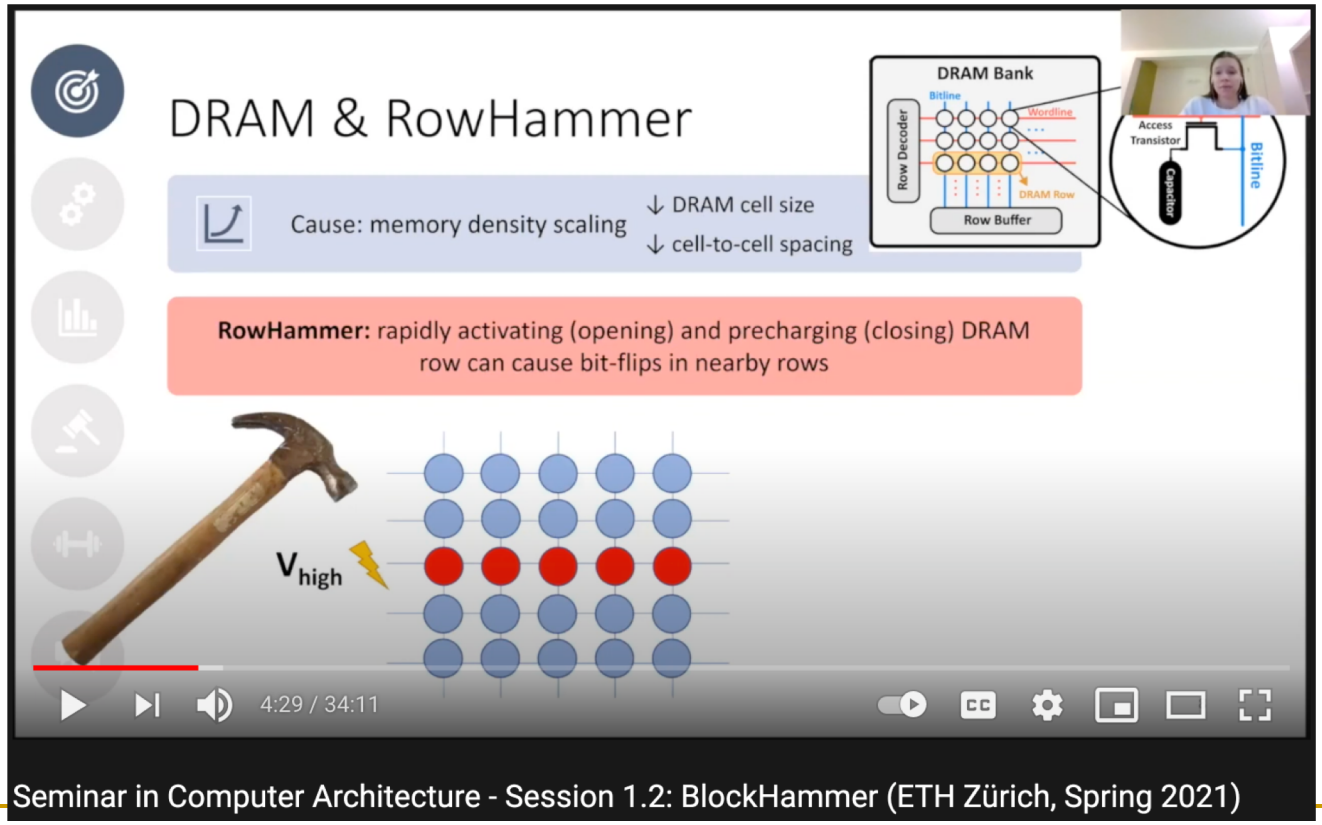
before you can

consciously choose to break them

Seminar Talk Examples

Past Seminar Presentation

Sofie Daniels
[BlockHammer: Preventing RowHammer at Low Cost by Blacklisting Rapidly-Accessed DRAM Rows, HPCA 2021,](#)
Session 1.2: Seminar in Computer Architecture - Spring 2021,
[Talk Video] (34 minutes excluding discussion)
[Slides (pptx) (pdf)]

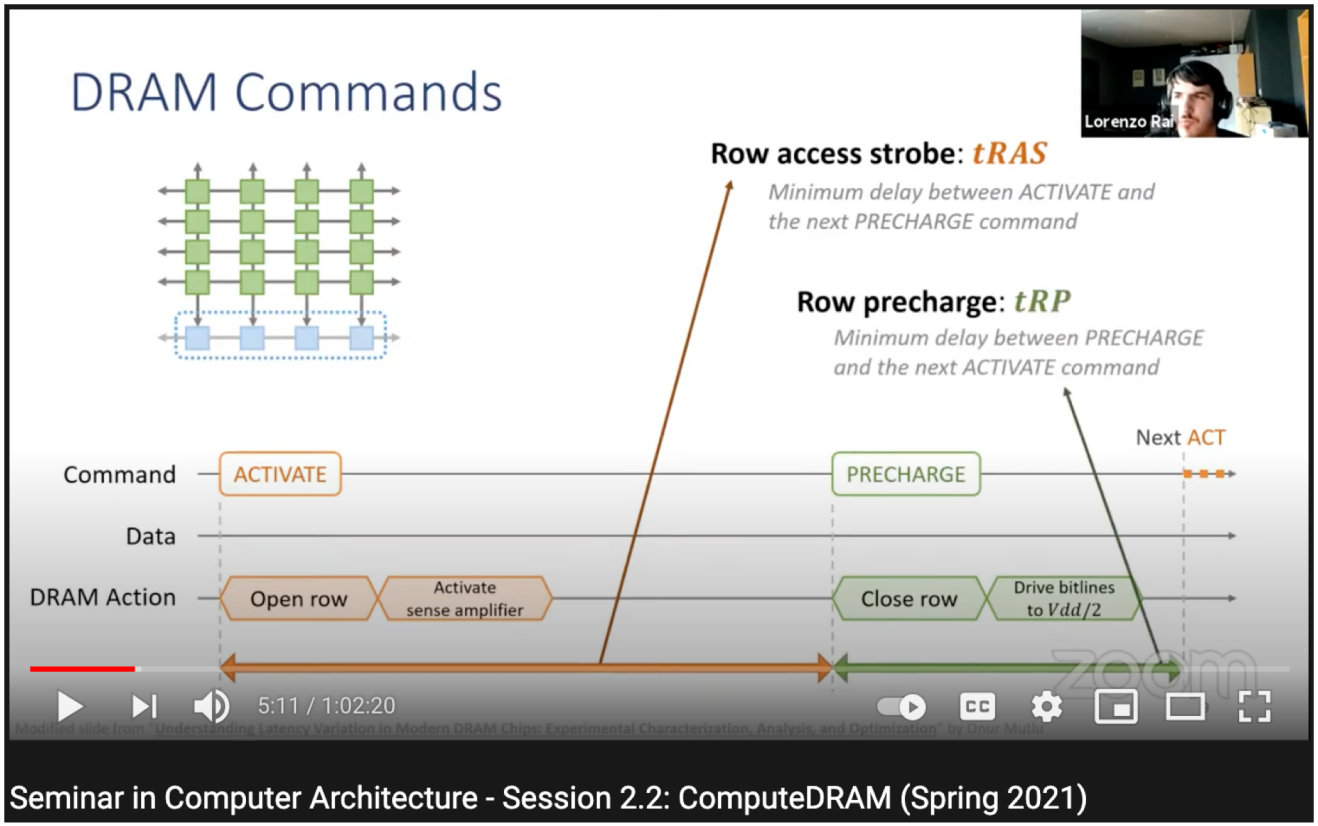


Past Seminar Presentation and Discussion

https://www.youtube.com/watch?v=NzlLCGepHW8&list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4&index=13

Past Seminar Presentation and Discussion

Lorenzo Rai
ComputeDRAM: In-Memory Compute Using Off-the-Shelf DRAMs, MICRO 2019
Session 1.2: Seminar in Computer Architecture - Spring 2021,
[Talk Video] (62 minutes including discussion)
[Slides (pptx) (pdf)]

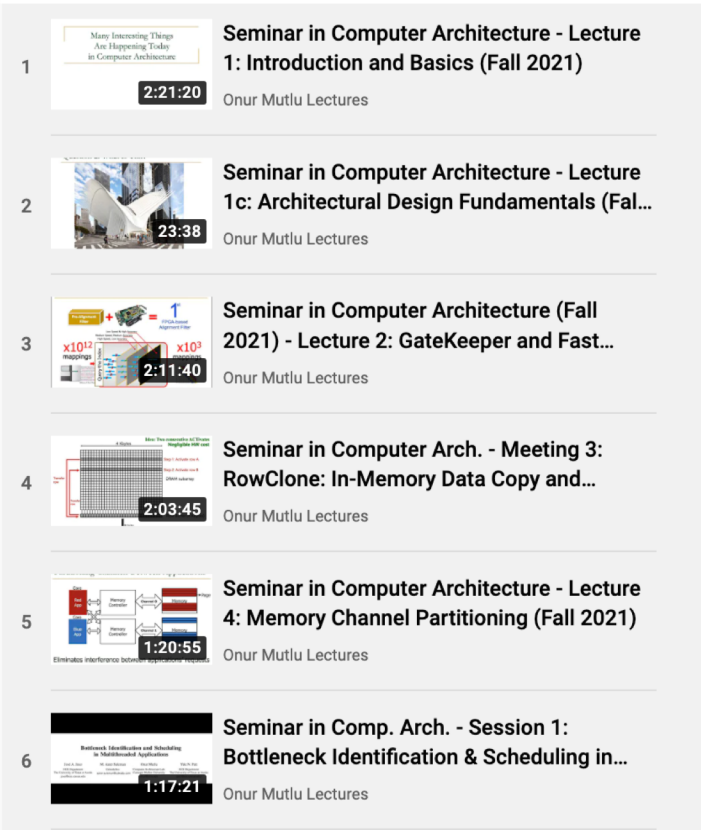


Other Example Presentations & Discussions

[List of example papers presented]:
https://safari.ethz.ch/architecture_seminar/fall2021/doku.php?id=schedule
[List of YouTube videos]:
https://www.youtube.com/playlist?list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4

Fall 2021 Lectures/Schedule

Week	Date	Livestream	Lecture
W1	23.09 Thu.	YouTube Live	L1a: Course Logistics (PDF) (PPT)
			L1b: Introduction and Basics (PDF) (PPT)
			L1c: Architectural Design Fundamer (PDF) (PPT) YouTube Video
W2	30.09 Thu.	YouTube Live	L2: GateKeeper (PDF) (PPT)
W3	07.10 Thu.	YouTube Live	L3: RowClone (Processing using DI (PDF) (PPT)
W4	14.10 Thu.	YouTube Live	L4: Memory Channel Partitioning (PDF) (PPT)



Past Example Reviews

[List of example reviews]:
https://safari.ethz.ch/architecture_seminar/fall2021/doku.php?id=schedule
[List of YouTube videos]:
https://www.youtube.com/playlist?list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4

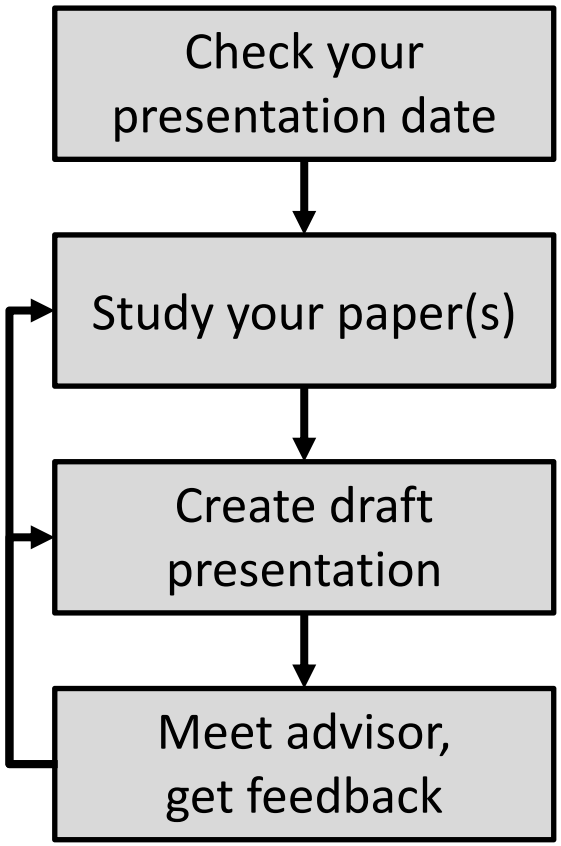
How to Participate

How to Make the Best Out of This?

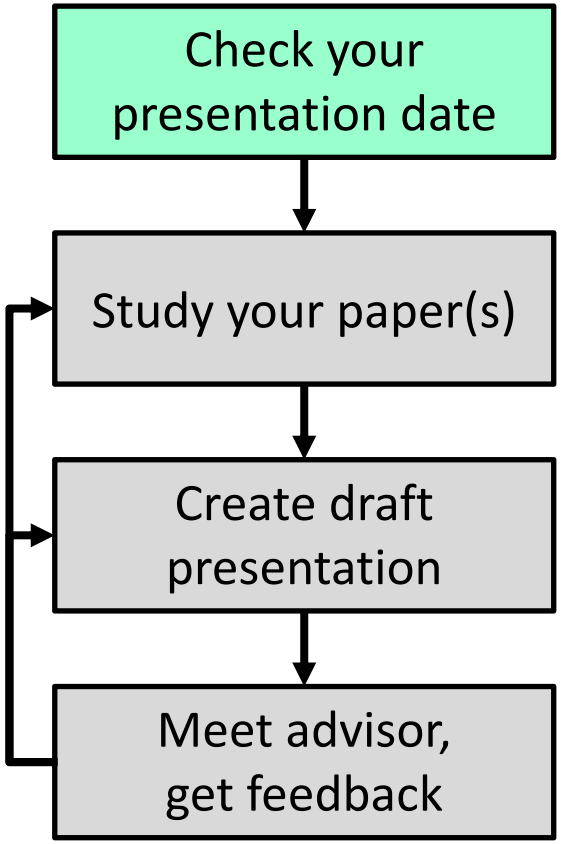
- Come prepared → Read and critically evaluate the paper
- Think new ideas
- Bring discussion points and questions; read other papers
- Be critical
- Brainstorm – be open to new ideas
- Pay attention and discuss+contribute
- Participate online before and after each meeting

Guided Talk Preparation

Preparing a Talk

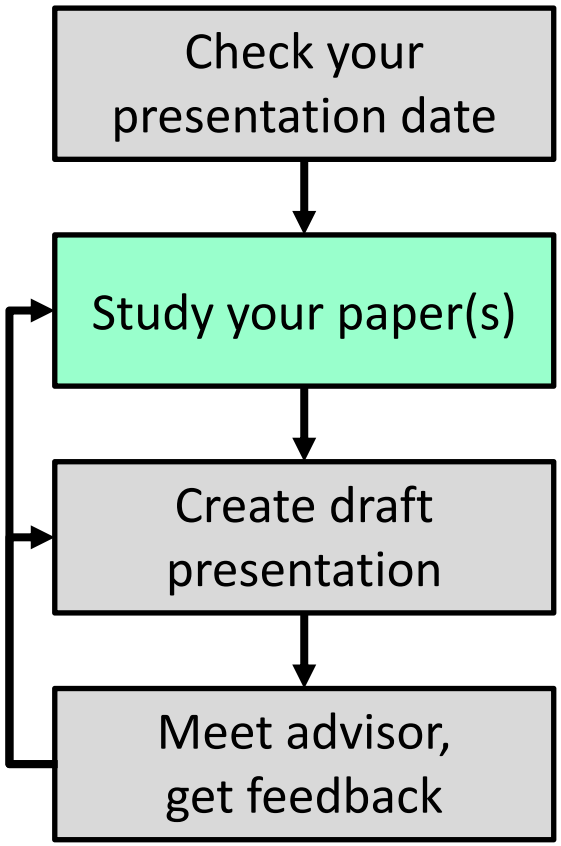


Preparing a Talk: Start Early



- Preparing a good presentation takes time
- Start early!

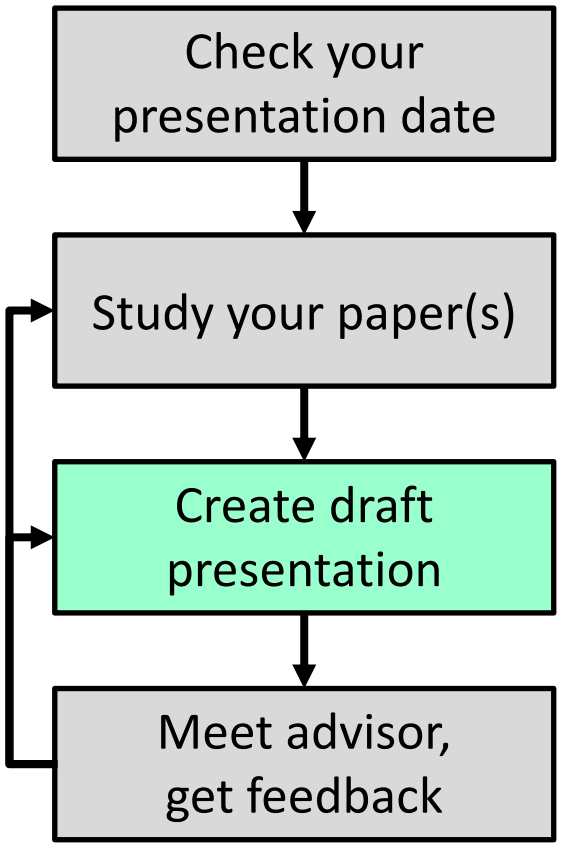
Preparing a Talk: Study Paper



- 3 'C's of reading
  - *Carefully:* look up terms, possibly read cited papers
  - *Critically:* find limitations, flaws
  - *Creatively:* think of improvements
- Try examples by hand
- Try tools if available

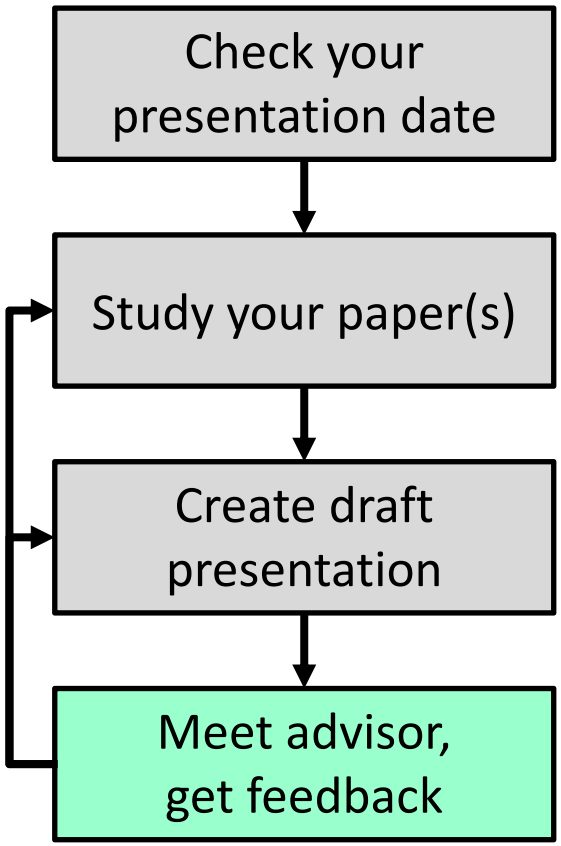
- Consult with TA if questions

Preparing a Talk: Create Draft



- Explain the motivation for the work
- Clearly present the technical solution and results
  - Include a demo if appropriate
- Outline limitations or improvements
- Focus on the key concepts
  - Do not present all of the details

Preparing a Talk: Get Feedback



- Prepare for the meeting
  - Schedule early
  - Send slides in advance
  - Write down questions
- Make sure you address feedback
  - Take notes
- Meetings are mandatory!
  - At least one week before the talk
  - Two meetings

Grading and Feedback

Grading Rubric

- Quality of your presentation (60%)
  - How well did you understand the material?
  - How well did you present it?
  - How well did you answer the questions?
  - Be prepared to explain technical terms
  - We will take into account the difficulty of the paper and the time you had to prepare.
- Quality of the final synthesis paper (30%)
  - How well did you understand some of the papers presented during the seminar?
- Attendance & Quizzes (10%)
- Participation (during class and online) (BONUS 10%)
  - Did you ask good questions?
  - Did you participate and contribute to the discussion?

Feedback

- We will try to (briefly) discuss strengths/weaknesses of your talk in class
  - Let us know upfront if you would prefer **not** to
- You can arrange a meeting with your TA to get feedback

Expected Schedule

Schedule

- We will meet once a week, with two presentations per session
  - *Next meeting next week*
  - *Your presentations start on 10 March*
  - 22 presentations in total
  - Each presentation: 50 minutes including questions & discussion

- Paper assignment
  - Will be done online
  - Study the list of papers
  - Check your email and be responsive

Homework 0

- Due March 3
  - https://safari.ethz.ch/architecture_seminar/spring2022
- Information about yourself
- All future grading is predicated on homework 0
- If it is not submitted on time, we cannot schedule you for a presentation.

Paper Review Preferences

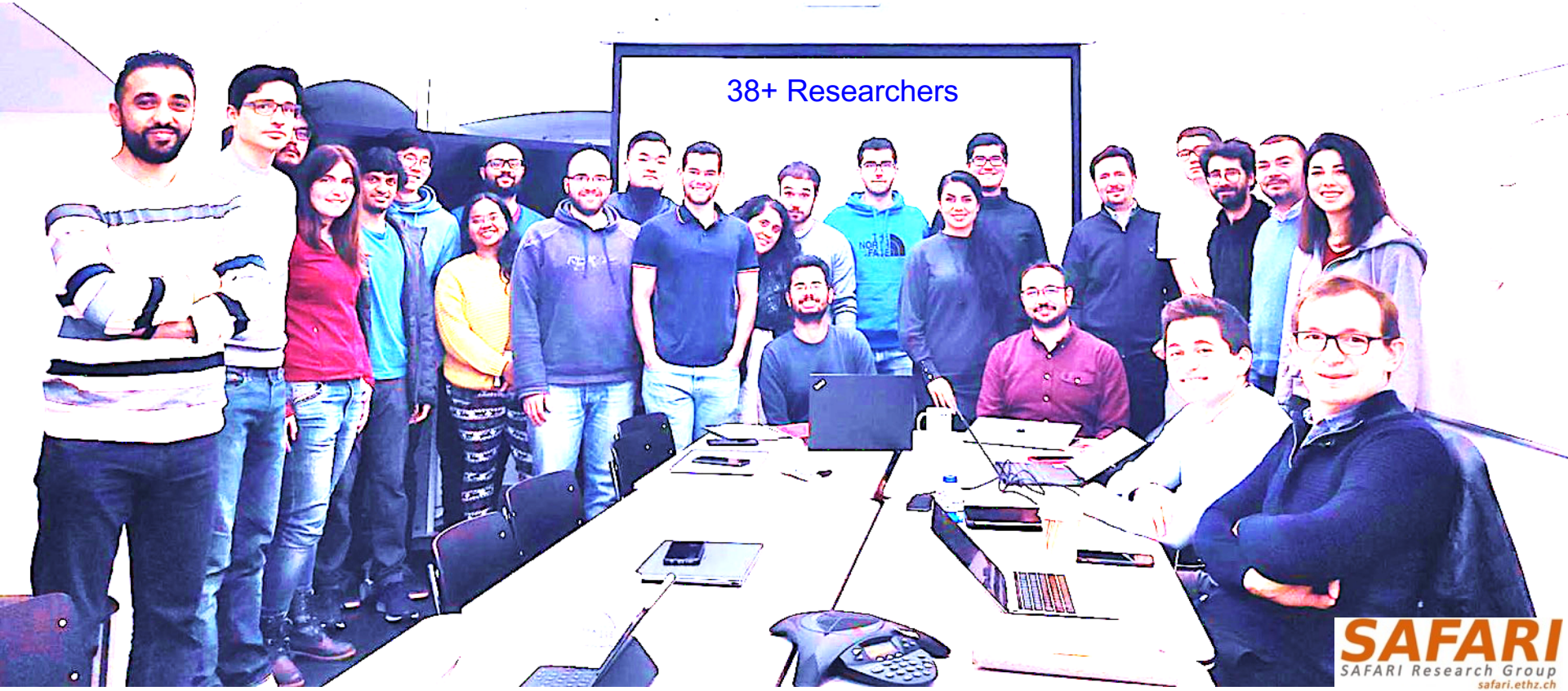
- Due TBD
- Check the website and Moodle for instructions
- If it is not submitted on time, we cannot schedule you for a presentation.

Synergistic Activities

Onur Mutlu's SAFARI Research Group

Computer architecture, HW/SW, systems, bioinformatics, security, memory

https://safari.ethz.ch/safari-newsletter-april-2020/



Think BIG, Aim HIGH!

SAFARI

https://safari.ethz.ch

SAFARI Newsletter January 2021 Edition

- https://safari.ethz.ch/safari-newsletter-january-2021/

SAFARI
SAFARI Research Group

Newsletter
January 2021

Think Big, Aim High, and Have a Wonderful 2021!

Dear SAFARI friends,

Happy New Year! We are excited to share our group highlights with you in this second edition of the SAFARI newsletter (You can find the first edition from April 2020 here). 2020 has

SAFARI Newsletter December 2021 Edition

- https://safari.ethz.ch/safari-newsletter-december-2021/

SAFARI
SAFARI Research Group

Think Big, Aim High

ETH zürich

View in your browser
December 2021

SAFARI PhD and Post-Doc Alumni

- https://safari.ethz.ch/safari-alumni/

- Minesh Patel (ETH Zurich), MICRO 2020 and DSN 2020 Best Paper Awards; ISCA Hall of Fame 2021
- Damla Senol Cali (Bionano Genomics), SRC TECHCON 2019 Best Student Presentation Award
- Nastaran Hajinazar (ETH Zurich)
- Gagandeep Singh (ETH Zurich), FPL 2020 Best Paper Award Finalist
- Amirali Boroumand (Stanford Univ → Google), SRC TECHCON 2018 Best Student Presentation Award
- Jeremie Kim (ETH Zurich), EDAA Outstanding Dissertation Award 2020; IEEE Micro Top Picks 2019; ISCA/MICRO HoF 2021
- Nandita Vijaykumar (Univ. of Toronto, Assistant Professor), ISCA Hall of Fame 2021
- Kevin Hsieh (Microsoft Research, Senior Researcher)
- Justin Meza (Facebook), HiPEAC 2015 Best Student Presentation Award; ICCD 2012 Best Paper Award
- Mohammed Alser (ETH Zurich), IEEE Turkey Best PhD Thesis Award 2018
- Yixin Luo (Google), HPCA 2015 Best Paper Session
- Kevin Chang (Facebook), SRC TECHCON 2016 Best Student Presentation Award
- Rachata Ausavarungnirun (KMUNTB, Assistant Professor), NOCS 2015 and NOCS 2012 Best Paper Award Finalist
- Gennady Pekhimenko (Univ. of Toronto, Assistant Professor), ISCA Hall of Fame 2021; ASPLOS 2015 SRC Winner
- Vivek Seshadri (Microsoft Research)
- Donghyuk Lee (NVIDIA Research, Senior Researcher), HPCA Hall of Fame 2018
- Yoongu Kim (Software Robotics → Google), TCAD'19 Top Pick Award; IEEE Micro Top Picks'10; HPCA'10 Best Paper Session
- Lavanya Subramanian (Intel Labs → Facebook)

- Samira Khan (Univ. of Virginia, Assistant Professor), HPCA 2014 Best Paper Session
- Saugata Ghose (Univ. of Illinois, Assistant Professor), DFRWS-EU 2017 Best Paper Award
- Jawad Haj-Yahya (Huawei Research Zurich, Principal Researcher)

Short Video on SAFARI Research Group

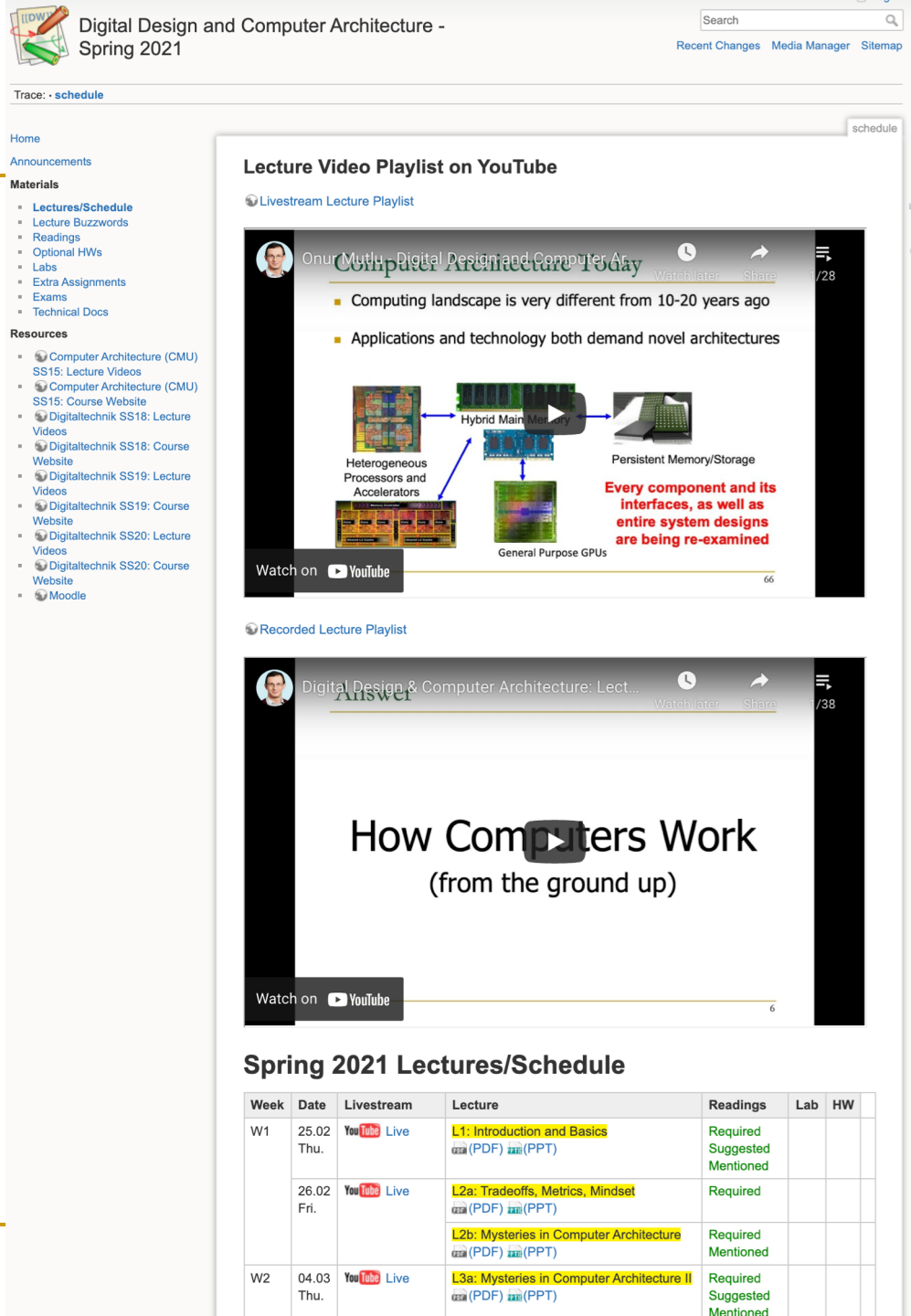
https://www.youtube.com/watch?v=mSr1QQmYuX0

Our Major Courses & Lectures

- **First Computer Architecture & Digital Design Course**
  - Digital Design and Computer Architecture
  - Spring 2021 Livestream Edition: https://www.youtube.com/watch?v=LbC0EZY8yw4&list=PL5Q2soXY2Zi_uej3aY39YB5pfW4SJ7LlN
- **Advanced Computer Architecture Course**
  - Computer Architecture
  - Fall 2021 Livestream Edition: https://www.youtube.com/watch?v=4yfkM_5EFgo&list=PL5Q2soXY2Zi-Mnk1PxjEIG32HAGILkTOF
- **Seminar in Computer Architecture**
  - https://www.youtube.com/watch?v=4TcP297mdsI&list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4

DDCA (Spring 2021)

- https://safari.ethz.ch/digitaltechnik/spring2021/doku.php?id=schedule
- https://www.youtube.com/watch?v=LbC0EZY8yw4&list=PL5Q2soXY2Zi_uej3aY39YB5pfW4SJ7LlN
- Bachelor's course
  - 2nd semester at ETH Zurich
  - Rigorous introduction into "How Computers Work"
  - Digital Design/Logic
  - Computer Architecture
  - 10 FPGA Lab Assignments

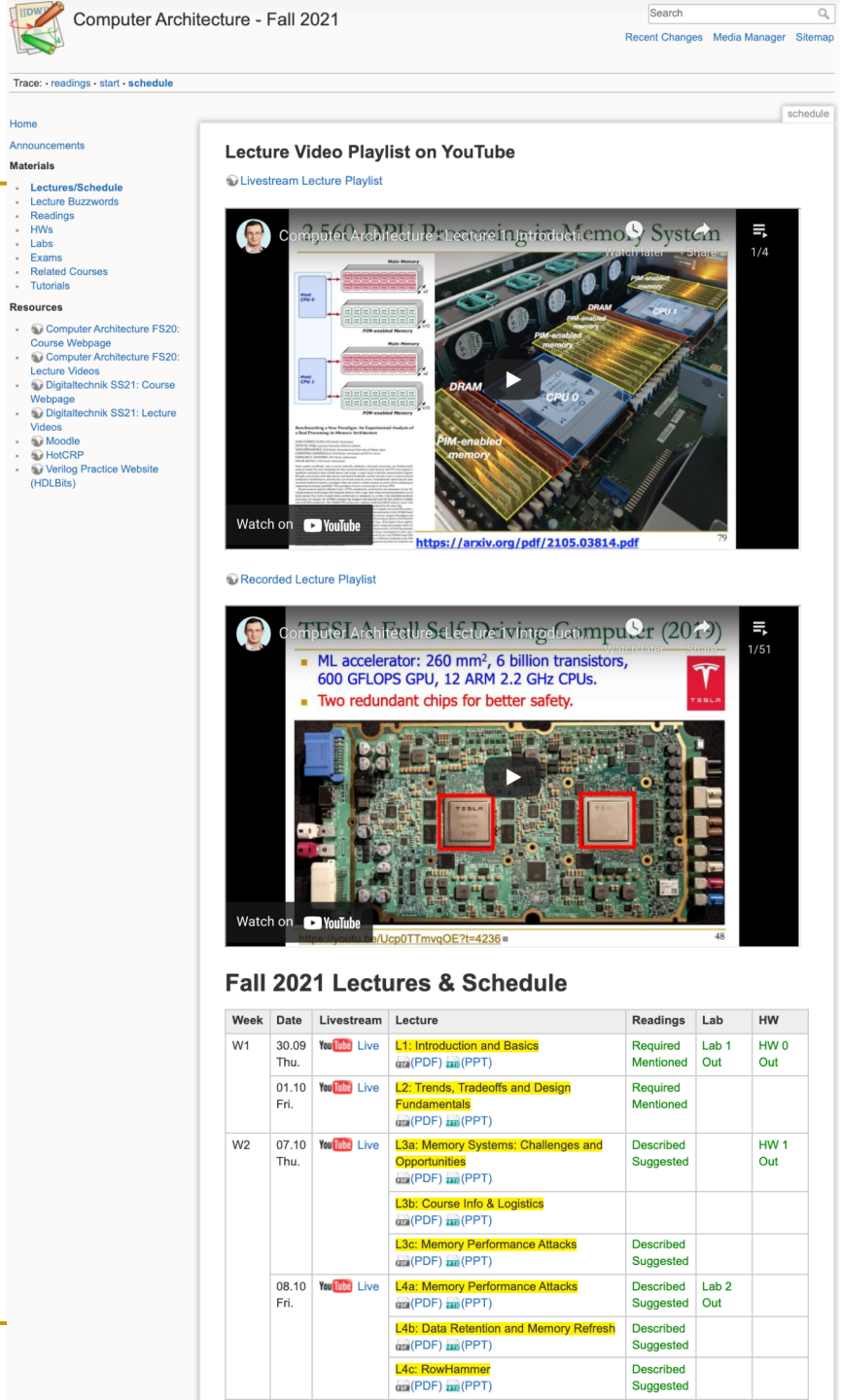


Comp Arch (Fall 2021)

- https://safari.ethz.ch/architecture/fall2021/doku.php?id=schedule

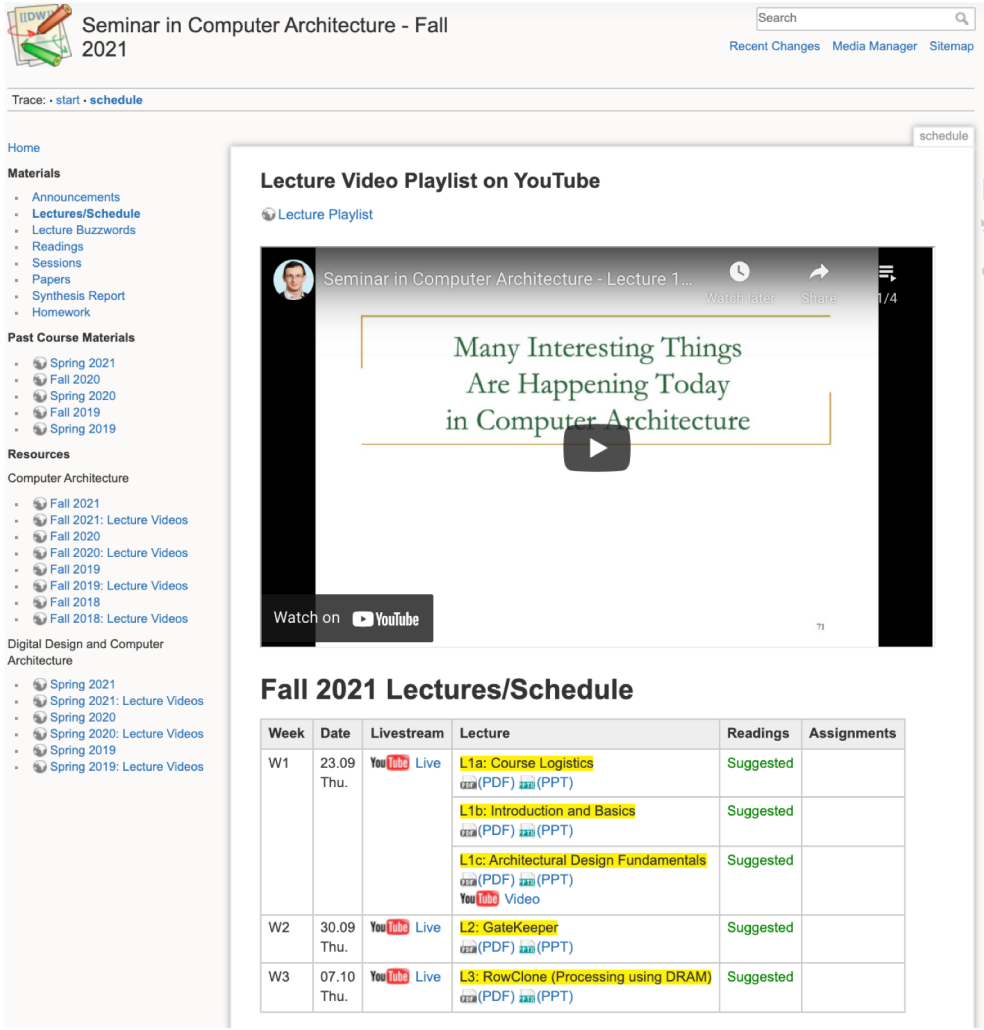
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=4yfkM_5EFgo&list=PL5Q2soXY2Zi-Mnk1PxjEIG32HAGILkTOF

- Master's level course
  - Taken by Bachelor's/Masters/PhD students
  - Cutting-edge research topics + fundamentals in Computer Architecture
  - 5 Simulator-based Lab Assignments
  - Potential research exploration
  - Many research readings



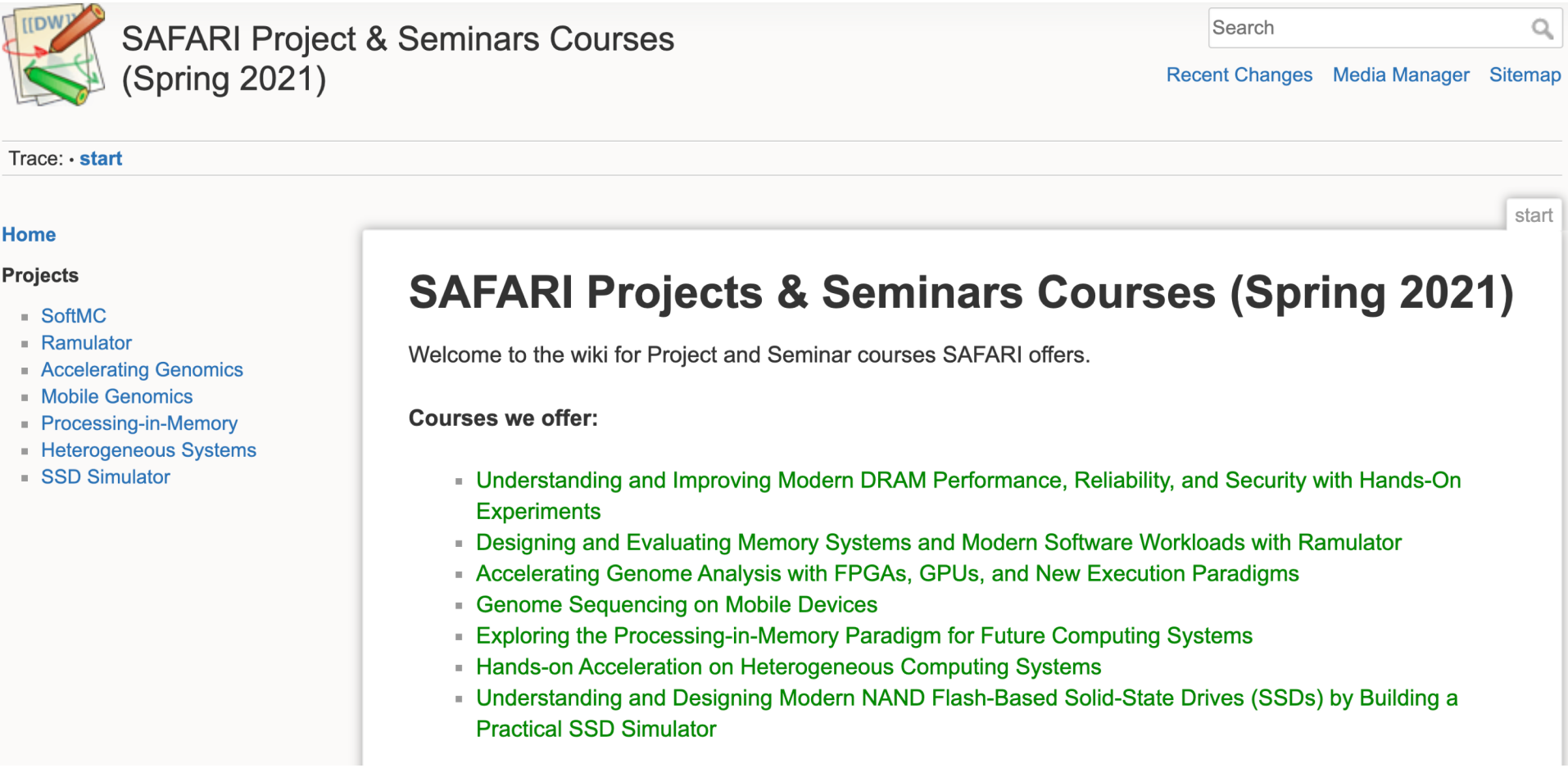
Seminar in Comp Arch (Fall 2021)

- https://safari.ethz.ch/architecture_seminar/fall2021/doku.php?id=schedule
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=4TcP297mdsI&list=PL5Q2soXY2Zi_7UBNmC9B8Yr5JSwTG9yH4
- Critical analysis course
  - Taken by Bachelor's/Masters/PhD students
  - Cutting-edge research topics + fundamentals in Computer Architecture
  - 20+ research papers, presentations, analyses



Hands-On Project Courses

- https://safari.ethz.ch/projects_and_seminars/doku.php

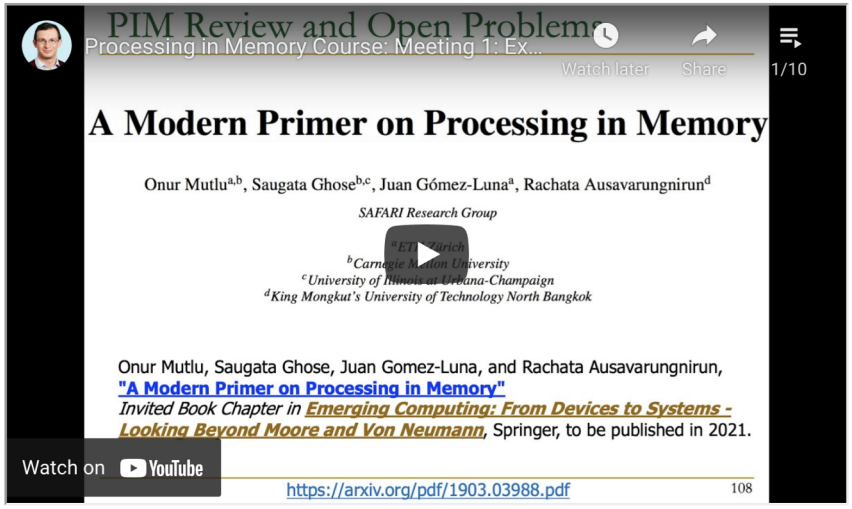


PIM Course (Fall 2021)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=processing_in_memory
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=9e4Chnwdovo&list=PL5Q2soXY2Zi-841fUYYUK9EsXKhQKRPyX
- Project course
  - Taken by Bachelor's/Master's students
  - Processing-in-Memory lectures
  - Hands-on research exploration
  - Many research readings

Lecture Video Playlist on YouTube

Lecture Playlist

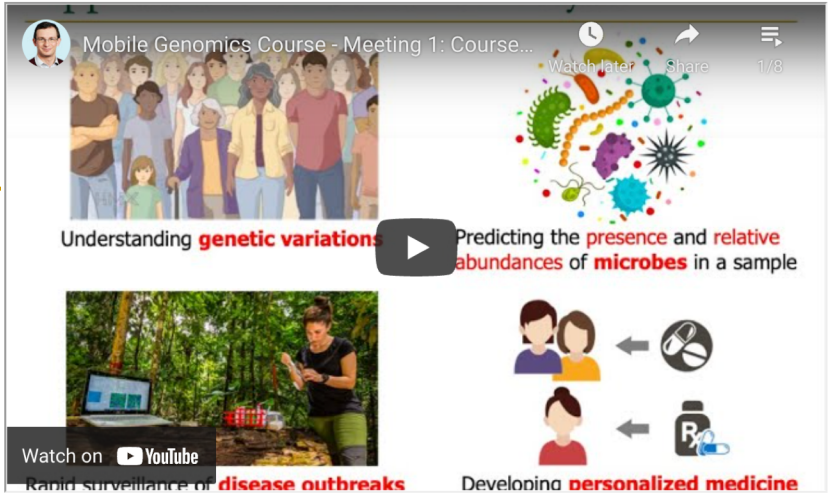


Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	05.10 Tue.	YouTube Live	M1: P&S PIM Course Presentation (PDF) (PPT)	Required Materials Recommended Materials	HW 0 Out
W2	12.10 Tue.	YouTube Live	M2: Real-World PIM Architectures (PDF) (PPT)		
W3	19.10 Tue.	YouTube Live	M3: Real-World PIM Architectures II (PDF) (PPT)		
W4	26.10 Tue.	YouTube Live	M4: Real-World PIM Architectures III (PDF) (PPT)		
W5	02.11 Tue.	YouTube Live	M5: Real-World PIM Architectures IV (PDF) (PPT)		
W6	09.11 Tue.	YouTube Live	M6: End-to-End Framework for Processing-using-Memory (PDF) (PPT)		
W7	16.11 Tue.	YouTube Live	M7: How to Evaluate Data Movement Bottlenecks (PDF) (PPT)		
W8	23.11 Tue.	YouTube Live	M8: Programming PIM Architectures (PDF) (PPT)		
W9	30.11 Tue.	YouTube Live	M9: Benchmarking and Workload Suitability on PIM (PDF) (PPT)		
W10	07.12 Tue.	YouTube Live	M10: Bit-Serial SIMD Processing using DRAM (PDF) (PPT)		

Genomics (Fall 2021)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=bioinformatics
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=MnogTeMjY8k&list=PL5Q2soXY2Zi8sngH-TrNZnDhDkPq55J9J
- Project course
  - Taken by Bachelor's/Master's students
  - Genomics lectures
  - Hands-on research exploration
  - Many research readings

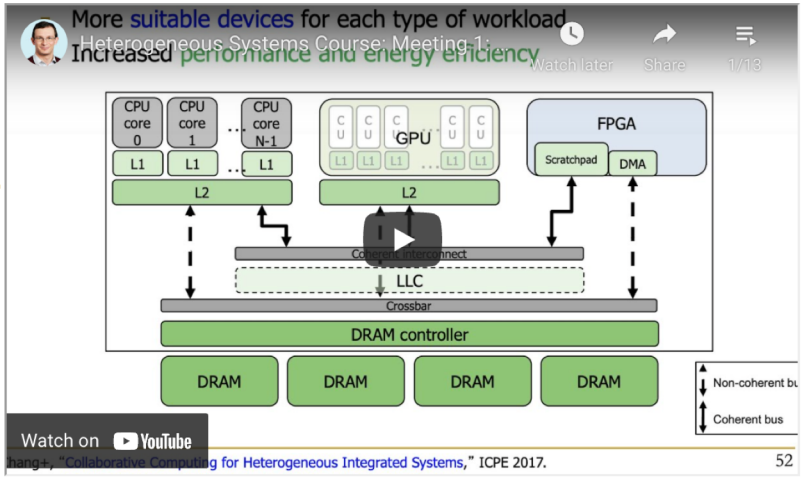


Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	5.10 Tue.	YouTube Live	M1: P&S Accelerating Genomics Course Introduction & Project Proposals (PDF) (PPT) YouTube Video	Required Materials Recommended Materials	
W2	20.10 Wed.	YouTube Live	M2: Introduction to Sequencing (PDF) (PPT)		
W3	27.10 Wed.	YouTube Live	M3: Read Mapping (PDF) (PPT)		
W4	3.11 Wed.	YouTube Live	M4: GateKeeper (PDF) (PPT)		
W5	10.11 Wed.	YouTube Live	M5: MAGNET & Shouji (PDF) (PPT)		
W6	17.11 Wed.		M6.1: SneakySnake (PDF) (PPT) Video		
			M6.2: GRIM-Filter (PDF) (PPT) YouTube Video		
W7	24.11 Wed.		M7: GenASM (PDF) (PPT) YouTube Video		
W8	01.12 Wed.	YouTube Live	M8: Genome Assembly (PDF) (PPT)		
W9	13.12 Mon.	YouTube Live	M9: GRIM-Filter (PDF) (PPT)		
W10	15.12 Wed.	YouTube Live	M10: Genomic Data Sharing Under Differential Privacy (PDF) (PPT)		

Hetero. Systems (Fall'21)

- **Fall 2021 Edition:**
  - https://safari.ethz.ch/projects_and_seminars/fall2021/doku.php?id=heterogeneous_systems
- **Youtube Livestream:**
  - https://www.youtube.com/watch?v=QY_bjwzsfMM&list=PL5Q2soXY2Zi_OwkTgEyA6tk3UsoPBH737
- Project course
  - Taken by Bachelor's/Master's students
  - GPU and Parallelism lectures
  - Hands-on research exploration
  - Many research readings



Fall 2021 Meetings/Schedule

Week	Date	Livestream	Meeting	Learning Materials	Assignments
W1	07.10 Thu.	Live	M1: P&S Course Presentation (PDF) (PPT)	Required Materials Recommended Materials	HW 0 Out
W2	14.10 Thu.	Live	M2: SIMD Processing and GPUs (PDF) (PPT)		
W3	21.10 Thu.	Live	M3: GPU Software Hierarchy (PDF) (PPT)		
W4	28.10 Thu.	Live	M4: GPU Memory Hierarchy (PDF) (PPT)		
W5	04.11 Thu.	Live	M5: GPU Performance Considerations (PDF) (PPT)		
W6	11.11 Thu.	Live	M6: Parallel Patterns: Reduction (PDF) (PPT)		
W7	18.11 Thu.	Live	M7: Parallel Patterns: Histogram (PDF) (PPT)		
W8	25.11 Thu.	Live	M8: Parallel Patterns: Convolution (PDF) (PPT)		
W9	02.12 Thu.	Live	M9: Parallel Patterns: Prefix Sum (Scan) (PDF) (PPT)		
W10	09.12 Thu.	Live	M10: Parallel Patterns: Sparse Matrices (PDF) (PPT)		
W11	16.12 Thu.	Live	M11: Parallel Patterns: Graph Search (PDF) (PPT)		
W12	22.12 Thu.	Live	M12: Dynamic Parallelism (PDF) (PPT)		
W13	06.01 Thu.	Live	M13: Collaborative Computing (PDF) (PPT)		

A Talk on Impactful Growth

Arch. Mentoring Workshop @ISCA'21 - Applying to Grad School & Doing Impactful Research - Onur Mutlu

1,563 views • Premiered Jun 16, 2021

74 1 SHARE SAVE ...

Onur Mutlu Lectures
17.2K subscribers

ANALYTICS EDIT VIDEO

Panel talk at Undergraduate Architecture Mentoring Workshop at ISCA 2021
(https://sites.google.com/wisc.edu/uar...)

https://www.youtube.com/watch?v=83tlorht7Mc&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJl&index=54

An Interview on Computing Futures

https://www.youtube.com/watch?v=8ffSEKZhmvo

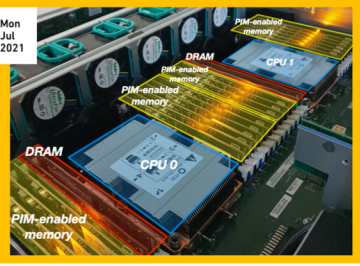
SAFARI Live Seminars (I)

SAFARI Live Seminars in Computer Architecture

Dr. Juan Gómez Luna, ETH Zurich

Understanding a Modern Processing-in-Memory Architecture: Benchmarking and Experimental Characterization

12 Mon Jul 2021

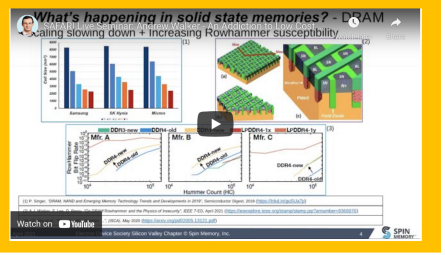


SAFARI Live Seminars in Computer Architecture

Dr. Andrew Walker, Schiltron Corporation & Nexgen Power Systems

An Addiction to Low Cost Per Memory Bit – How to Recognize it and What to Do About it

19 Mo Jul 2021

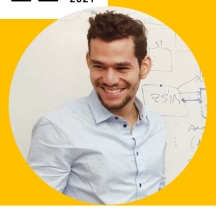


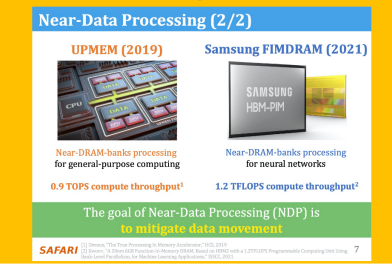
SAFARI Live Seminars in Computer Architecture

Geraldo F. Oliveira, ETH Zurich

DAMOV: A New Methodology and Benchmark Suite for Evaluating Data Movement Bottlenecks

22 Do Jul 2021



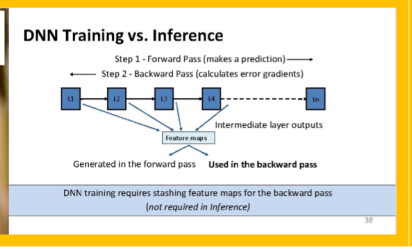


SAFARI Live Seminars in Computer Architecture

Gennady Pekhimenko, University of Toronto

Efficient DNN Training at Scale: from Algorithms to Hardware

5 Do Aug 2021

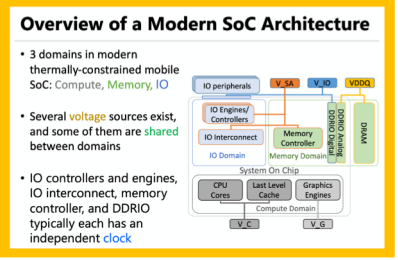


SAFARI Live Seminars in Computer Architecture

Jawad Haj-Yahya, Huawei Research Center Zurich

Power Management Mechanisms in Modern Microprocessors and Their Security Implications

16 Mo Aug 2021

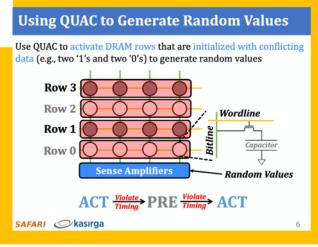


SAFARI Live Seminars in Computer Architecture

Ataberk Olgun, TOBB & ETH Zurich

QUAC-TRNG: High-Throughput True Random Number Generation Using Quadruple Row Activation in Commodity DRAM Chips

15 Mi Sep 2021

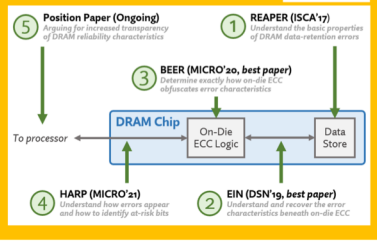


SAFARI Live Seminars in Computer Architecture

Minesh Patel, ETH Zurich

Enabling Effective Error Mitigation in Memory Chips That Use On-Die ECCs

21 Tues Sep 2021

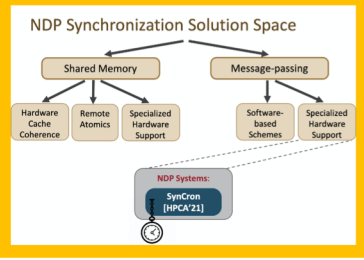


SAFARI Live Seminars in Computer Architecture

Christina Giannoula, National Technical University of Athens

Efficient Synchronization Support for Near-Data-Processing Architectures

27 Mo Sep 2021

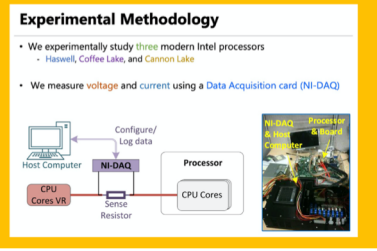


SAFARI Live Seminars in Computer Architecture

Jawad Haj-Yahya, Huawei Research Center Zurich

Security Implications of Power Management Mechanisms In Modern Processors, Current Studies and Future Trends

4 Mo Okt 2021



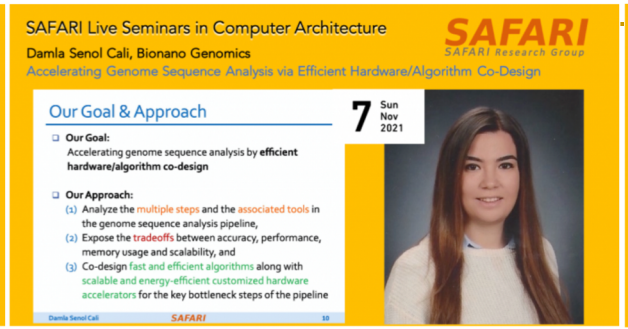
SAFARI

https://safari.ethz.ch/safari-seminar-series/

SAFARI Live Seminars (II)

SAFARI Live Seminar: Nastaran Hajinazar 27 Oct 2021

Posted on October 1, 2021 by ewent



SAFARI Live Seminar: Damla Senol Cali 07 Nov 2021

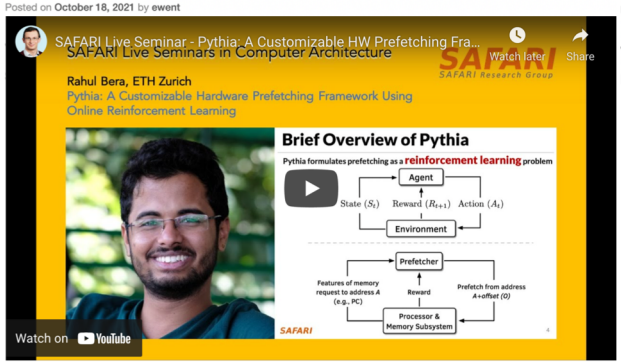
Posted on October 18, 2021 by ewent

SAFARI Live Seminar: Gennady Pekhimenko 08 Nov 2021

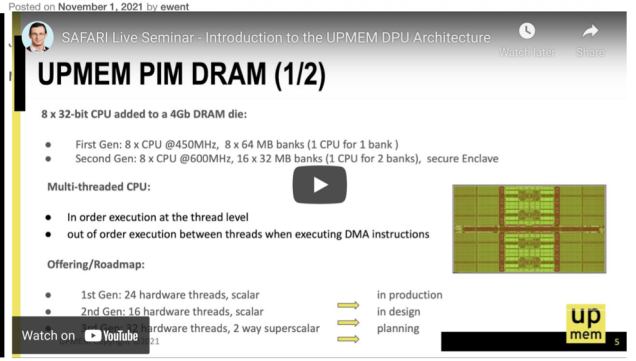
Posted on November 1, 2021 by ewent

SAFARI Live Seminar: Serghei Mangul 11 Nov 2021

Posted on November 5, 2021 by ewent



SAFARI Live Seminar: Rahul Bera 20 Dec 2021

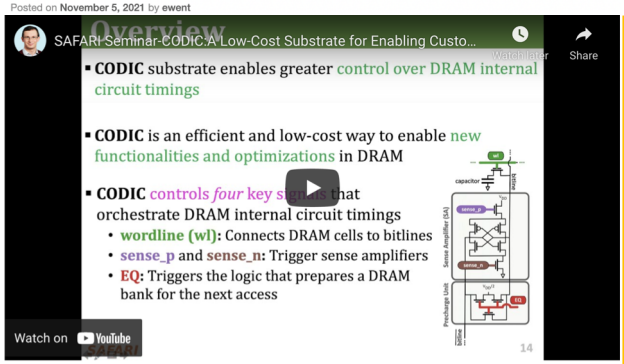


SAFARI Live Seminar: Fabrice Devaux, 2 Feb 2022

Posted on January 15, 2022 by ewent

Join us for our joint SAFARI Live Seminar & EFCL Seminar with Fabrice Devaux, UPMEM

Wednesday, February 2 2022 at 11:00 am Zurich time (CET)



SAFARI Live Seminar: Lois Orosa, 10 Feb 2022

Posted on January 16, 2022 by ewent

Join us for our next SAFARI Live Seminar with Lois Orosa.

Thursday, February 10 at 5:00 pm Zurich time (CET)

Posted on January 19, 2022 by ewent

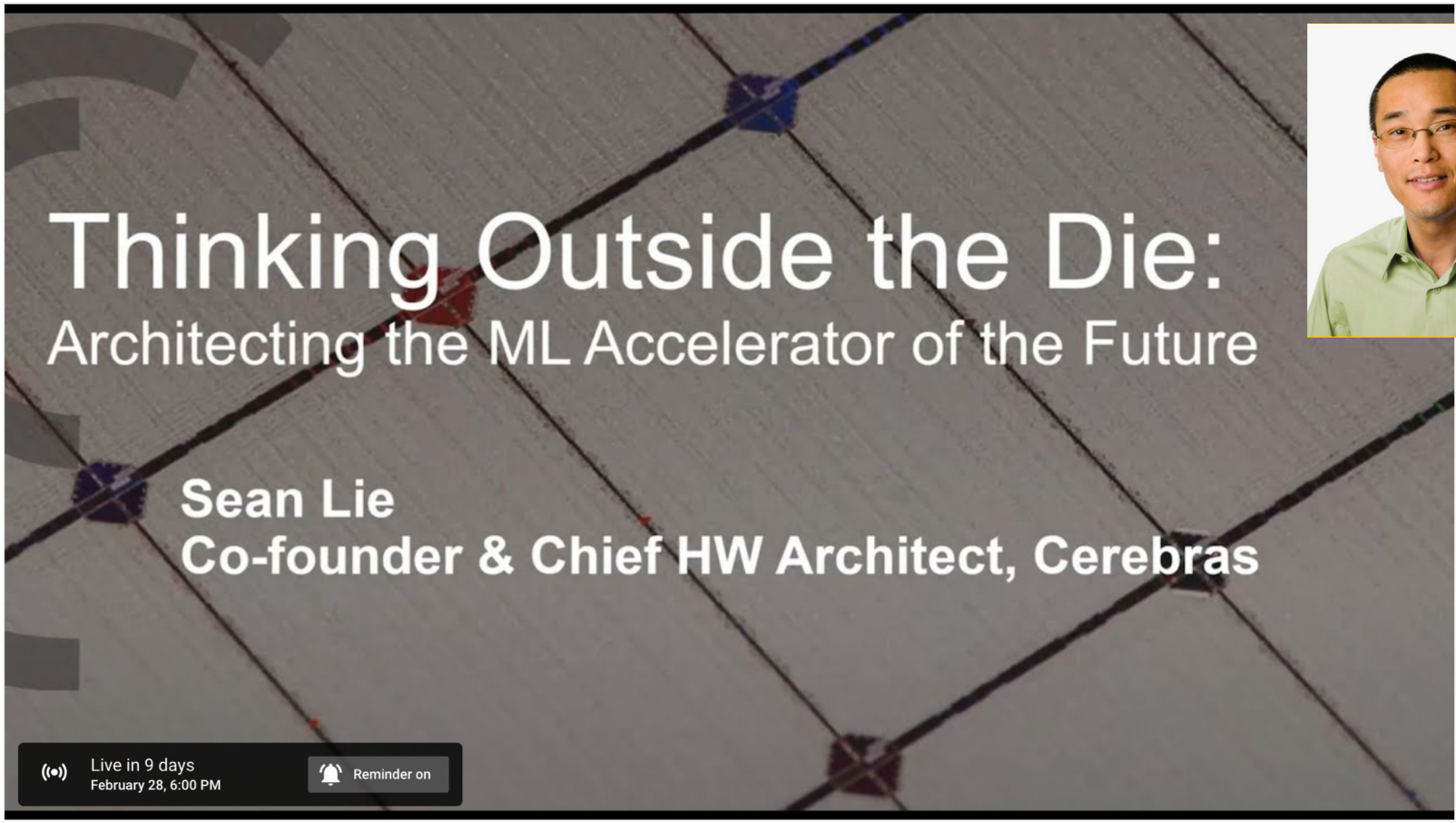
Join us for our SAFARI Live Seminar with Sean Lie, Cerebras Systems

Monday, February 28 2022 at 6:00 pm Zurich time (CET)

https://www.youtube.com/watch?v=D8Hjy2iU9l4&list=PL5Q2soXY2Zi_tOTAYm--dYByNPL7JhwR9&index=1

Upcoming SAFARI Live Seminar (Feb 28)

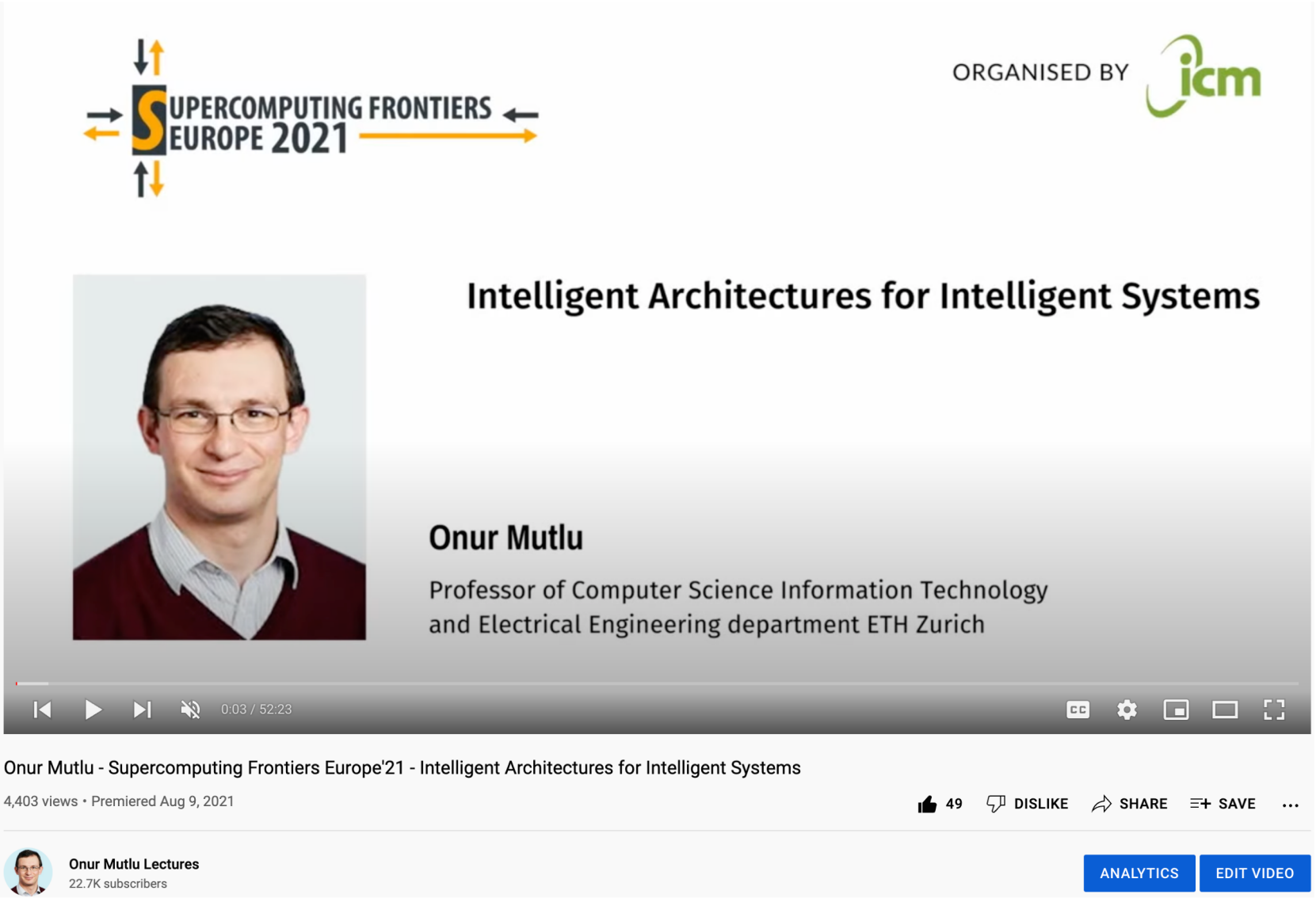
https://www.youtube.com/watch?v=x2-qB0J7KHw



Recommended Lecture for This Week

- Onur Mutlu,
  "Intelligent Architectures for Intelligent Systems"
  *Invited Talk at Supercomputing Frontiers Europe (**SCFE**)*,
  Virtual, 21 July 2021.
  [Slides (pptx) (pdf)]
  [Talk Video (52 minutes, including Q&A)]

Recommended Lecture for This Week



https://www.youtube.com/watch?v=jVYCchBGNVc&list=PL5Q2soXY2Zi8D_5MGV6EnXEJHnV2YFBJI&index=60

Seminar in Computer Architecture

Lecture 1a: Intro & Logistics

Prof. Onur Mutlu

ETH Zürich

Spring 2022

24 February 2022