ANDREA SCORSOGLIO

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PROFESSIONAL SUMMARY

- Graduate research assistant trained in the areas of aerospace engineering and machine learning. Current research emphasis on reinforcement learning, computer vision and physics informed neural networks applied to spacecraft guidance, navigation and control.
- Techincal skills aquired in the fields of coding using multiple programming languages (MATLAB, Python), applications and conducting multidisciplinary research.
- Experienced in discussing and critically thinking about engineering problems. Experience working with people with diverse backgrounds and personalities.
- Successful in communicating metodologies and achievements at engineering conferences and in peer reviewed articles.

EDUCATION

Jan 2019 – present

Doctor of Philosophy in Systems & Industrial Engineering
THE UNIVERSITY OF ARIZONA, Tucson, AZ, USA
Courses: Statistical Machine Learning, Theory of Linear Systems, Fundamentals of Optimization, Engineering Statistics, Stochastic Modeling, Orbital Mechanics and Space Flight, Spacecraft Optimal Estimation, Introduction to System Identification Methods, Computational Multi-body Dynamics.
Advisor: Prof. Roberto Furfaro

Oct 2015 – Jul 2018

Master of Science in Space Engineering
POLITECNICO DI MILANO, Milano, Italy
Relevant courses and projects:

- Space mission analysis and design - team project: develop feasibility study for space weather monitoring from Sun-Earth L5 lagrangian point. Lead of mission analysis group. Designed trajectories leveraging non-keplerian orbital dynamics. Developed system-wide requirements (system engineering).
- Modeling and simulation of aerospace systems - team project: modeling and simulation of real satellite system (GOCE) "drag free" control system. Designed and simulated the non-linear model of the electrostatic accelerometer coupled with the propulsion system and the orbital dynamics.
- Spacecraft attitude dynamics and control - project: modelling of the attitude determination and control system of a spacecraft.

Oct 2017 – April 2018

Visiting scholar at The University of Arizona, Tucson, AZ, USA
Developed master's dissertation: *Adaptive ZEM/ZEV feedback guidance for rendezvous in lunar NRO with collision avoidance*
Developed a proprietary advantage actor-critic algorithm both in MATLAB and Python. Used to obtain a state-dependent zero-effort-miss/zero-effort-velocity (ZEM/ZEV) guidance. The algorithm was applied to rendezvous in near rectilinear orbits with path constraints.
Advisors: Prof. Mauro Massari (Politecnico di Milano), Prof. Roberto Furfaro (University of Arizona)

Oct 2012 – Jul 2015

Bachelor's Degree in Aerospace Engineering
POLITECNICO DI MILANO, Milano, Italy
*Relevant courses: C*alculus I/II, Mechanics, Electromagnetism, Numerical Methods, Fluid Dynamics, Structural Mechanics, Introduction to Orbital Mechanics, Propulsion Systems.

EXPERIENCE

Jan 2019 – present **Graduate Research Assistant**
THE UNIVERSITY OF ARIZONA, Tucson, AZ, USA

- *Part of the Target Follow-up working group on the NASA mission Near Earth Objects Surveillance Mission (NEOSM) – currently in phase B*
  Developing a ranking and decision-making tool based on fuzzy cognitive maps, capable of assessing the importance of follow-up for each observed target and providing critical information to decision-makers for tasking space and ground assets. Also developing a simulator used, at this stage, to test the tool on a synthetic dataset of objects and that will then support real data inputs and will help the decision-making process on later phases of the mission.
- Working on an orbit determination and simulation pipeline that integrates Find_Orb orbit determination software with GMAT and MATLAB.
- Working on various research projects about applications of reinforcement learning to spacecraft guidance navigation and control, as well as physics informed neural networks for orbit determination.
- Collaborated in the University of Arizona CubeSat project (CatSat) as attitude dynamics and control, and simulation lead. Learned to use the MATLAB package "Spacecraft Control Toolbox (SCT)" from Princeton Satellite Systems.
- Collaborated on a tool that generates and maintains a catalog of objects in cislunar space by performing orbit determination and matching. Part of a team that designed and maintains a webpage for requests of data products related to the project.
- Worked as teaching assistant for the class of Theory of Linear Systems. Graded assignments and kept student class records for a class of roughly 20 people as well as provided assistance to students during office hours.

Oct-Dec 2018 **High School Teacher**
LICEO MELCHIORRE GIOIA, Piacenza, Italy
Developed a teaching program in two mathematics courses at different levels. Explained concepts of varying difficulties to different audiences (aged 14-16). Developed a testing and grading strategy.

RESEARCH EXPERIENCE

Topics: (meta-)reinforcement learning, recurrent neural networks, convolutional neural networks, semantic segmentation, physics informed neural networks, systems visualization, computer vision and 3D simulation, guidance navigation and control, keplerian and non-keplerian orbital mechanics, orbit determination, modeling and simulation of linear and non-linear systems.

- Worked on a proprietary **advantage actor-critic reinforcement learning** algorithm coded from scratch in MATLAB and Python. The method is based on a radial-basis function network that allows for spacial representation of neurons and very fast training for low dimensional inputs. Applied to planetary landing and relative motion in highly non-linear systems.
- Working on **computer vision for space applications**.
  - Developed an in-house simulator for **real-time rendering of 3D visual environments** based on Blender and OpenAI Gym. Created custom OpenAI Gym environment for testing. Used on different projects to train reinforcement learning agents.
  - Used **semantic segmentation** to obtain **hazard maps** of lunar surface based on digital terrain models, to be used for on-line landing site selection.
  - Used visual simulator and hazard maps to train a meta-reinforcement learning model for **real-time landing site selection** and landing guidance.
- Worked on **meta-reinforcement learning** techniques using recurrent and convolutional neural networks.
  - Used proximal policy optimization (PPO) with convolutional-recurrent neural networks to create a guidance algorithm for planetary landing with optical observations and uncertain dynamics and engine failures (coded in Python using PyTorch).
  - Applied a similar architecture based on convolutional-recurrent neural networks to a binary asteroid redirect mission (used the Python package RLlib).
  - Applied recurrent neural networks also to generate a guidance algorithm capable of carrying out multi-target missions in the asteroid belt.
- Collaborated on recurrent neural networks for velocity estimation of a satellite using optical measurements in asteroid environment.

- Working on **physics informed neural networks** for orbit determination applications. Applied a neural network to learn the state of a satellite both in keplerian and non-keplerian dynamics using range/range-rate and angle measurements. Used the physics of the problem to regularize training which makes for better generalization of the solution to points in the training domain. Coded in MATLAB with no additional packages.

CONFERENCE PAPERS AND PREPRINTS

- **Scorsoglio, A.,** Furfaro, R., Linares, R., & Massari, M. (2019). Actor-critic reinforcement learning approach to relative motion guidance in near-rectilinear orbit. *29th AAS/AIAA Space Flight Mechanics Meeting, 2019, Ka'anapali, Maui, HI, Advances in the Astronautical Sciences*, *168*, 1737-1756.
- **Scorsoglio, A.,** & Furfaro, R. (2019). ELM-based Actor-Critic Approach to Lyapunov Vector Fields Relative Motion Guidance in Near-Rectilinear Orbit. In *AAS/AIAA Astrodynamics Specialist Conference, 2019, Portland, ME*. *Advances in the Astronautical Sciences* 171 (2019) (pp. 1-20).
- **Scorsoglio, A.,** Furfaro, R., Linares, R., & Gaudet, B. (2020). Image-based deep reinforcement learning for autonomous lunar landing. In *AIAA Scitech 2020 Forum* (p. 1910).
- **Scorsoglio, A.,** D'Ambrosio, A., Ghilardi, L., Furfaro, R., Gaudet, B., Linares, R., & Curti, F. (2020, August). Safe Lunar landing via images: A Reinforcement Meta-Learning application to autonomous hazard avoidance and landing. In *Proceedings of the 2020 AAS/AIAA Astrodynamics Specialist Conference, Virtual* (pp. 9-12).
- **Scorsoglio, Andrea,** et al. "Orbit determination via physics informed neural networks." *31st AAS/AIAA Space Flight Mechanics Meeting, Virtual, 2021.*
- **Scorsoglio, Andrea** et al. "Orbit determination via physics informed neural networks in cislunar environment." *AAS/AIAA Astrodynamics Specialist Conference, Big Sky Virtual, 2021.*
- **Scorsoglio, A.,** & Furfaro, R. (2021). VisualEnv: visual Gym environments with Blender. *arXiv preprint arXiv:2111.08096*.
- Holt, H., Armellin, R., **Scorsoglio, A**., & Furfaro, R. (2020). Low-thrust trajectory design using closed-loop feedback-driven control laws and state-dependent parameters. In *AIAA Scitech 2020 Forum* (p. 1694).
- Holt, H. J., Armellin, R., Baresi, N**., Scorsoglio, A.,** & Furfaro, R. (2020). Low-thrust trajectory design using state-dependent closed-loop control laws and reinforcement learning. In *2020 AAS/AIAA Astrodynamics Specialist Conference*. University of Surrey.
- Furfaro, R., Drozd, K., Linares, R., Gaudet, B., & **Scorsoglio, A.** (2020). Deep imitation learning and clustering in astrodynamics. In *AAS/AIAA Astrodynamics Specialist Conference, 2019* (pp. 3567-3584). Univelt Inc..
- Federici, L., **Scorsoglio, A.,** Zavoli, A., & Furfaro, R. (2021). Autonomous Guidance for Cislunar Orbit Transfers via Reinforcement Learning. In *AAS/AIAA Astrodynamics Specialist Conference*.
- Federici, L., **Scorsoglio, A.,** Zavoli, A., & Furfaro, R. (2021). Meta-Reinforcement Learning for Adaptive Spacecraft Guidance during Multi-Target Mission. In *72nd International Astronautical Congress (IAC) 2021*.
- Federici, L., **Scorsoglio, A**., Ghilardi, L., D'Ambrosio, A., Benedikter, B., & Furfaro, R. (2022). Image-Based Meta-Reinforcement Learning for Autonomous Terminal Guidance of an Impactor in a Binary Asteroid Systems. In *AIAA SCITECH 2022 Forum* (p. 2270).
- Furfaro, R., D'Ambrosio, A., Schiassi, E., & **Scorsoglio, A.** (2022). Physics-Informed Neural Networks for Closed-Loop Guidance and Control in Aerospace Systems. In *AIAA SCITECH 2022 Forum* (p. 0361).

PEER REVIEWED ARTICLES

- **Scorsoglio, A.,** D'Ambrosio, A., Ghilardi, L., Gaudet, B., Curti, F., & Furfaro, R. (2021). Image-Based Deep Reinforcement Meta-Learning for Autonomous Lunar Landing. *Journal of Spacecraft and Rockets*, 1-13.
- Furfaro, R., **Scorsoglio, A.,** Linares, R., & Massari, M. (2020). Adaptive generalized ZEM-ZEV feedback guidance for planetary landing via a deep reinforcement learning approach. *Acta Astronautica*, *171*, 156-171.
- Holt, H., Armellin, R., Baresi, N., Hashida, Y., Turconi, A., **Scorsoglio, A.,** & Furfaro, R. (2021). Optimal Q-laws via reinforcement learning with guaranteed stability. *Acta Astronautica*, *187*, 511-528.
- Gaudet, B., Furfaro, R., Linares, R., & **Scorsoglio, A.** (2021). Reinforcement Metalearning for Interception of Maneuvering Exoatmospheric Targets with Parasitic Attitude Loop. *Journal of Spacecraft and Rockets*, *58*(2), 386-399.
- **Scorsoglio, A,** Ghilardi, L., & Furfaro, R., (2022), Orbit Determination via Physics Informed Neural Networks, *Journal of Astronautical Sciences* (in preparation)

SKILLS

Essential: Public Speaking | Time Management | Problem Solving | Teamwork | Critical Thinking | Research Strategy

Computer

- Programming languages and data analysis: MATLAB | Python | R

- Python Packages: PyTorch | Tensorflow/Keras | OpenAI gym | OpenAI baselines | Ray RLlib | matplotlib | numpy | scipy
- Mission analysis: GMAT | Spacecraft Control Toolbox (SCT)
- Modeling and rendering software: Blender
- Game Engines: Unreal Engine 4
- CAD: Solid Edge | SolidWorks | Autodesk Inventor
- Productivity: Word | Excel | PowerPoint | Latex
- Operating systems: Linux/Unix | Windows | Mac OSX
- Command line interface and scripting: bash

Languages

Italian: native | English: fluent | Spanish: basic

OTHER ACTIVITIES

EBEC (European BEST Engineering Competition), *Board of European Students of Technology*.

2013, 2014 regional phase. 2015, 2016 national phase (second place)

Worked in a team to design and build a physical prototype to accomplish a predetermined task, given some constraints on actions, materials, and time. Developed problem solving and teamworking skills in a time-sensitive environment.