Practical Lab

Computer Systems Lab

https://github.com/TUM-DSE/sys-lab

Dr. David Schall
Prof. Pramod Bhatotia

Course instructors

Dr. David Schall

Postdoc

Prof. Pramod Bhatotia

Professor

Systems Research Group

https://dse.in.tum.de/team/

Mentors

Jiyang Chen
PhD student

Francisco Romão
PhD student

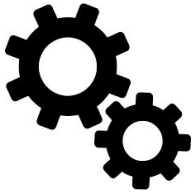
Patrick Sabanic
PhD student

David Schall
Postdoc

Computer systems lab (aka “sys-lab”)

Team
(~3-4 students per team)
advised by a mentor

Understand



Evaluate

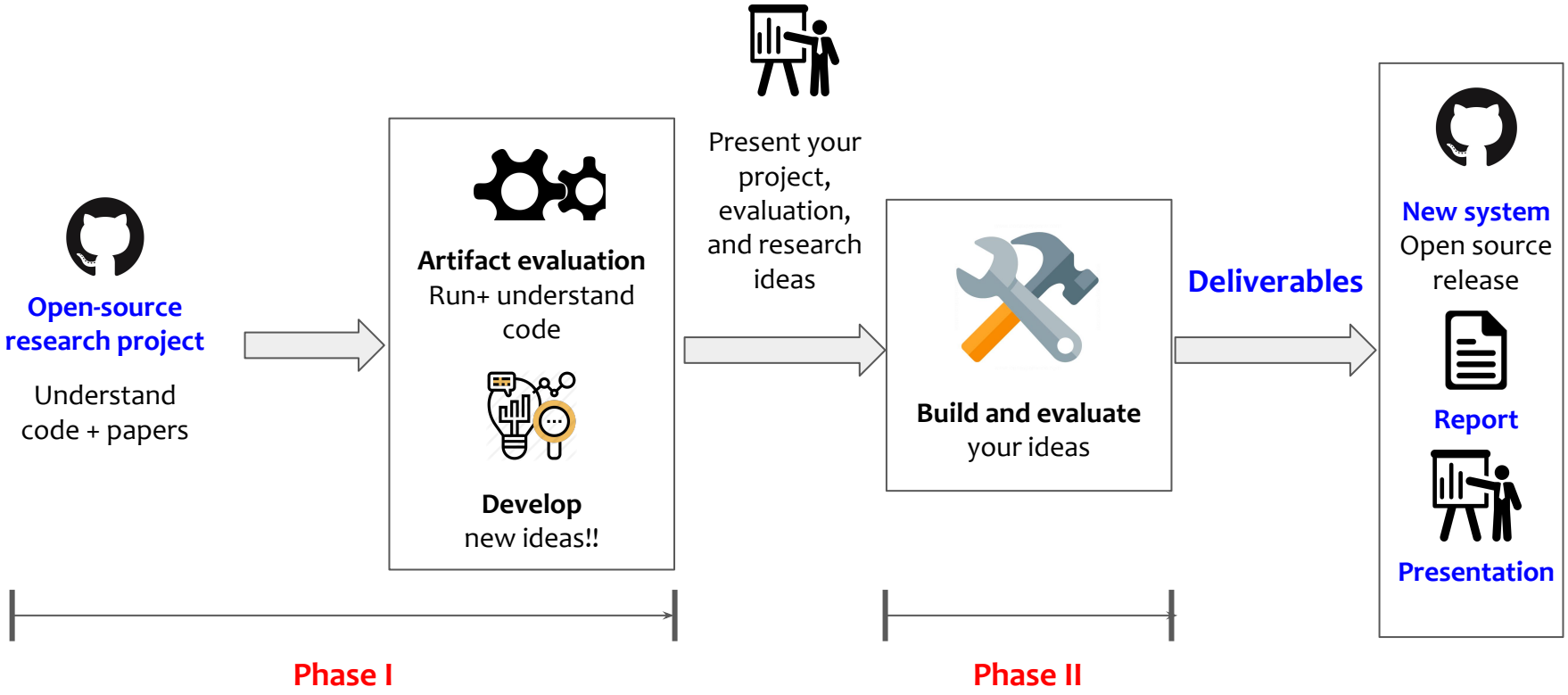
Generate ideas

Build on your ideas

sys-lab

Open source project
(state-of-the-art research topic)

Format


Open-source research project
Understand code + papers
Artifact evaluation
Run+ understand code
Develop
new ideas!!
Present your project, evaluation, and research ideas
Build and evaluate
your ideas
Deliverables
New system
Open source release
Report
Presentation
Phase I
Phase II

Focus of this Lab

- State of the art open-source computer systems projects

- End-to-end system design and development
  - What is it? → Learn by understanding the system
  - How can we use it? → Learn by evaluating the system
  - What can be improved? → Learn by generating new ideas!
  - How to realise our ideas? → Learn by building the system

Topics (WS 24/25)

Projects are based on the research themes at the chair

1. Hardware acceleration (Jiyang Chen)
2. Quantum simulation (Francisco Ramao)
3. Cloud security (Patrick Sabanic)
4. Computer architecture (David Schall)

Project selection – Each project will have up to 4 team members

- Add **your name to a project** in the following spreadsheet https://docs.google.com/spreadsheets/d/16l99dSNBTV5wBZRtSoe_EnveJ_r0gW6J68lkTzeILbU/edit?usp=sharing
- **Only one choice per student, FCFS!**

Project #1: Hardware acceleration

Project lead: Jiyang

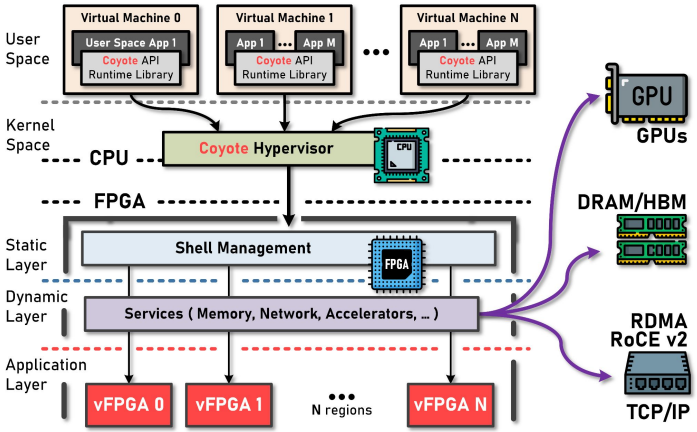
Context and motivation:

- FPGA shell is a framework that provides OS-like services for FPGA applications
- Existing shells do not support dynamically loading services

Research:

- Evaluate services in state-of-art FPGA shell
- Explore porting static services to dynamic ones

Artifact: Coyote v2



Project #2: Quantum simulation

Project lead: Francisco

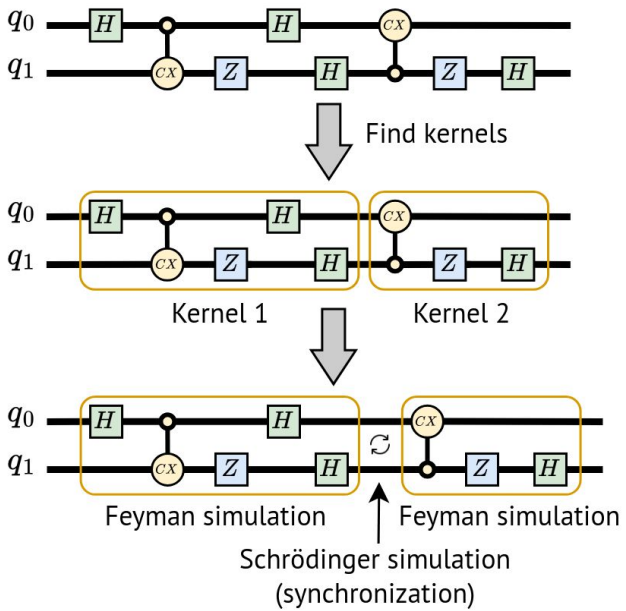
Context and motivation:

- Quantum simulation allows to explore quantum algorithms more efficiently, without hardware errors or resource constraints
- The complexity of simulating quantum circuits grows exponentially with the number of qubits, in time and in memory usage

Research:

- The objective of this is to reduce the time and memory usage of a quantum simulate, thus improving its scalability

Artifact: GraFeyn



Project #3: Cloud security

Project lead: Patrick

Context and motivation:

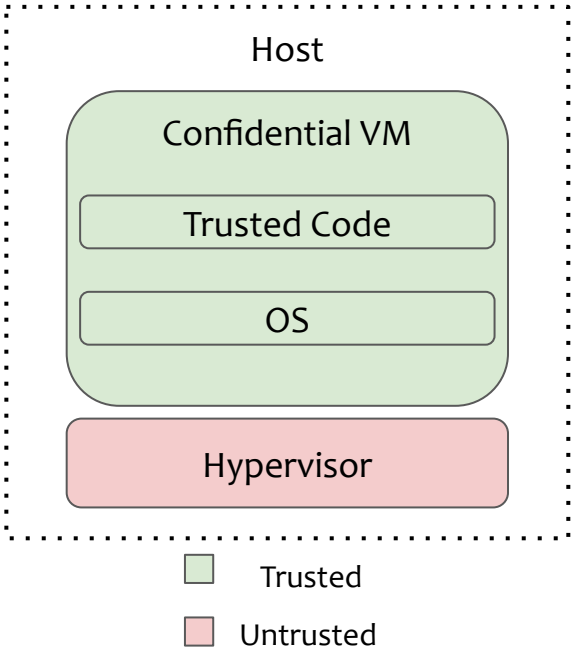
- Modern cloud offers confidential computing in the form of TEEs such as AMD SEV-SNP or Intel SGX
- TEEs often don't provide persistence and other cryptographic measure need to be taken, which might then be vulnerable to rollback attacks

Research:

- Evaluate the performance and effectiveness
- Explore possible improvements

Technology: Confidential Virtual Machines (AMD SEV-SNP) / Intel SGX

Artifact: Nimble

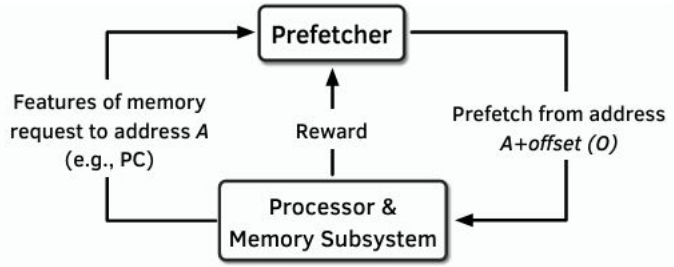


Project #4: Computer Architecture

Project lead: David

Context and motivation:

- Hardware prefetching is a key microarchitectural technique to overcome the memory wall
- Prefetching must be timely to be effective and not detrimental
- Reinforcement learning is a promising solution but complex



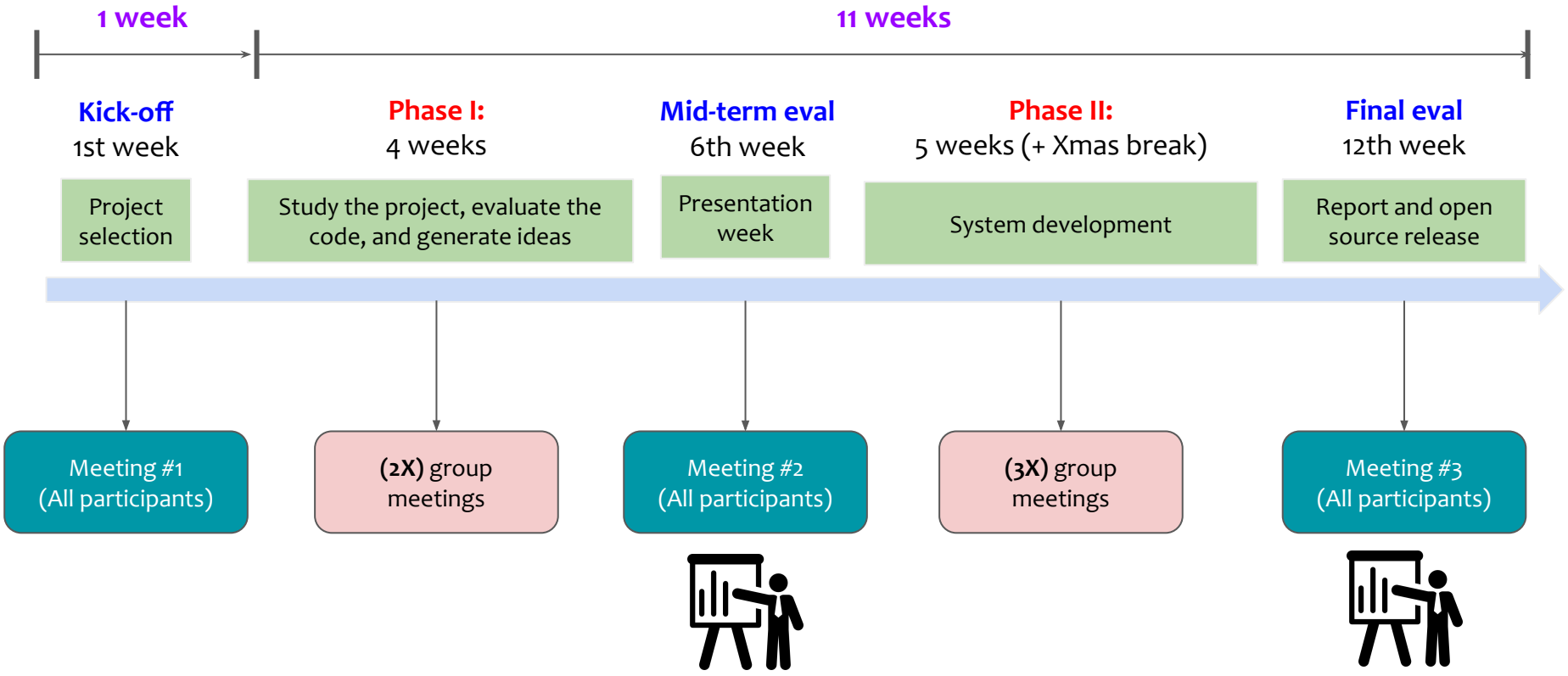
Research:

- Evaluate the effectiveness of existing features
- Explore new features and optimizations

Technology: Hardware simulation (ChampSim)

Artifact: Pythia

Timeline


1 week
11 weeks
Kick-off
1st week
Project selection
Phase I:
4 weeks
Study the project, evaluate the code, and generate ideas
Mid-term eval
6th week
Presentation week
Phase II:
5 weeks (+ Xmas break)
System development
Final eval
12th week
Report and open source release
Meeting #1 (All participants)
(2X) group meetings
Meeting #2 (All participants)
(3X) group meetings
Meeting #3 (All participants)

Phase #1 deliverables

- (1x) Presentation
  - Explain the research work covered in the paper
  - Artifact evaluation and main findings
  - Research ideas (a laundry list)
- (1x) Report
  - A brief summary of the research work
  - Artifact evaluation results (expected vs obtained results)
  - A summary of research ideas (one idea per team member)

Phase #2 deliverables

- (1x) Presentation
  - Explain your research proposal and key ideas
  - Explain the system design and implementation
  - Present key results
- (1x) Report
  - Explain your research proposal and key ideas
  - Explain the system design and implementation
  - Present key results
- Code
  - Properly documented source code of implemented system

Dates

All participant meetings – **IN PERSON**	**Dates (Thu, 13:00h)**
Kick-off: Project selection	17th October 2024 (**13:00h-14:00h**)
Phase I: Mid-term evaluation	28th November 2024 (**13:00h-16:00h**)
Phase II : Final evaluation	30th January 2025 (**13:00h-17:00h**)

Group meetings – **Preferably IN PERSON**	**Dates**
(2x) phase I group meetings	Directly organized with the team mentor
(3x) Phase II group meetings	Directly organized with the team mentor

Report submission

Per email to:

- Your project lead
- CC: David (david.schall@tum.de)

Deadline: Same as the presentation deadlines!

Grading

Category	Details	Grade
Phase I: Artifact evaluation	Running and evaluating code by reproducing the results described by the authors	20%
Phase II: System building	Extending the system with your own ideas	40%
(2x) Presentations	Two presentations are due after each phase, audience participation is also graded	20%
Report + Open-source release	One report covering all aspects	20%

Grading

Category	Details	Grade
Phase I: Artifact evaluation	Running and evaluating code by reproducing the results described by the authors	20%
Phase II: System building	Extending the system with your own ideas	40%
(2x) Presentations	Two presentations are due after each phase, audience participation is also graded	20%
Report + Open-source release	One report covering all aspects	20%

If applicable: Pull requests to the project -> Bonus points

Organization

- **Project-based course (~4 students per team) advised by a Team Leader**
- **Meetings:**
  - **3x** all participant meetings
  - **5x** group meetings (with the team mentor)
- **Communication:**
  - Slack: course channel for announcements and group channel for the team work
- **Format:**
  - **Meeting #1: Kick-off** -- project selection, team formation, and next steps
  - **Meeting #2: Intermediate presentation** covering overview, evaluation, and new ideas!
  - **Meeting #3: Final presentation** covering your final contributions (demo, code, & report)

Learning goals

- Our goal is to have fun breaking and hacking computer systems
- Learn about cutting-edge research in computer systems
- Cultivate an environment for innovation and collaboration
  - Pushes the boundaries of the state of the art
  - Contributing to ongoing open-source research projects
- Communication: presenting your work to your peers and giving constructive feedback to improve other's work
- Reproducibility: delivering your work such that others can build on it

Code of conduct

- University plagiarism policy
  - https://www.in.tum.de/en/current-students/administrative-matters/student-code-of-conduct/

- Decorum
  - Promote freedom of thoughts and open exchange of ideas
  - Cultivate dignity, understanding and mutual respect, and embrace diversity
  - Racism and bullying will not be tolerated

Contacts

- David Schall
  - david.schall@tum.de
- Prof. Pramod Bhatotia
  - pramod.bhatotia@tum.de

  - **All course information:** https://github.com/TUM-DSE/sys-lab

Workspace: http://ls1-courses-tum.slack.com/

Channel: #ws-24-sys-lab

Join us with TUM email address (@tum.de)

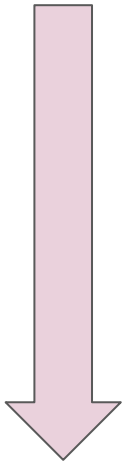
NOTE

Phase #1 Presentation

Format

- Structure your presentation across four dimensions

31 mins
per team



1. **Research paper** ~7 mins
2. **Artifact evaluation** ~7 mins
3. **Research ideas** ~7 mins
4. **Discussion** ~10 mins

Presentation guidelines

1. Research work **("Explain the research paper")**
   a. What is the problem?
   b. Why is it important or interesting?
   c. What is the state-of-the-art? What is the "research gap"?
   d. Why is it difficult? Or what are the challenges?
2. Artifact evaluation **("Explain your evaluation")**
   a. Explain the experimental setup and methodology
   b. Explain the key results (expected vs obtained results)
   c. What are the key findings
3. Potential of future work **("Research ideas")**
   a. How can you improve the solution or evaluation?
   b. Are there any other interesting problems or alternative approaches?
   c. Can the proposed techniques or solutions applicable for different problems/context?

At this stage: It's OK to have a laundry list of potential ideas (one per team member)!
We will jointly brainstorm and pick one idea for the research exploration phase

Presentation template

- Please prepare your presentation using the following template:

  https://docs.google.com/presentation/d/1ytwJP9atgGDLwvJFyb_XWpVqTcxH6lzXpODJLbKqQvc/edit?usp=drive_link

- If you hesitate to use Google docs for personal/data protection issues, please feel free to use a different software.

References

- How to give presentation
  - Markus Puschel: How to give good technical presentations
    - https://people.inf.ethz.ch/markusp/teaching/guides/guide-presentations-new.pdf
  - Simon Peyton Jones: How to give a great research talk
    - https://www.microsoft.com/en-us/research/academic-program/give-great-research-talk/

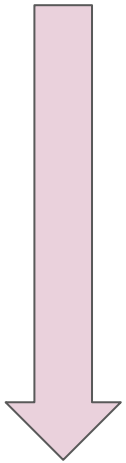
NOTE

Phase #2 Presentation

Format

- Structure your presentation across four dimensions

31 mins
per team



1. **Research proposal** ~7 mins
2. **Contributions** ~7 mins
3. **Evaluation results** ~7 mins
4. **Discussion** ~10 mins

Presentation guidelines

1. Your research proposal **(“Why”?)**
   a. What is the problem?
   b. Why is it important or interesting?
   c. What is the state-of-the-art? What is the “research gap”?
   d. Why is it difficult? Or what are the challenges?
2. Contributions of the work **(“How”?)**
   a. What is the proposed solution?
   b. What are the key insights? And what are the novel aspects?
   c. How did you design and implement the system?
3. Evaluation **(“Evaluation”)**
   a. How did your solution improved the state-of-the-art?
   b. What are the key findings or results?

Presentation template

- Please prepare your presentation using the following template:

  https://docs.google.com/presentation/d/1ytwJP9atgGDLwvJFyb_XWpVqTcxH6lzXpODJLbKqQvc/edit?usp=drive_link

- If you hesitate to use Google docs for personal/data protection issues, please feel free to use a different software.

References

- How to give presentation
  - Markus Puschel: How to give good technical presentations
    - https://people.inf.ethz.ch/markusp/teaching/guides/guide-presentations-new.pdf
  - Simon Peyton Jones: How to give a great research talk
    - https://www.microsoft.com/en-us/research/academic-program/give-great-research-talk/

NOTE

Phase #1 Report Instructions

Report

- We require a report covering three parts:
  - Part A: Paper summary
  - Part B: Artifact evaluation results
  - Part C: Research ideas (one idea per team member)

- Report format
  - Short and sweet
  - USENIX format: https://www.usenix.org/conferences/author-resources/paper-templates

Part A: Paper summary (1 page)

1. Context of the work **("Why"?)**
   a. What is the problem?
   b. Why is it important or interesting?
   c. What is the state-of-the-art? What is the "research gap"?
   d. Why is it difficult? Or what are the challenges?
2. Contributions of the work **("How"?)**
   a. What is the proposed solution?
   b. How it works at a high-level?
   c. What are the key insights?
   d. Or what are the novel aspects?

Part B: Artifact evaluation results

1. Explain the experimental setup and methodology
2. Evaluation results (expected vs obtained results)
3. Key findings

Part C: Research proposal

1. Context of your research **(“Why”?)**
   a. What is the problem?
   b. Why is it important or interesting?
   c. Why is it difficult? Or what are the challenges?
2. Proposed approach of your research work **(“How”?)**
   a. What is the proposed idea?
   b. How will it work?
   c. How would you measure and evaluate the idea?
   d. What would be the potential impact?

NOTE

Phase #2 Report Instructions

Report

- We require a report covering two parts:
  - Part A: Research proposal
  - Part B: Present key results and findings

Important: Host your source code on Github and include the link as part of the report

- Report format
  - Short and sweet
  - At most 5 pages, excluding references
  - USENIX format: https://www.usenix.org/conferences/author-resources/paper-templates

Part A: Research proposal

1. Context of the work **(“Why”?)**
   a. What is the problem?
   b. Why is it important or interesting?
   c. What is the state-of-the-art? What is the “research gap”?
   d. Why is it difficult? Or what are the challenges?
2. Contributions of the work **(“How”?)**
   a. What is the proposed solution?
   b. How it works at a high-level?
   c. What are the key insights?
   d. Or what are the novel aspects?
3. Design and Implementation **(“How”?)**
   a. Explain how did you design and implement the system

Part B: Evaluation

1. Explain the experimental setup and methodology
2. Evaluation results
3. Key findings

References

- How to write report
  - Simon Peyton Jones: *How to write a great research paper*
    - https://www.microsoft.com/en-us/research/academic-program/write-great-research-paper/
  - *How to write a great research proposal*
    - https://www.microsoft.com/en-us/research/academic-program/how-to-write-a-great-research-proposal/