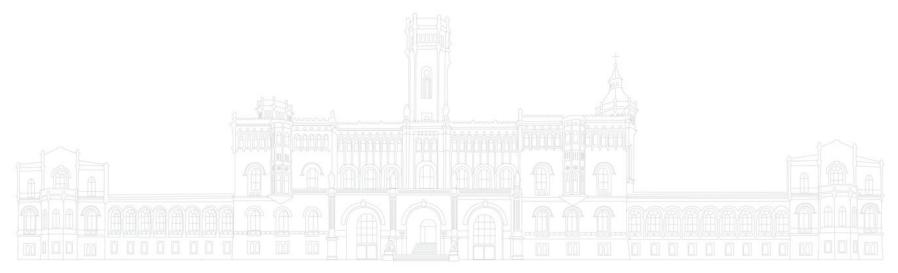# Advanced Topics in Deep Reinforcement Learning

Project

Learning Goals

Knowledge Goals:

- Overview of current RL, MetaRL & AutoRL research landscape
- Modelling real-world problems as RL tasks
- Challenges of different RL paradigms
- Best empirical practices for RL

Skill Goals:

- Find, read and discuss current research
- Synthesize new solutions from the literature
- Present and iterate on own ideas
- Implement state-of-the-art RL algorithms

What Is The Exam?

- Oral exam with project part
- You write a research proposal and can use all results and materials from your pitches
- You present this proposal during the exam and will answer questions
- The second part of the exam will be about the lecture content
- Grading:
    - 50% proposal, 50% Q&A
    - We use your proposed grade if there are no significant disagreements (i.e. difference of a full grade or more)

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- Pick any idea within the lecture scope (which is most of empirical RL)
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- Needs to contain:
  - Motivation of the research question(s)
  - Prior work related to your idea (incl. at least 3 papers not from the lecture slides!)
  - Explanation of your approach
  - Experimental details
  - First set of experiments (they do not need to work!)
  - Explanation of the experimental results

What Is A 4-page Workshop Paper?

- Same basic structure as a full conference paper
- Results and evaluations are still preliminary
    - Not tested on many environments
    - No significant results yet
    - Results can't be explained well, only theorized about

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Example: the SPaCE workshop paper

- Results already look good and there is some analysis
- Evaluation is very limited (one environment and no good baselines)

What To Submit

- Proposal

- Link to public GitHub repository

- Self-grading sheet (see template)

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  - At most 5 pages (can be as short as 3) excl. citations
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- Proposal
    - At most 5 pages (can be as short as 3) excl. citations
    - Use latex template I'll send around in StudIP
    - No appendix
- Link to public GitHub repository
    - All code you use
    - Readme explaining how to run experiments
    - Your result data
- Self-grading sheet (see template)

How To Choose A Topic

- Are there any ideas you had for the seminar you'd like to extend?
- Are there any papers we talked about you thought had obvious flaws?
- Are there any problems that came up in discussion you think warrant further investigation?
- Are the any limitations we talked about in the lecture that have not been tested yet?

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- Be aware of implementation overhead

- Be aware of compute overhead

- Be aware of reproducibility issues

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- Be aware of reproducibility issues
    - If you want to build on an idea: check if it will likely reproduce
    - Have a backup plan: what happens if it doesn't?

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- HPO is important for everything you do, so have a plan where to get good hyperparameter configurations (can you tune yourself? can you reuse them?)

Benchmarking

- Stick to well-known benchmarks wherever possible
- For generalization problems: please use MiniGrid or CARL
- For offline RL: use Minari
- For HPO: use ARLBench if possible (for runtime reasons)
- Pufferlib is good for CPU parallel evaluations of common environments (including multi-agent ones)

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    - JAX is often harder to use than torch and not as established
    - Can be 100-1000x faster for RL
    - Intro notebook and new JAX RL library
- Best "library" for you want to use torch: CleanRL
- Good practice: check if you have a baseline whose code you can use

Rules

- Copying someone's idea or code without credit is plagiarism
- The research questions and experimental setup has to be your own
- You can get help and feedback from others (e.g. if you want to use the forum)
- You should still have written the full code and proposal you submit
- LLMs are okay if you acknowledge them and don't just copy their output

Self-Grading

- My reasoning: research is gambling and I can't see whether you get lucky or put in the work
- You score different aspects of your project for yourself
- There are also some open questions
- All of that will give you a final grade for the project
- We grade the Q&A separately and then briefly discuss whether we agree with your project grade or not
- If we think you were too hard on yourself, we will correct the grade up
- We only correct down if we disagree substantially with your assessment

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Example knowledge question: Which categories of curriculum learning did we discuss in the lecture?

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Example knowledge question: Which categories of curriculum learning did we discuss in the lecture?

Example opinion question: where do you think are challenges for NAS in RL?

Timeline

1. You have until the 09.09. 23:59 to submit your proposal
2. You have until the 13.09. 23:59 to submit slides for the exam
3. You'll be able to sign up for exam slots beforehand
4. You show up on time for your slot
5. You give a 10 minute presentation using your slides
6. We ask you questions about the project for roughly 5 minutes
7. We'll have a 15 minute Q&A session
8. You leave the room so we can debate your grades
9. You come back and we briefly talk about your grade proposal vs ours and tell you the result

Other LUHAI Lectures

- Lectures:
    - Interpretable ML in the winter semester
    - AutoML in the summer semester
    - Social Responsibility in ML in the summer semester
- Projects:
    - AutoML project in the winter semester
    - ML project (mini thesis) in the summer semester
    - New: RL + Robotics project next winter semester
        - Called "Projekt: Reinforcement Learning"
        - Group project on either our arms or our new dog