PiTree: Practical Implementations of ABR Algorithms Using Decision Trees

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Motivation

ABR algorithms are increasingly heavyweight

Server-side Implementation

- High operating expenses.

--- Up to millions of concurrent viewers.

Client-side Implementation

- Large page size.

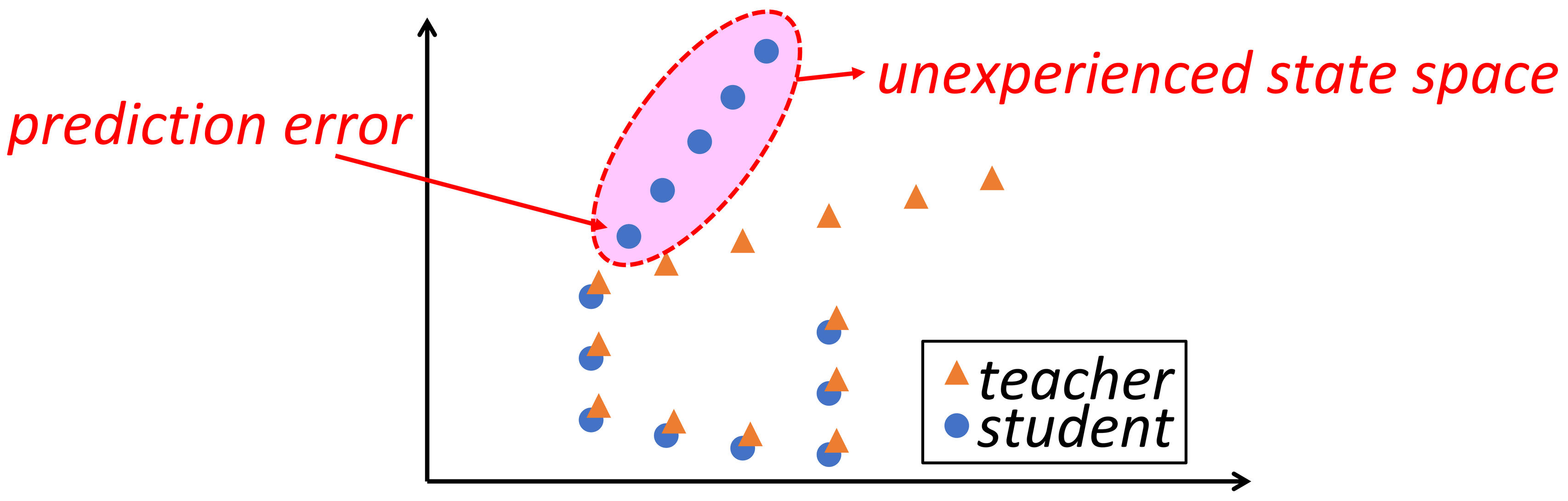
--- Page load time of Pensieve is increased by ~10s.

- Long decision latency.

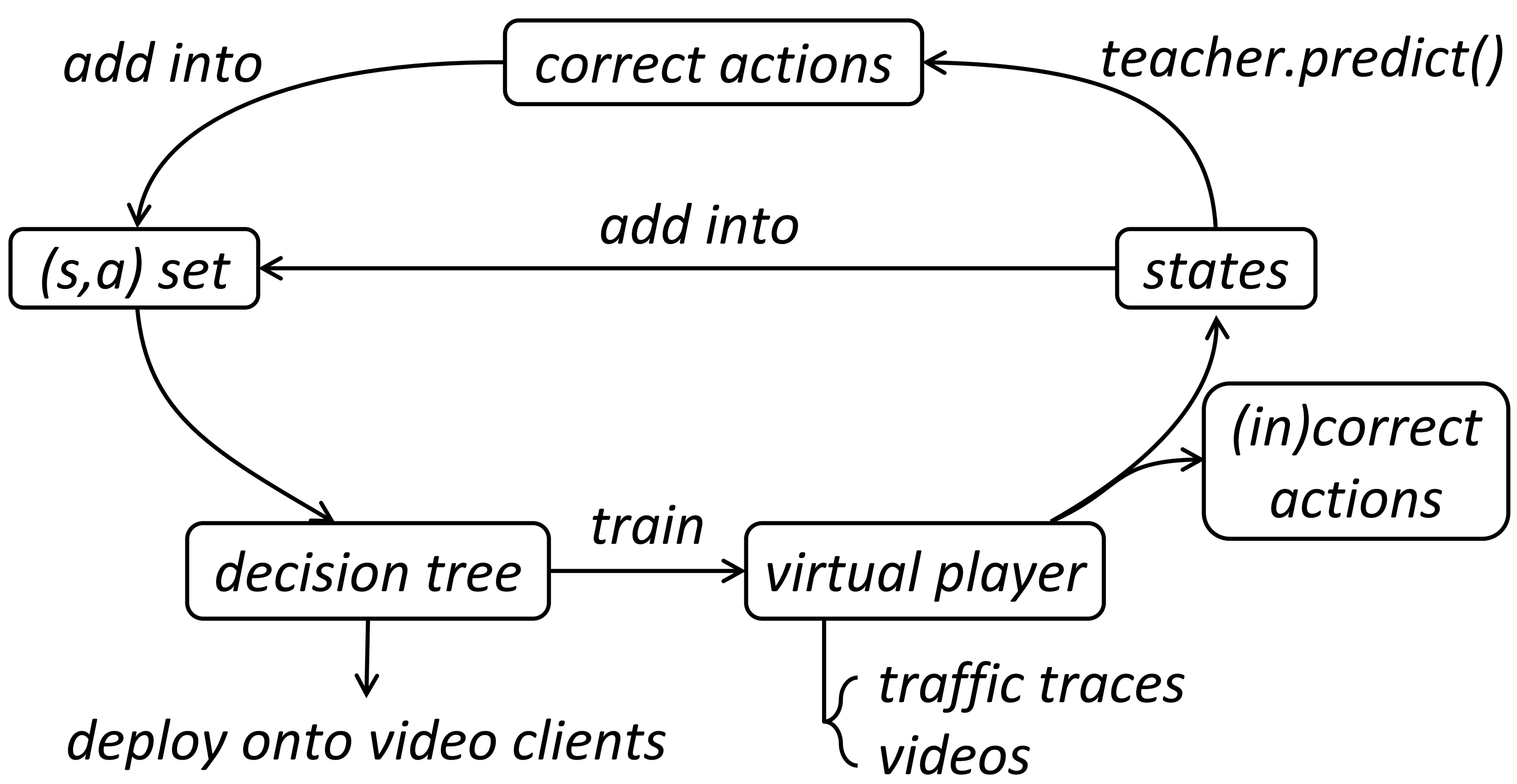
--- Decision latency of RobustMPC > chunk length.

Challenges

ABR Control is a sequential decision-making process. One wrong prediction may drive the student off the teacher's trajectory.



Design



Algorithm pseudocodes:

$(\mathbb{S}, \mathbb{A}) \leftarrow VirtualPlay(\pi^*)$

For i **from** 1 **to** M:

$\pi_i \leftarrow TrainDT(\mathbb{S}, \mathbb{A})$

$(\mathbb{S}_i, \mathbb{A}_i) \leftarrow VirtualPlay(\pi_i)$

$\mathbb{A}_i^* \leftarrow Predict(\pi^*, \mathbb{S}_i)$

Aggregate $\mathbb{S} \leftarrow \mathbb{S} \cup \mathbb{S}_i, \mathbb{A} \leftarrow \mathbb{A} \cup \mathbb{A}_i^*$

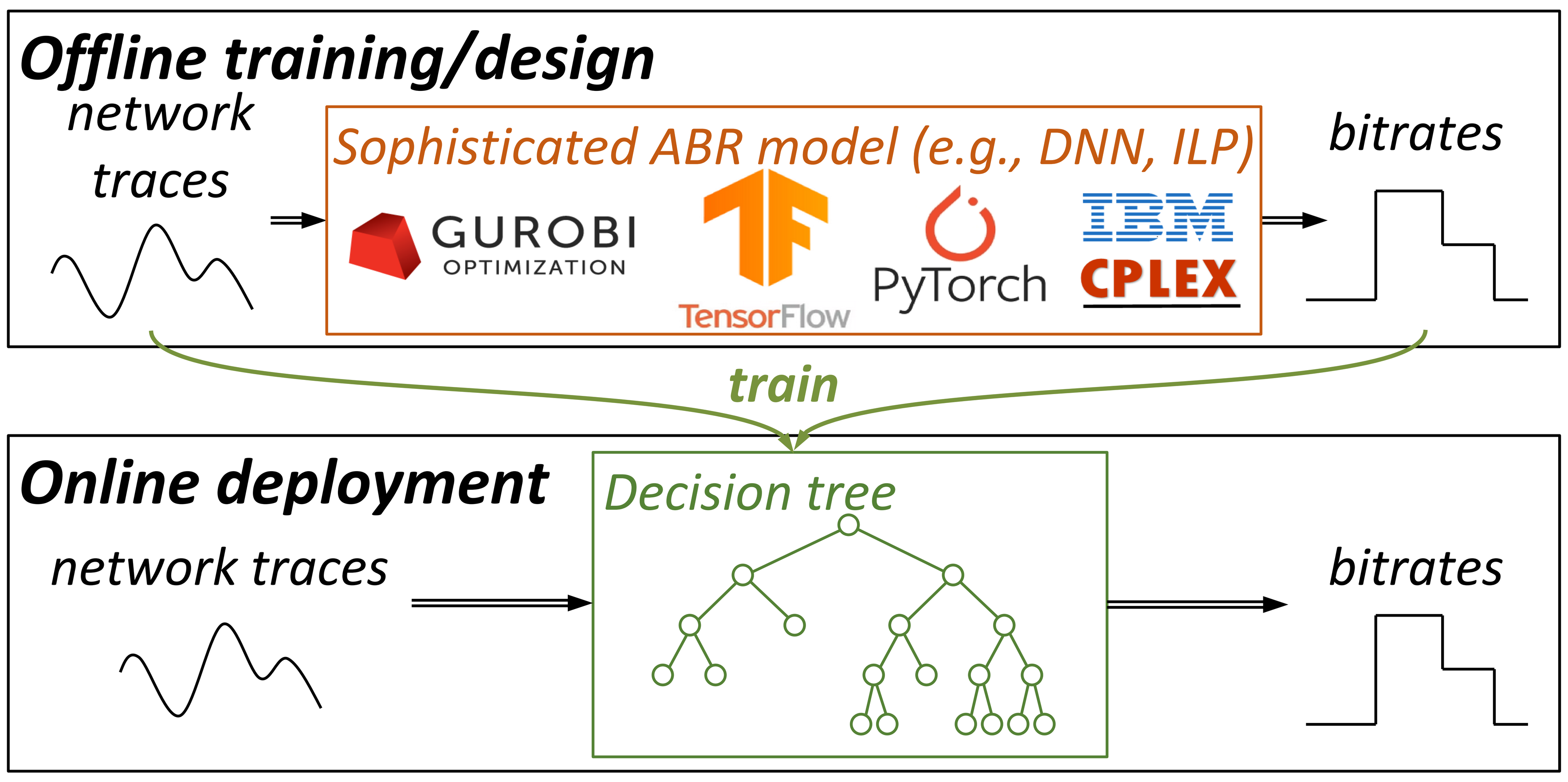
Loss in decision tree training: $\ell(r; r_0) = \frac{(r-r_0)^2}{(R_{max}-R_{min})^2}$

Theoretical bound

For any $\delta > 0$, with training loss ε_M, there exists a policy $\hat{\pi} \in \{\pi_1, \cdots, \pi_M\}$ s.t. the average optimization loss satisfies:

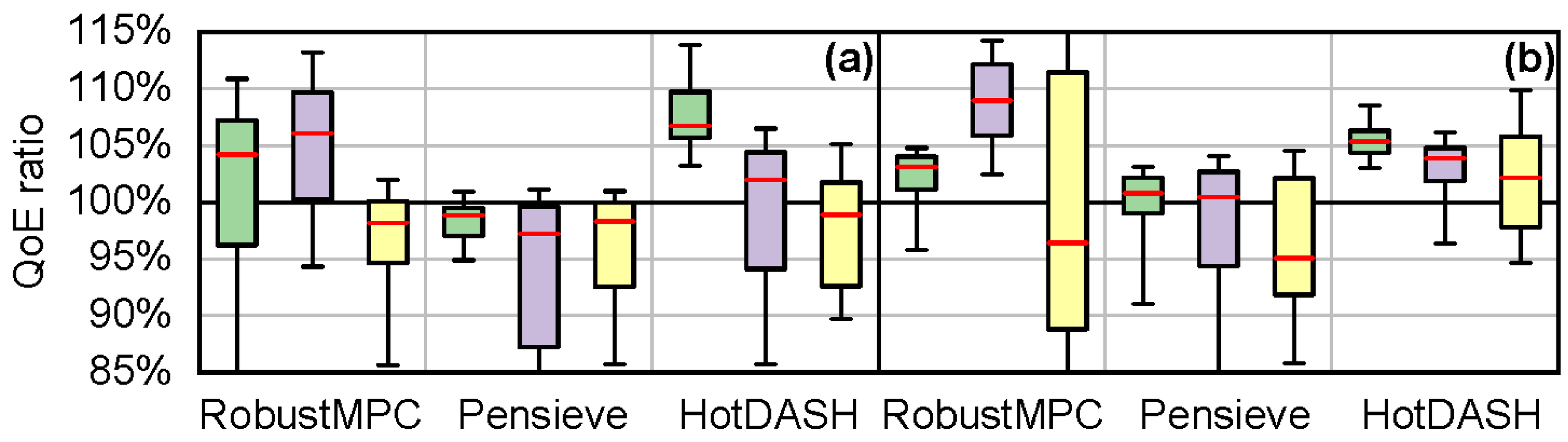
$$\mathbb{E}_{s \sim d_{\hat{\pi}}}\left[\ell(\hat{\pi}(s); \pi^*(s))\right] \leq \varepsilon_M + \Theta(1/T)$$

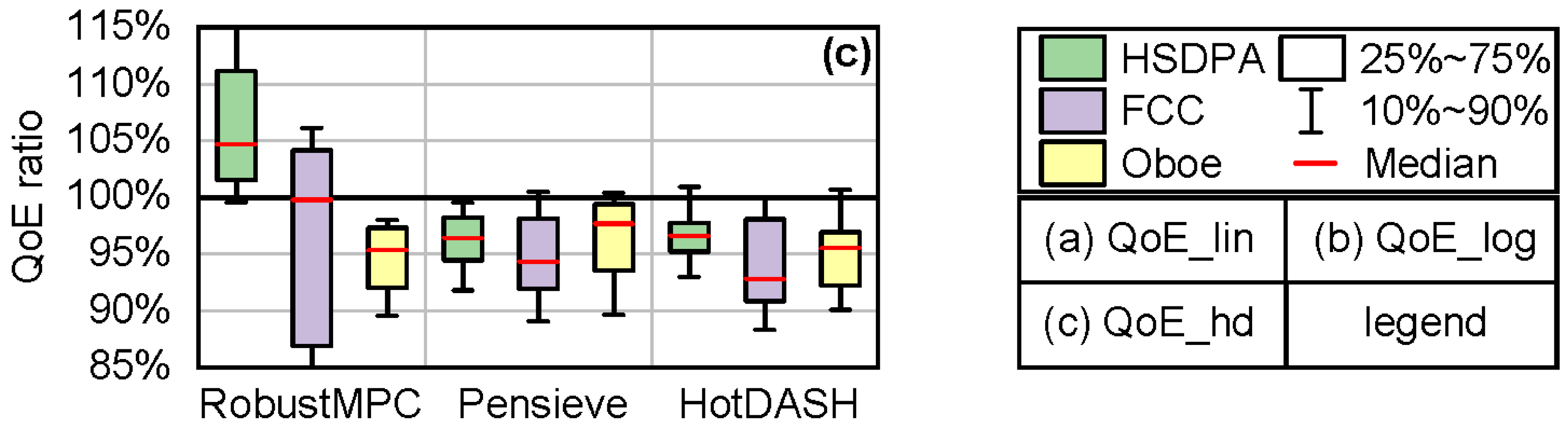
Solution

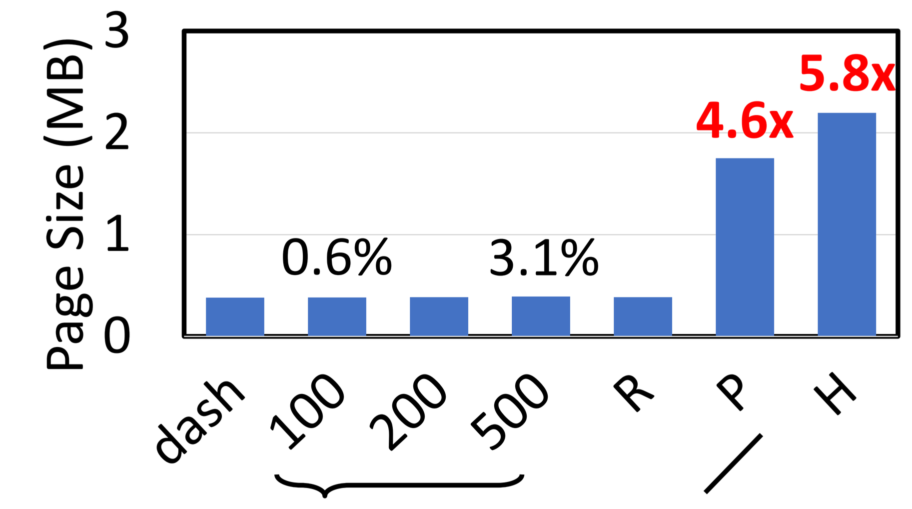


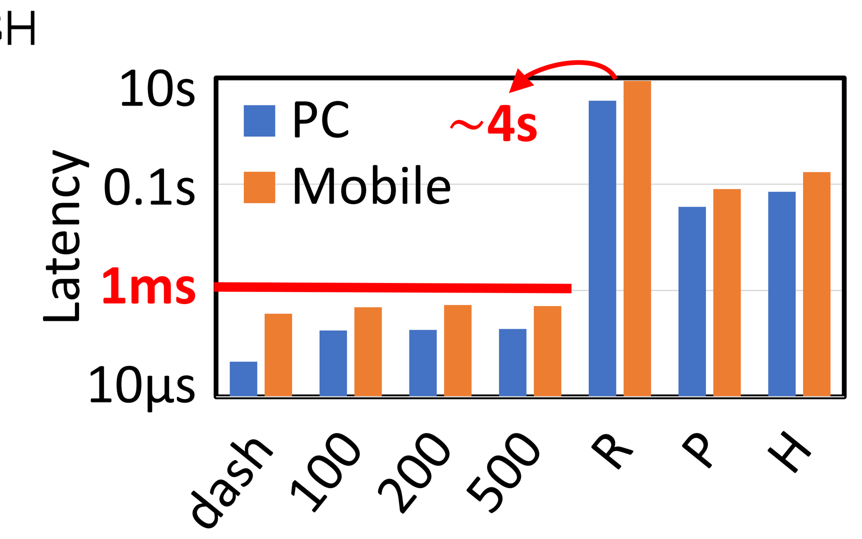
Evaluation

ABR: RobustMPC [SIGCOMM'15], Pensieve [SIGCOMM'17], HotDASH [ICNP'18]	Traces: HSDPA, FCC, Oboe	QoE: Lin, Log, HD









Our experiments: **<0.1s** @ 1Mbps HotDASH: **14.5s** @ 1Mbps

PC: Intel Core i7-8550

Mobile: Qualcomm Snapdragon 821

Coming soon

Explaining Complex Networked Systems

Decision trees are not only lightweight, but also explainable.

Partial results are online at *arXiv:1910.03835*.