

NEWSLETTER



DIGI4ECO PROJECT: 1 YEAR OF SUCCESS

The DIGI4ECO project completed its first 12 months in March 2025, during which time it achieved notable progress in research and innovation.



Throughout the past year, DIGI4ECO has been making impressive progress. Our technical work packages have been advancing steadily, driving us closer to our ambitious goals with each milestone.

But it's not just about the technology –the project also made great headway in spreading the word, communicating project's objectives and highlights.



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SCIENTIFIC UPDATES

Marine Institute advances biological groundwork for the Digital Twin of Galway Bay

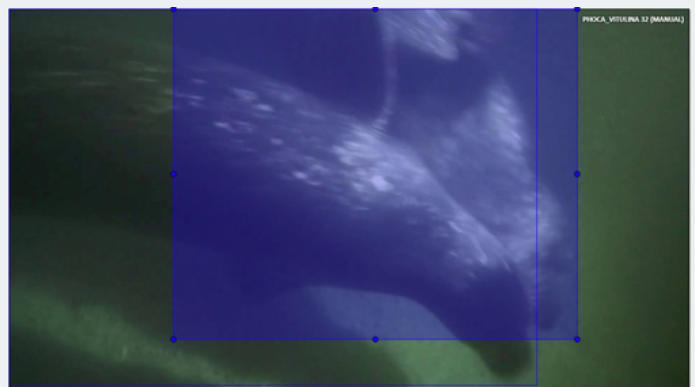


Marine Institute scientist Marco Francescangeli and bursar student Eva Crosse have built an impressive catalogue of over 600 species-labelled images—laying the groundwork for deeper biological analysis and smart monitoring solutions.

They have combined data from SmartBay observatory in Galway Bay, the MINKA citizen science repository and videos recorded at the Galway aquarium.

This work will lay the foundation for training a “You Only Look Once” model to automatically detect and classify fish species as well as seals (*Phoca vitulina*) in the large video repository of SmartBay observatory, which is collecting 24/7 videos of the surrounding marine environment since 2016 with fixed cameras.

This will greatly advance DIGI4ECO’s efforts to create a Digital Twin of the area, adding valuable biological information to complement existing environmental data.



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SCIENTIFIC UPDATES

GEOMAR Gears Up in Gullmars Fjord, Sweden – June 2025

The DIGI4ECO deployment is officially underway, as GEOMAR scientists made significant progress this June despite the challenging weather conditions.



Leveraging the opportunities provided by the concurrent Summer School held in the Kristineberg Marine Research institute, the team—comprised of Sascha Flögel, Ralf Schwarz, Marc Buss, Rink Teunis, and Morane Clavel-Henry—conducted a series of successful field tests in Gullmars Fjord.

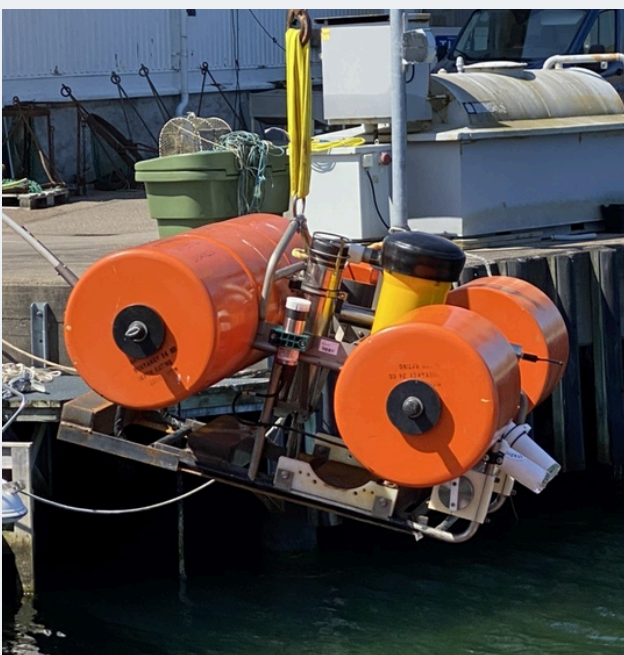
Key milestones included the deployment and testing of the Fuel Cell Lander, as well as the operation of the MANSIO-VIATOR systems under real-world conditions, utilizing both acoustic and optical homing technologies. Additionally, a sensor-equipped SLM (Satellite Lander Module) Lander was deployed to collect ecological data for several days.



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Environmental DNA (eDNA) samples were gathered both prior to and following lander deployments, while larval sampling was performed at multiple locations, both within and outside the primary test site. Thanks to GEOMAR flexible funds for postdoctoral activities.



These activities directly support DIGI4ECO's main objective: to develop a high-resolution, multi-dimensional understanding of marine ecosystems through the integration of spatial, environmental, molecular, and biological data.



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DISSEMINATION ACTIVITIES

Seminar in the School of Data Science of Chinese University of Hong Kong (CUHK)

The poster is for a seminar titled "Localize and Track Underwater Objects: From Autonomous Vehicles to Marine Animals" by speaker Ivan Masmitja. It features the logos of the Chinese University of Hong Kong (CUHK), the School of Data Science, and the SDBS (Seminar Data Science Series). The abstract discusses the challenges of tracking underwater targets and the use of deep reinforcement learning for optimal sensor placement and path planning. The poster also includes a section about the speaker, Ivan Masmitja, who is a researcher at the Instituto de Ciencias del Mar. At the bottom, it provides the date (02.19 February), time (2:00PM - 2:45PM), and venue (401 Meeting Room, Dao Yuan Building).

Speaker
Ivan Masmitja
Researcher
Instituto de Ciencias del Mar

Localize and Track Underwater Objects: From Autonomous Vehicles to Marine Animals

Abstract
Tracking underwater targets represents a major challenge for observing biological processes in situ, and methods to robustly respond to a changing environment during monitoring missions are needed. Analytical techniques for optimal sensor placement and path planning to locate underwater targets are not straightforward in complex scenarios such as multi-vehicle cooperation, highly mobile targets, or low informative sensors. Here we have investigated from traditional least square triangulation techniques and optimization sensor placement to the use of deep reinforcement learning as a tool for range-only underwater target tracking optimization, whose promising capabilities have been demonstrated in terrestrial scenarios. To evaluate its usefulness, a reinforcement learning method was implemented as a path-planning system for an autonomous surface vehicle while tracking an underwater mobile target. A complete description of an open-source model, performance metrics in simulated environments, and evaluated algorithms based on more than 15 hours of at-sea field experiments are presented. These efforts demonstrate that deep reinforcement learning is a powerful approach that enhances the abilities of autonomous robots in the ocean and encourages the deployment of algorithms like these for monitoring marine biological systems in the future.

About the Speaker
I love developing underwater technology. My interest is in using new algorithms and robotic platforms to study the movement of marine organisms as well as a wide range of other marine topics. PhD in Electronic Engineering (January 2020). I have extensive experience in electronic design, programming (Python, MATLAB, LabView, C++), embedded platforms, machine-learning algorithms, and experiment design. I have been working with range-only target tracking methods with autonomous underwater vehicles, and I have implemented (multi-agent) reinforcement learning algorithms to increase the vehicles' performance and tracking capabilities. Throughout my career, I have participated in a variety of field experiments, projects, and teaching and advising graduate and undergraduate students. I am very interested in working with a multi-disciplinary team to join efforts towards protecting our ocean. In 2020, I was awarded a postdoctoral Marie Skłodowska-Curie Actions Individual-Fellowship Global-Fellowship (AlforUTracking - ID:893089). I have conducted part of my postdoctoral research at the Monterey Bay Aquarium Research Institute - MBARI (California, USA), one of the world's top non-profit companies related to marine research, and at VICOROB research group from Universitat de Girona. I did part of my PhD studies at Iseñ Yncréa Ouest - Site De Brest (France) with Prof. Pierre-Jean Bouvet, and MBARI. Right now, I am a Ramon y Cajal researcher at Instituto de Ciencias del Mar (ICM-CSIC).

Host / Junfeng WU
Associate Professor
School of Data Science

02.19 February
BEIJING TIME **2:00PM - 2:45PM**
VENUE **401 Meeting Room**
Dao Yuan Building
CONTACT **7360 076 7000 0733**

QR code for SDBS Wechat

"Localize and Track Underwater Objects: From Autonomous Vehicles to Marine Animals"



19 February 2025



Shenzhen, China

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DISSEMINATION ACTIVITIES

Bilateral meeting with the Barcelona Supercomputing Centre (BSC)



17 February 2025



Barcelona, Spain.

DIGI4ECO was presented at the MSc course BLOC-512DL "Blockchain Systems and Architectures", at the University of Nicosia



**UNIVERSITY
of NICOSIA**



March 2025



Nicosia, Cyprus



**Funded by
the European Union**

DIGI4ECO has received funding from the European Union's Horizon Europe programme under grant agreement No 101112883.

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DISSEMINATION ACTIVITIES

Marine Institute Showcased DIGI4ECO at European Maritime Day 2025



21–23 May 2025



Cork, Ireland

UNITED NATIONS OCEAN CONFERENCE!



4–6 June 2025



Nice, France



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DISSEMINATION ACTIVITIES

iFOODis Project's Summer School

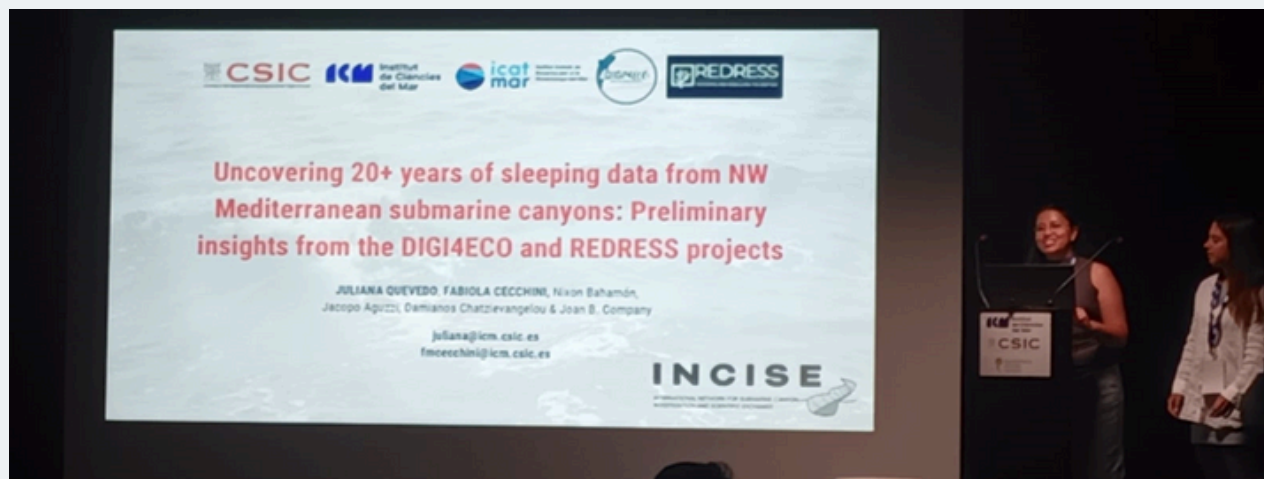


13 June 2025



Fiskebäckskil, Sweden

INCISE 2025 Conference



16-19 June 2025



Barcelona, Spain



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JOURNAL PUBLICATIONS

Published as a conference paper at ICLR 2025

SIMPLIFYING DEEP TEMPORAL DIFFERENCE LEARNING

Mattéo Galliet^{1,2} Mattie Fellows² Benjamin Ellis² Mario Martin¹
Bartomeu Posa^{1,3} Ivan Masmitja² Jakob Nicolai Foerster²
¹Universitat Politècnica de Catalunya ²University of Oxford
³Barcelona Supercomputing Center ⁴Institut de Ciències del Mar
(galliet,mmartin)@cs.upc.edu (matthew.fellows,benjamin.ellis,jakob.foerster)@eng.ox.ac.uk
(bartomeu.posa,mattie.fellows,masmitja@icm.csic.es

ABSTRACT

Q-learning played a foundational role in the field of reinforcement learning (RL). However, TD algorithms with off-policy data, such as Q-learning, or nonlinear function approximation like deep neural networks require several additional tricks to stabilise training, primarily a large replay buffer and target networks. Unfortunately, the delayed updating of frozen network parameters in the target network harms the sample efficiency and, similarly, the large replay buffer introduces memory and implementation overheads. In this paper, we investigate whether it is possible to accelerate and simplify off-policy TD training while maintaining its stability. Our key theoretical result demonstrates for the first time that regularisation techniques such as LayerNorm can yield provably convergent TD algorithms without the need for a target network or replay buffer, even with off-policy data. Empirically, we find that online, parallelised sampling enabled by vectorised environments stabilises training without the need for a large replay buffer. Motivated by these findings, we propose PQN, our simplified deep online Q-learning algorithm. Surprisingly, this simple algorithm is competitive with more complex methods like Rainbow in Atari, PPO-RNN in Crafter, QMix in Smac, and can be up to 50x faster than traditional DQN without sacrificing sample efficiency. In an era where PPO has become the go-to RL algorithm, PQN reestablishes off-policy Q-learning as a viable alternative. We open-source our code at: <https://github.com/mattgalliet/pqn>.

1 INTRODUCTION

In reinforcement learning (RL), the challenge of developing simple, efficient and stable algorithms remains open. Temporal difference (TD) methods have the potential to be simple and efficient, but are notoriously unstable when combined with either off-policy sampling or nonlinear function approximation (Tsetnik & Van Roy, 1997). Starting with the introduction of the seminal deep Q-network (DQN)(Mnih et al., 2013), many tricks have been developed to stabilise TD for use with deep neural network function approximators, most notably: the introduction of batched learning through a replay buffer (Mnih et al., 2013), target networks (Mnih et al., 2015), trust region based methods (Schulman et al., 2015), double Q-networks (Wang & Blei, 2017; Fujimoto et al., 2018), maximum entropy methods (Haarnoja et al., 2017, 2018) and ensemble (Chen et al., 2021). Out of this myriad of algorithmic combinations, proximal policy optimisation (PPO)(Schulman et al., 2017) has emerged as the de facto choice for RL practitioners, proving to be a strong and efficient baseline across popular RL domains. Unfortunately, PPO is far from stable and simple: PPO does not have provable convergence properties for nonlinear function approximation and requires extensive tuning and additional tricks to implement effectively (Huang et al., 2022a; Engstrom et al., 2020).

Recent empirical studies (Lyle et al., 2023, 2024; Bhat et al., 2024) provide evidence that TD can be stabilised without target networks by introducing regularisation such as BatchNorm (Ioffe & Szegedy, 2015) and LayerNorm (Ba et al., 2016; Nauman et al., 2024) into the Q-function approximator. Little is known about why these techniques work or whether they have unintended side-effects. Motivated

^{*}Equal Contribution.

1

“Enhancing fish community monitoring at a cabled observatory by combining environmental DNA and imaging analysis”

DOI:

<https://doi.org/10.3390/computers13120329>

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DOI: 10.1111/jb.70096

BRIEF COMMUNICATION



Enhancing fish community monitoring at a cabled observatory by combining environmental DNA and imaging analysis

Maddalena Tibone^{1,2} | Marco Francescangeli³ | Sergio Stefanni² |
Jacopo Aguzzi³ | Bernadette O'Neill¹ | Joaquin Del Rio⁴ | Daniel Mihai Toma⁴ |
Luca Mirimin^{1,2}

¹Department of Natural Resources and the Environment, Marine and Freshwater Research Centre, School of Science and Computing, Atlantic Technological University, Galway, Ireland

²Stazione Zoologica Anton Dohrn, Naples, Italy

³Instituto de Ciencias del Mar, Consejo Superior de Investigaciones Científicas, Barcelona, Spain

⁴IMT Research Group, Universitat Politècnica de Catalunya Barcelona Tech, Barcelona, Spain

Correspondence

Maddalena Tibone, Department of Natural Resources and the Environment, Marine and Freshwater Research Centre, School of Science and Computing, Atlantic Technological University, Galway, Ireland.
Email: maddalena.tibone@research.atu.ie

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Abstract

Cabled multiparametric observatories are sustaining ecological monitoring by collecting long-term real-time biological and environmental data. Here, we investigated fish communities by sampling environmental DNA (eDNA) over 4 days near the multiparametric cabled video-observatory OISEA (Northwestern Mediterranean Sea). The multi-marker eDNA metabarcoding approach resulted in an increased species detection and helped provide a more comprehensive view of the local fish community when combined with imaging data. These results underline the potential of omics methods in long-term monitoring of economically and ecologically important fish species.

KEYWORDS

cabled observatories, ecological monitoring, eDNA metabarcoding, fish communities, omics, visual census

1 | INTRODUCTION

Effective marine monitoring of economically and ecologically important fish communities requires multiparametric time series of continuous and high-frequency data (i.e., biological, oceanographic and geochemical). Video-cabled observatories are sustaining such data collection in a long-term (from weeks to years) and continuous (i.e., near-real or real-time) manner, therefore, allowing the establishment of in situ ecological laboratories in both continental margins and abyssal plains (Ezranova et al., 2017). Most of these observatories are equipped with cameras that provide long-term imaging data, favouring the compilation of local species' richness

and biodiversity lists (Francescangeli et al., 2025; Stefanni et al., 2023). Moreover, the environmental and multidisciplinary data collected facilitate the fine-scale monitoring of shifts in species presence, as well as their behaviour, at different temporal scales (Cuvellier et al., 2017; De Leo et al., 2018; Matabos et al., 2010). For instance, changes in the observed fish communities were related to tidal and day/night cycles at the OISEA underwater cabled observatory off the coast of Catalonia (Spain) (Aguzzi et al., 2013), as well as at the SmartBay multiparametric platform in Galway Bay (Ireland) (Aguzzi, López-Romero, et al., 2020). Over a longer time scale, imaging data from underwater cameras in the Mediterranean Sea were used to detect

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“Simplifying Deep Temporal Difference Learning.” *The Thirteenth International Conference on Learning Representations (ICLR)*

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DIGI4ECO OFFICIAL VIDEO IS OUT – WATCH NOW!



DIGI4ECO released its official video.

In just a few minutes, the video introduces the project's main goals and explains the specifications of the PTO-DTO architecture and different work aspects in relation to data elaboration.

[WATCH THE VIDEO](#)



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CLUSTERING ACTIVITIES



DIGI4ECO is part of the Marine Shield Cluster!

The Marine Shield Cluster is a powerful alliance of EU-funded projects dedicated to combating water pollution. The cluster focuses on focus on three core pillars:

- advanced monitoring
- effective prevention
- innovative remediation.

The cluster is coordinated by iMERMAID project



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OUR TEAM



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