Supplementary Information for "ProjectionPathExplorer: Exploring Visual Patterns in Projected Decision-Making Paths"

ANDREAS HINTERREITER, Johannes Kepler University Linz, Austria and Imperial College London, UK
CHRISTIAN STEINPARZ, Johannes Kepler University Linz, Austria
MORITZ SCHÖFL, Johannes Kepler University Linz, Austria
HOLGER STITZ, Johannes Kepler University Linz, Austria and datavisyn GmbH, Austria
MARC STREIT, Johannes Kepler University Linz, Austria

INTERACTIVE PHYSICAL RUBIK'S CUBE DEMONSTRATOR

To tighten the connection between our visualization approach and real-world actions and decisions made by users, we built a physical interactive demonstrator. The setup is shown schematically in Figure 1. It consists of a special Rubik's cube with sensors and Bluetooth connectivity (Giiker Supercube, http://www.giiker.cn), a Lego Mindstorm robot (MindCub3r [1]), and a display showing an adapted version of the interactive Rubik's cube visualization. While the user tries to solve the cube, rotations are immediately reflected in the visualization. The trail of previous cube states, as well as the current one, are shown in the embedded state space of several hundreds of reference solution trajectories of random initial cubes. Since the current cube state may not have been part of this initial set of calculated solutions, out-of-sample extension must be used. We implemented a parametric, real-time out-of-sample extension, based on the work by Gisbrecht et al. [2]. Along with the reference trajectories and the trajectory of movements performed so far, also the future path necessary to arrive at the solution is displayed (for a selected solution algorithm). Upon each cube movement, the future path is updated, if it has been affected by the user's decision. This serves as a highly salient visual feedback for the user, as "incorrect" movements may result in drastic changes of the computed future paths. To aid the users, the correct movements to stay on the right track are shown with a rendering of Rubik's cube. If users decide to stop trying to solve the cube on their own, they can hand the cube over to a Lego Mindstorms robot that will continue the solution. Users can then simultaneously watch the real cube being solved, while the current cube state moves along the solution trajectory in the visualization. The demonstrator setup also includes a two-player mode, in which two players can race through the solution trajectories with two separate Bluetooth cubes. The setup will be mainly used to introduce prospective computer science students to the functioning of algorithms, interactive visualization, and projection techniques.

REFERENCES

[1] David Gilday. 2019. How to build MindCub3r for Lego Mindstroms EV3. https://www.mindcuber.com/mindcub3r/mindcub3r.html Accessed: 2019-10-28.
[2] Andrej Gisbrecht, Alexander Schulz, and Barbara Hammer. 2015. Parametric nonlinear dimensionality reduction using kernel t-SNE. *Neurocomputing* 147 (Jan. 2015), 71–82. https://doi.org/10.1016/j.neucom.2013.11.045

Authors' addresses: Andreas Hinterreiter, Johannes Kepler University Linz, Altenberger Straße 69, Linz, Austria, 4040, andreas.hinterreiter@jku.at, Imperial College London, South Kensington Campus, London, UK, SW7 2AZ, a.hinterreiter@imperial.ac.at; Christian Steinparz, Johannes Kepler University Linz, Altenberger Straße 69, Linz, Austria, 4040, christian.steinparz@jku.at; Moritz Schöfl, Johannes Kepler University Linz, Altenberger Straße 69, Linz, Austria, 4040, moritz.schoefl@jku.at; Holger Stitz, Johannes Kepler University Linz, Altenberger Straße 69, Linz, Austria, 4040, holger.stitz@jku.at, datavisyn GmbH, Altenberger Straße 69, Linz, Austria, 4040, holger.stitz@datavisyn.io; Marc Streit, Johannes Kepler University Linz, Altenberger Straße 69, Linz, Austria, 4040, marc.streit@jku.at.

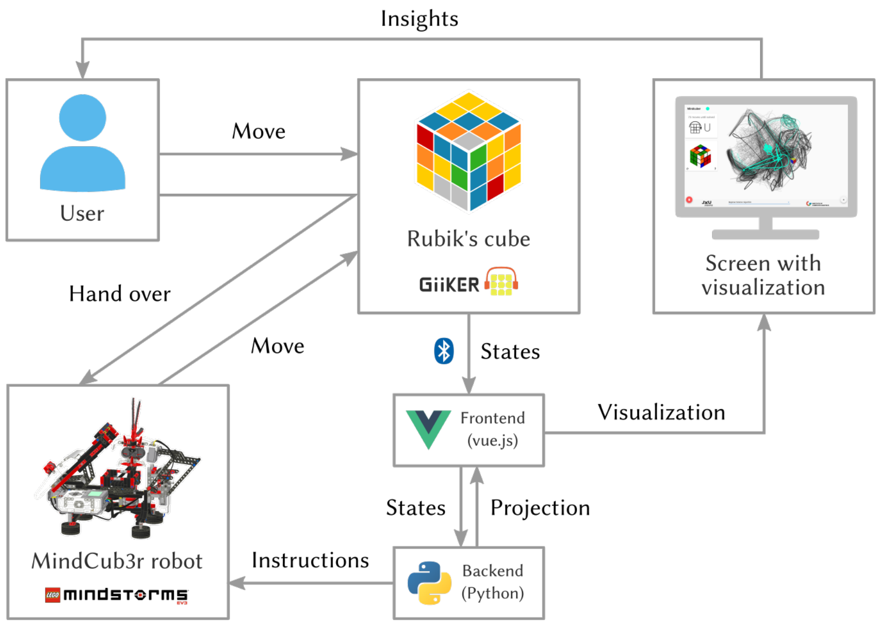

Fig. 1. Schematic of the Rubik's cube physical demonstrator setup. Users can solve a Rubik's cube, which transmits its states to a vue.js-powered web application via Bluetooth. The projected cube states are calculated in real time using out-of-sample extension implemented in Python. The projection of the current state and the previous trajectory are visualized on a screen. Users can hand off the unsolved cube to a Lego Mindstorms robot, which receives its instructions from the Python backend, and automatically solves the cube.