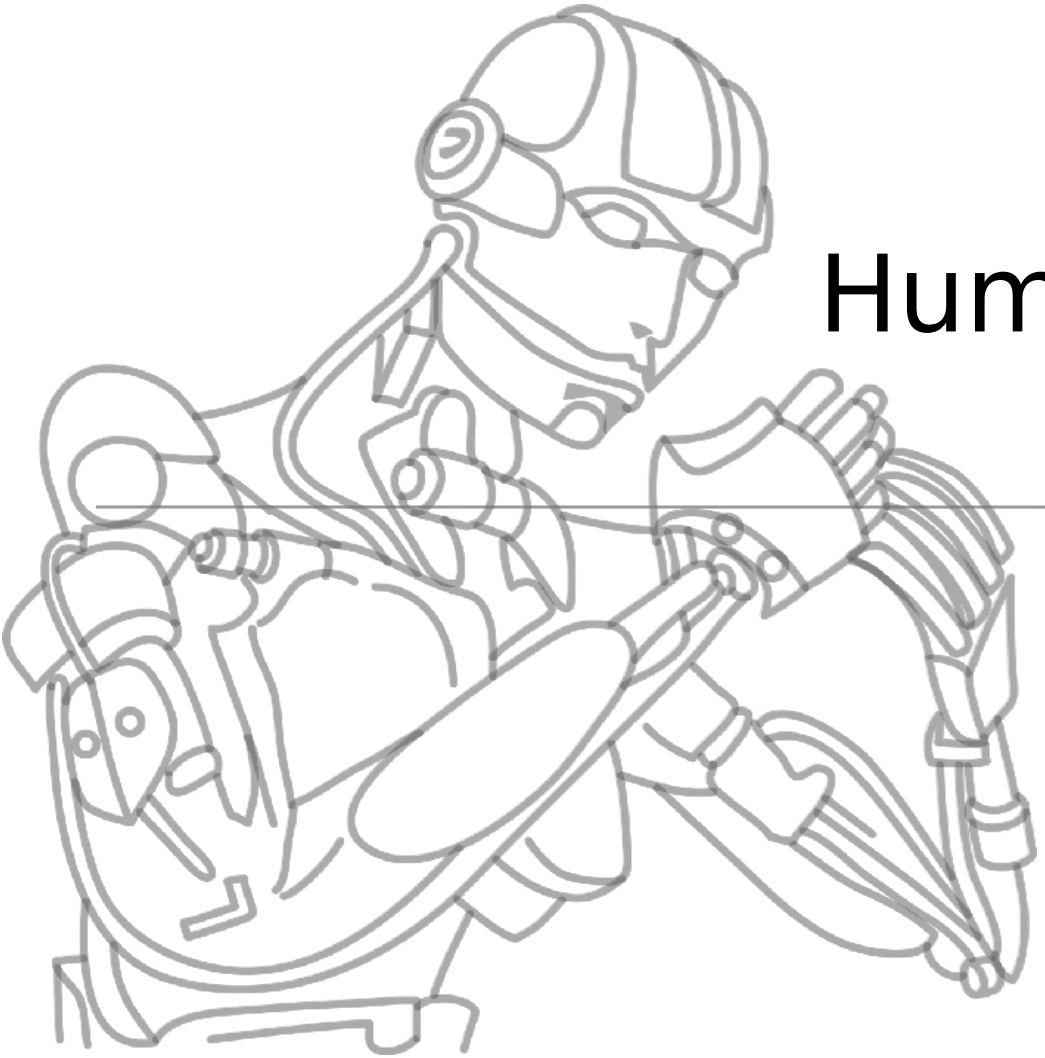


Seminar

Humanoid Robotics

TECHNISCHE UNIVERSITÄT DARMSTADT

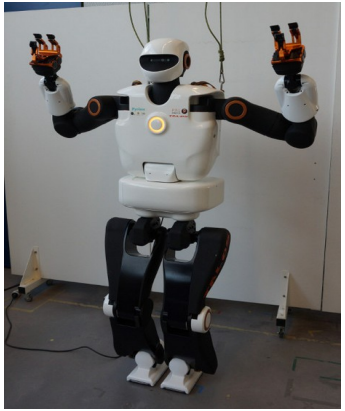
Today’s Agenda

1) Why Humanoids? (a teaser)
2) Organization
3) Offered Topics
4) Important Dates

Some Background

About me & the seminar:

- Permanent Postdoc @ IAS
- Responsible for the Humanoid Robotics Laboratory
  - We should get our TALOS by ~~End of 2022~~ July 2024
  - I'll coordinate research, supervise students & PhD students, own research, a bit of teaching, etc.



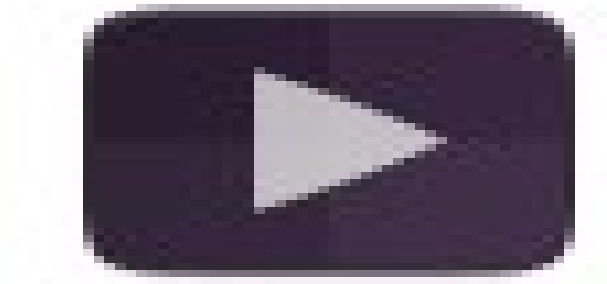
Seminar Goals:

For you: Get into a topic of your choice

For me: Get good students, HiWis, future PhDs, ...

Why Humanoids?

The State of Art I



The State of Art II

Open Problems

Impressive results for specific problems, but still a long way to go!*(just like AI)

Hard open problems:

- Performing many different skills
- Lifelong learning
- Using prior knowledge / models
- Long-Horizon Planning
- Human-Humanoid Interactions
- Scene Understanding
- ...

Today’s Agenda

1) Why Humanoids? (a teaser)
2) **Organization**
3) Offered Topics
4) Important Dates

Organization

Communication:

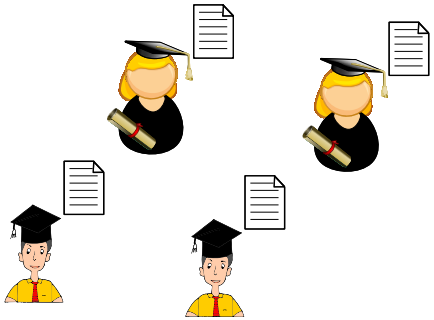
- I’ll send messages via TUCan (register!). Did anyone get my message?
- Join our discord server: https://discord.gg/C2XwjnwW (link valid till next Thursday, contact me directly after joining for getting proper permissions)
- Questions? Mail oleg.arenz@tu-darmstadt.de

Organization

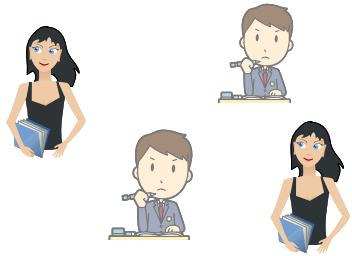
Three phases:

1) Topic Assignment
2) Studying
3) Peer-Teaching

Phase 1: Topic Assignment



Until Friday, 27.10.



Phase 1: Topic Assignment

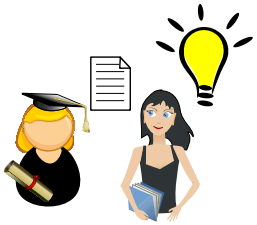
Topics will be presented later today.

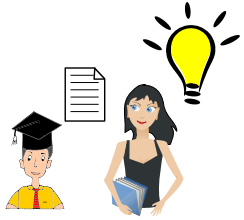
You need to send me an e-mail at latest next Monday (23:59) with

- An ordered list of topics you would like to study, e.g. “C > G = D > F”,
- Your relevant background and interests

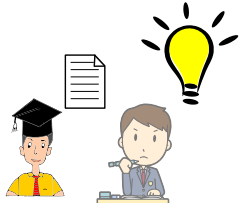
You choose our topics but the TAs also choose you!

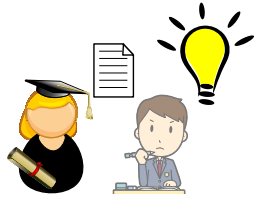
Phase 2: Studying





February, 2024





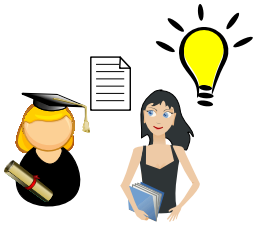
Phase 2: Studying

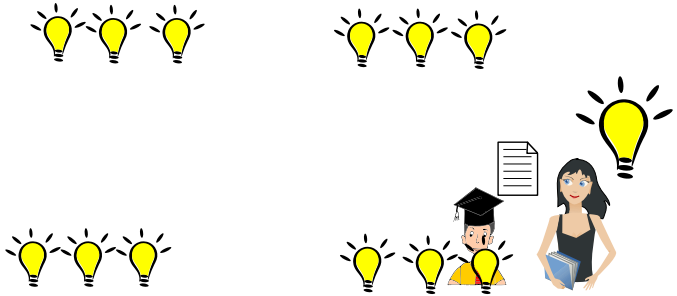
You should regularly meet with your advisor!

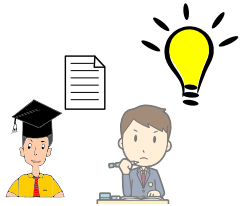
They will

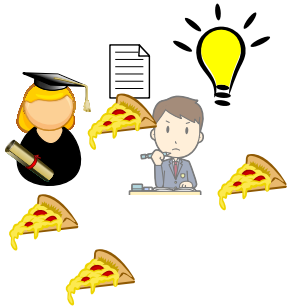
- help you understand,
- point you to related work,
- give you tips for your article and poster.

Phase 3: Peer-Teaching









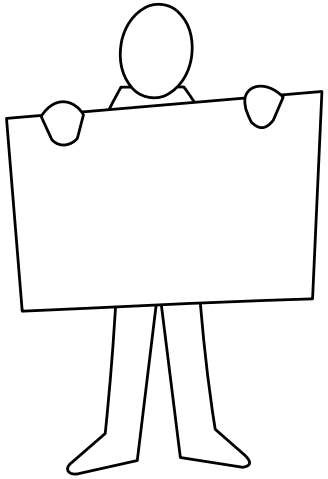
February, 2024

Phase 3: Peer-Teaching

Compress your main insights and communicate them to your peers.

1) Write a report (6-8 pages)

2) Present your topic during a poster session



Today’s Agenda

1) Why Humanoids? (a teaser)
2) Organization
3) **Offered Topics**
4) Important Dates

Offered Topics

A) Michael Drolet. Learning Natural Locomotion from Demonstrations.

B) Michael Drolet. Imitation Learning for Bimanual Manipulation.

C) Junning Huang. Optimal reduced-order modeling of bipedal locomotion.

D) Kay Hansel. Controlling Humanoid Robots: A Comprehensive Analysis of Teleoperation Frameworks, Challenges, and Solutions.

E) Paul Jansonnie. Bipedal Locomotion for Football.

F) Nico Bohlinger. Reinforcement Learning for Humanoid Locomotion.

G) Firas Al-Hafez. Combining Imitation Learning with Additional Objectives - Examples and Justifications.

H) Oleg Arenz. Gait Embeddings.

I) Oleg Arenz. A Comparative Review of Current Robot Simulators.

J) Supervisor X. The topic you are curious arbout!

Today’s Agenda

1) Why Humanoids? (a teaser)
2) Organization
3) Offered Topics
4) **Important Dates**

Important Dates

- Deadline for E-Mail with topic preferences: **Monday, 23.10. 23:59**
- Topic Assignments finished: Friday, 27.10. 23:59
- Deadline for Report: February, 2024
- Peer-Teaching Event: February, 2024

Any Questions?

Topic References (A)

Michael Drolet. Learning Natural Locomotion from Demonstrations.

a. Wang, Y., Jiang, Z., & Chen, J. (2023). Learning Robust, Agile, Natural Legged Locomotion Skills in the Wild. arXiv preprint arXiv:2304.10888.

b. Alejandro Escontrela, Xue Bin Peng, Wenhao Yu, Tingnan Zhang, Atil Iscen, Ken Goldberg, and Pieter Abbeel. Adversarial motion priors make good substitutes for complex reward functions. IROS. 2022

c. Xue Bin Peng, Erwin Coumans, Tingnan Zhang, Tsang-Wei Lee, Jie Tan, and Sergey Levine. Learning agile robotic locomotion skills by imitating animals. arXiv preprint arXiv:2004.00784, 2020

d. Vollenweider, E., Bjelonic, M., Klemm, V., Rudin, N., Lee, J., & Hutter, M. (2023, May). Advanced skills through multiple adversarial motion priors in reinforcement learning. ICRA

Topic References (B)

Michael Drolet. Imitation Learning for Bimanual Manipulation
a. Zhao, T. Z., Kumar, V., Levine, S., & Finn, C. (2023). Learning fine-grained bimanual manipulation with low-cost hardware. Robotics: Science and Systems (RSS)
b. Stepputtis, S., Bandari, M., Schaal, S., & Amor, H. B. (2022, October). A system for imitation learning of contact-rich bimanual manipulation policies. In 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 11810-11817). IEEE.
c. Xie, F., Chowdhury, A., De Paolis Kaluza, M., Zhao, L., Wong, L., & Yu, R. (2020). Deep imitation learning for bimanual robotic manipulation. Advances in neural information processing systems, 33, 2327-2337.

Topic References (C)

Junning Huang. Optimal reduced-order modeling of bipedal locomotion
a. Chen, Y. M., & Posa, M. (2020, May). Optimal reduced-order modeling of bipedal locomotion. In 2020 IEEE International Conference on Robotics and Automation (ICRA) (pp. 8753-8760). IEEE.
b. Chen, Y. M., Bui, H., & Posa, M. (2023). Reinforcement Learning for Reduced-order Models of Legged Robots. arXiv preprint arXiv:2310.09873.
c. Chen, Y. M., Hu, J., & Posa, M. (2023). Beyond Inverted Pendulums: Task-optimal Simple Models of Legged Locomotion. arXiv preprint arXiv:2301.02075.

Topic References (D)

Kay Hansel. Controlling Humanoid Robots: A Comprehensive Analysis of Teleoperation Frameworks, Challenges, and Solutions.
a. Penco, Luigi, et al. "A multimode teleoperation framework for humanoid loco-manipulation: An application for the icub robot." IEEE Robotics & Automation Magazine 26.4 (2019): 73-82.
b. Darvish, Kourosh, et al. "Teleoperation of humanoid robots: A survey." IEEE Transactions on Robotics (2023).
c. Jorgensen, Steven Jens, et al. "Deploying the nasa valkyrie humanoid for ied response: An initial approach and evaluation summary." 2019 IEEE-RAS 19th International Conference on Humanoid Robots (Humanoids). IEEE, 2019.

Topic References (E)

Paul Jansonnie. Bipedal Locomotion for Football
a. Haarnoja, T., Moran, B., Lever, G., Huang, S. H., Tirumala, D., Wulfmeier, M., ... & Heess, N. (2023). Learning agile soccer skills for a bipedal robot with deep reinforcement learning. arXiv preprint arXiv:2304.13653.

Topic References (F)

Nico Bohlinger. Reinforcement Learning for Humanoid Locomotion
a. Radosavovic, Ilija, Tete Xiao, Bike Zhang, Trevor Darrell, Jitendra Malik, and Koushil Sreenath. (2023). Learning Humanoid Locomotion with Transformers. arXiv preprint arXiv:2303.03381.
b. Siekmann, J., Green, K., Warila, J., Fern, A., & Hurst, J. (2021). Blind bipedal stair traversal via sim-to-real reinforcement learning. arXiv preprint arXiv:2105.08328.
c. Siekmann, J., Godse, Y., Fern, A., & Hurst, J. (2021). Sim-to-real learning of all common bipedal gaits via periodic reward composition. ICRA
d. Kumar, A., Li, Z., Zeng, J., Pathak, D., Sreenath, K., & Malik, J. (2022). Adapting rapid motor adaptation for bipedal robots. IROS

Topic References (G)

Firas Al-Hafez. Combining Imitation Learning with Additional Objectives - Examples and Justifications.

a. Xue Bin Peng, Ze Ma, Pieter Abbeel, Sergey Levine, Angjoo Kanazawa. AMP: Adversarial Motion Priors for Stylized Physics-Based Character Control. arxiv preprint arXiv:2104.02180, 2021

b. Wang, Y., Jiang, Z., & Chen, J. (2023). Learning Robust, Agile, Natural Legged Locomotion Skills in the Wild. arXiv preprint arXiv:2304.10888

Topic References (G)

Firas Al-Hafez. Combining Imitation Learning with Additional Objectives - Examples and Justifications.

a. Xue Bin Peng, Ze Ma, Pieter Abbeel, Sergey Levine, Angjoo Kanazawa. AMP: Adversarial Motion Priors for Stylized Physics-Based Character Control. arxiv preprint arXiv:2104.02180, 2021

b. Wang, Y., Jiang, Z., & Chen, J. (2023). Learning Robust, Agile, Natural Legged Locomotion Skills in the Wild. arXiv preprint arXiv:2304.10888

Topic References (H)

Oleg Arenz. Gait Embeddings

a. Bhattacharya, U., Roncal, C., Mittal, T., Chandra, R., Kapsaskis, K., Gray, K., ... & Manocha, D. (2020, August). Take an emotion walk: Perceiving emotions from gaits using hierarchical attention pooling and affective mapping. In European Conference on Computer Vision (pp. 145-163). Cham: Springer International Publishing.

b. Wu, J., Xue, Y., & Qi, C. (2023). Learning Multiple Gaits within Latent Space for Quadruped Robots. arXiv preprint arXiv:2308.03014.

Topic References (I)

Oleg Arenz. A Comparative Review of Current Robot Simulators

For example: Brax, IsaacSim, Mujoco 3, Gazebo, PyBullet, ...

Media References

Slide 3: Foto (top): O. Stasse u. a., „TALOS: A new humanoid research platform targeted for industrial applications“, Humanoids. 2017.
Slide 3: Foto (bottom): https://en.wikipedia.org/wiki/File:I_want_you.jpg
Slide 4: Video (left): https://www.youtube.com/watch?v=2dS0aDMQoD4&t=191s
Slide 4: Video (middle): https://www.youtube.com/watch?v=G8CYhk_59LM
Slide 4: Video (right): https://www.youtube.com/watch?v=P7oP70hkmbk
Slide 5: Video: https://www.youtube.com/watch?v=-e1_QhJ1EhQ
Slide 6: Video: https://www.youtube.com/watch?v=nzDkRjSPU_0
Slide 12-17: SVGs:
https://freesvg.org/vector-clip-art-of-copier-paper-icon,
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