Soan KIM

Ph.D. Candidate in Reinforcement Learning & Neuroscience

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AI Researcher in Closed-Loop Systems & Theoretical RL: I possess a unique dual background bridging **Theoretical Reinforcement Learning** (PI: Peter Dayan) and **Real-Time Decoded Neurofeedback** (PI: Aurelio Cortese). Unlike pure ML researchers, I combine mathematical modeling with hands-on systems engineering, having implemented real-time closed-loop architectures that couple autonomous agents with biological substrates. I am uniquely positioned to apply this **AI-in-the-loop** expertise to build the **AI Scientist**.

Education

Ph.D. Candidate in Neuroscience (Focus: AI & RL) — **Donostia, Spain**
Basque Center On Cognition, Brain, and Language — *09.2021 - Present*

- *Thesis: Metareasoning in Reinforcement Learning with Sparse Rewards (Expected: Sep. 2026)*

M.Sc. in Neuroscience — **Seoul, South Korea**
Korea University (Cumulative GPA: 4.15 / 4.5) — *09.2016 - 08.2019*

B.A. in English Lang. & Lit., Business Admin. — **Seoul, South Korea**
Korea University (Double Major) — *03.2013 - 08.2016*

Technical Skills

Languages: Python (10+ years), MATLAB, R, JavaScript, Bash

AI/ML Frameworks: PyTorch, TensorFlow, Scikit-learn, OpenAI Gym

Core Competencies: Reinforcement Learning (MCTS, DQN, Actor-Critic), Agent Architecture, Computational Modeling, Decoded Neurofeedback (MVPA), Experimental Design

Research & Engineering Experience

Predoctoral Researcher (RL & Neurofeedback) — **Donostia, Spain**
Basque Center On Cognition, Brain, and Language — *09.2021 - Present*

- **Agent Simulation:** Developed Monte Carlo Tree Search (MCTS) and Deep Q-Network (DQN) agents to simulate human meta-reasoning strategies, creating a quantitative framework for analyzing behavior in sparse-reward environments.
- **Real-Time Systems:** Implemented a closed-loop fMRI system with real-time decoded neurofeedback (MVPA) to causally induce prediction errors, demonstrating a link between neural states and improved problem-solving.
- **Data Pipeline:** Built end-to-end pipelines for processing large-scale neuroimaging and behavioral datasets using Python and High-Performance Computing (HPC) clusters.

Teaching Assistant, Deep Learning — **Remote**
Neuromatch Academy — *07.2023 & 07.2024*

- **Technical Leadership:** Guided 49 high-skilled graduate students and researchers through 3-week deep learning curriculum, facilitating 10 end-to-end research projects from hypothesis to PyTorch implementation.
- **Code Review & Debugging:** Provided daily technical mentorship, debugging complex model architectures (RL agents, RNNs, CNNs) and resolving implementation bottlenecks to ensure successful project delivery.
- **Collaborative Research:** Fostered a high-performance remote research environment, enabling diverse international teams to present novel findings in computational neuroscience and deep reinforcement learning.

Research Assistant — **Donostia, Spain**
Basque Center on Cognition, Brain, and Language — *12.2020 - 08.2021*

- Preprocessed and analyzed complex fMRI datasets using Python and MATLAB to identify neural correlates of cognitive function.
- Developed Python tutorials to upskill graduate students in computational analysis methods.

Key Projects: Agents & Modeling

- **Mathematical Problem-Solving by DQN Agent** [GitHub]: Architected a custom OpenAI Gym-like environment and successfully trained a Deep Q-Network agent to find optimal solutions, showcasing end-to-end RL project development.
- **Human Behavior Simulation with MCTS** [GitHub]: Implemented a Monte-Carlo Tree Search model to simulate human decision-making in a sparse-reward task, providing a robust benchmark for behavioral analysis.
- **Neural Reinforcement on Prediction Error with Real-time fMRI Decoded Neurofeedback** [Poster: Trained participants to induce prediction error by multi-voxel pattern analysis with decoded neurofeedback to enhance problem-solving performance.

Grants & Awards

- **Predoctoral Researcher-Plan Nacional FPI Fellow (2021-2025)**, Ministry of Science, Innovation and Universities, Spain *(PI: Dr. David Soto)*
- **Brain-AI Hybrid Travel Grant (2022)**, Japan Science and Technology Agency *(PI: Dr. Aurelio Cortese)*

Selected Conferences

- **Subcortical markers of successful self-regulation in fMRI-based decoded neurofeedback**
  *Villar-Rodríguez, E., Margolles, P., **Kim, S.**, & Soto, D. (2026). Poster at the Organization for Human Brain Mapping (OHBM) Annual Meeting, Bordeaux, France.*
- **Inducing Reward Prediction Error with Decoded Neurofeedback**
  ***Kim, S.**, Margolles, P., Cortese, A., & Soto, D. (2025). Poster at the 1st International Symposium on Decoded Neurofeedback, Kyoto, Japan.*
- **Confidence Prediction Error Predicts Learning and Insight**
  ***Kim, S.**, Bramlage, L., Cortese, A., & Soto, D. (2024). Poster at ASSC, Tokyo, Japan.*
- **Inducing Reward Prediction Error with Decoded Neurofeedback**
  ***Kim, S.**, Margolles, P., Cortese, A., & Soto, D. (2024). Poster at Real-Time Functional Imaging and Neurofeedback, Heidelberg, Germany.*
- **Confidence Prediction Error: A Metacognitive Monitoring Signal**
  ***Kim, S.**, Cortese, A., & Soto, D. (2023). Poster at Winter Workshop Mechanism of Brain and Mind, Hokkaido, Japan.*

Internships & Research Stays

Max Planck Institute for Biological Cybernetics — Tübingen, Germany
Computational Neuroscience — Advisor: Dr. Peter Dayan — *08.2024 – 11.2024*

Advanced Telecommunications Research Institute International (ATR) — Kyoto, Japan
Decoded Neurofeedback Lab — Advisors: Dr. Aurelio Cortese — *11.2022 – 02.2023*

Donders Institute for Brain, Cognition and Behaviour — Nijmegen, Netherlands
Computational Neuroscience — Advisor: Dr. Bernhard Englitz — *06.2020 – 11.2020*

Max Planck Institute for Psycholinguistics — Nijmegen, Netherlands
Cultural Brain Lab — Advisor: Dr. Falk Huettig — *09.2019 – 03.2020*

Certificates

HarvardX Calculus Applied (edX) 2022
Unity Deep Reinforcement Learning Nanodegree (Udacity) 2021
Neuromatch Academy Deep Learning (NMA) 2021

Dissemination

Reinforcement Learning: Animal, Machine, & Human — Pint of Science, Spain (05.2025)