Supplementary File for Adaptive Droplet Routing in Digital Microfluidic Biochips Using Deep Reinforcement Learning

This file contains supplementary materials for the submitting paper (ID 3297) for ICML 2020.

Fig. 1 and Fig. 2 show the training rewards for agents with varying number of concurrent environments and number of steps for each update. Fig. 3 and Fig. 4 show the results for different percentages of electrode degradation for various DMFB sizes. Recorded videos of the simulations and the biochip experiment are provided in [1].
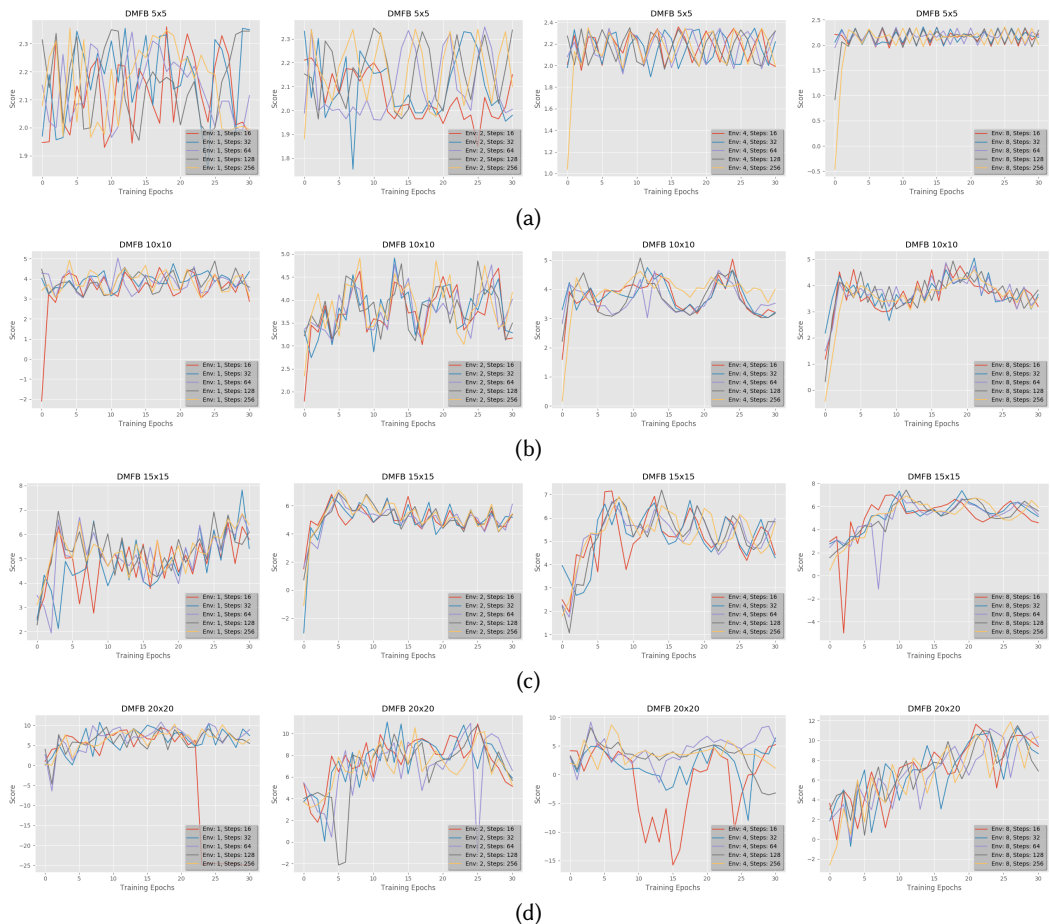

Fig. 1. Training rewards for agents with different hyper-parameter settings. Score is the total reward that the RL agent receives in a game. (a) Training rewards for DMFBs of size 5 × 5 electrodes. (b) Training rewards for DMFBs of size 10 × 10 electrodes. (c) Training rewards for DMFBs of size 15 × 15 electrodes. (d) Training rewards for DMFBs of size 20 × 20 electrodes.
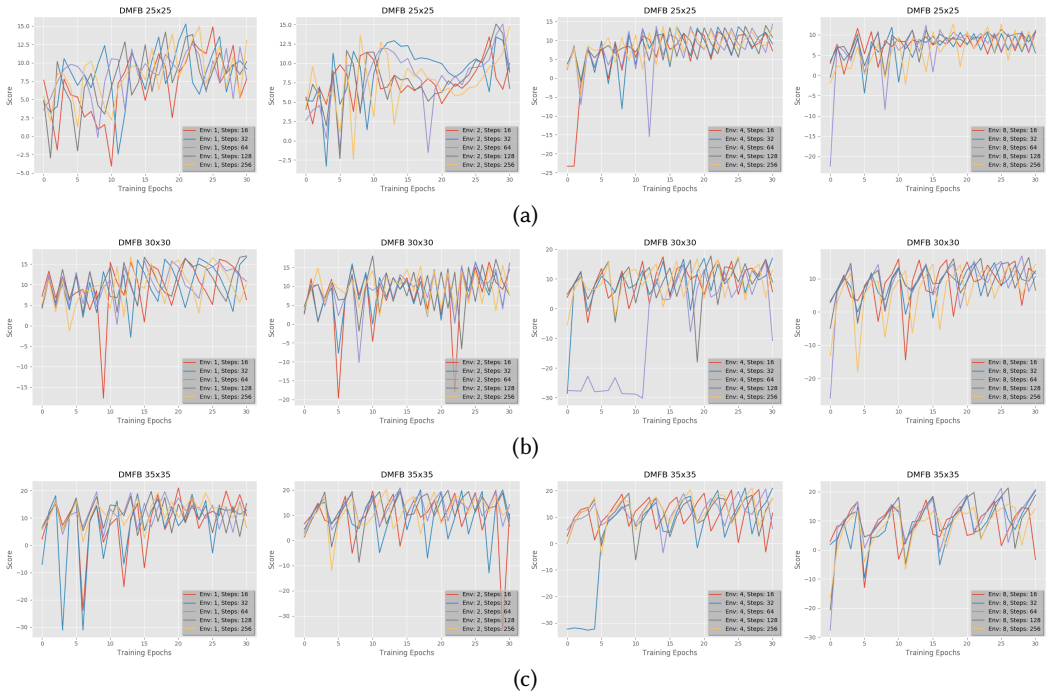
Fig. 2. Training rewards for agents with different hyper-parameter settings. Score is the total reward that the RL agent receives in a game. (a) Training rewards for DMFBs of size 25×25 electrodes. (b) Training rewards for DMFBs of size 30×30 electrodes. (c) Training rewards for DMFBs of size 35×35 electrodes.
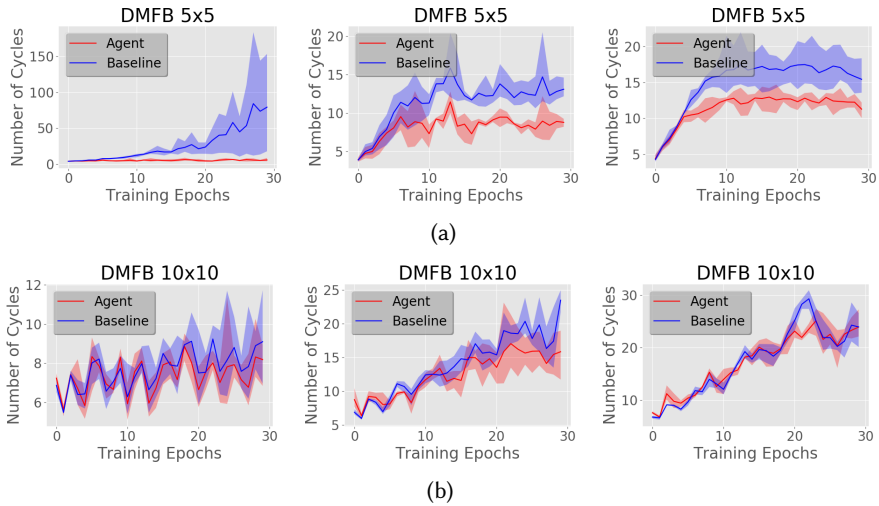

Fig. 3. Evaluation of the trained models in degrading mode of DMFB-Env. The performance, expressed as the required number of actuation (clock) cycles, is compared with the static routing method from [2]. In each sub-figure, three plots (from the left to the right) show 10% of the electrodes degrade over time, 50% of the electrodes degrade over time, and 90% of the electrodes degrade over time, respectively. (a) The performance for DMFBs of size 5×5 electrodes. (b) The performance for DMFBs of size 10×10 electrodes.
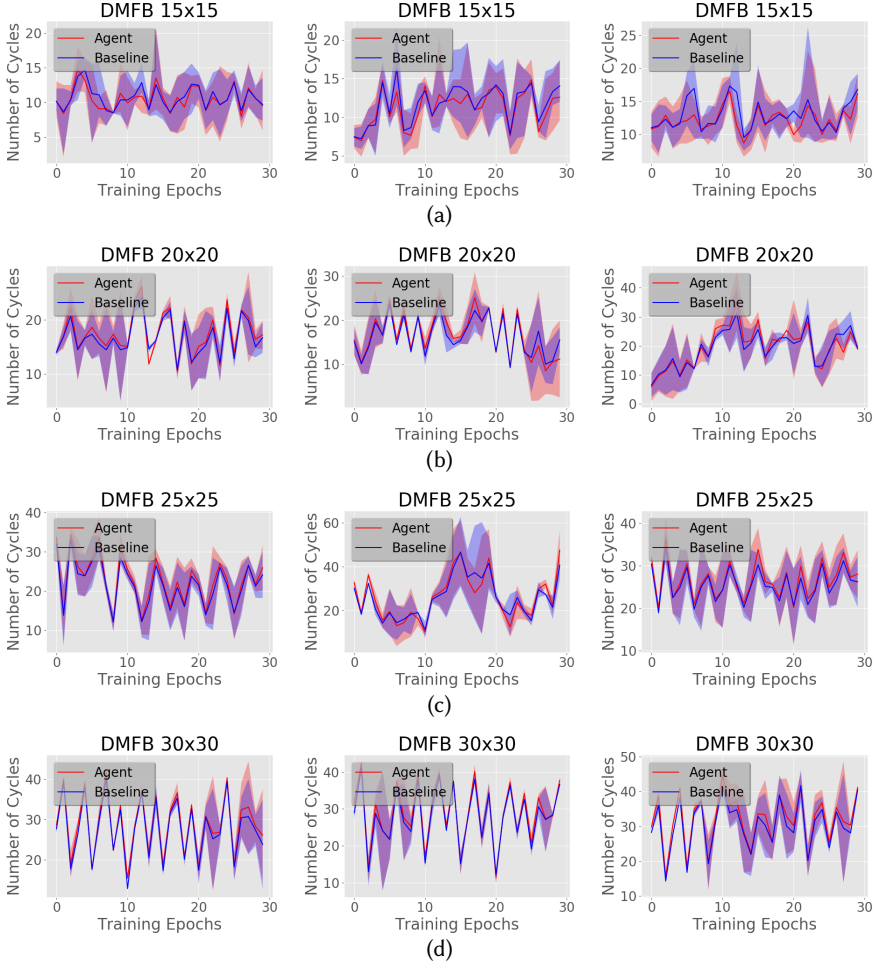
Fig. 4. Evaluation of the trained models in degrading mode of DMFB-Env. The performance, expressed as the required number of actuation (clock) cycles, is compared with the static routing method from [2]. In each sub-figure, three plots (from the left to the right) show 10% of the electrodes degrade over time, 50% of the electrodes degrade over time, and 90% of the electrodes degrade over time, respectively. (a) The performance for DMFBs of size 15×15 electrodes. (b) The performance for DMFBs of size 20×20 electrodes. (c) The performance for DMFBs of size 25×25 electrodes. (d) The performance for DMFBs of size 30×30 electrodes.

REFERENCES

[1] Authors. 2020. Recorded Videos during Training and Evaluation. https://drive.google.com/drive/folders/1suM0_3GdL1r6_65dTjl_sA78POKi7hRK?usp=sharing. [Online; accessed 31-January-2020].

[2] Yang Zhao and Krishnendu Chakrabarty. 2012. Simultaneous optimization of droplet routing and control-pin mapping to electrodes in digital microfluidic biochips. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* 31, 2 (2012), 242–254.