PiTree: Practical Implementations of ABR Algorithms Using Decision Trees

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Session 5C  14:15 Thu Oct 24  Rhodes 9  zilim@ieee.org  transys.io/pitree

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
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Algorithm pseudocodes:

\[(S, A) \leftarrow \text{VirtualPlay}(\pi^*)\]
For \(i\) from 1 to \(M\):
\[
\pi_i \leftarrow \text{TrainDT}(S, A)
\]
\[(S_i, A_i) \leftarrow \text{VirtualPlay}(\pi_i)\]
\[A_i^* \leftarrow \text{Predict}(\pi^*, S_i)\]
Aggregate \(S \leftarrow S \cup S_i, A \leftarrow A \cup A_i^*\)

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

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

\[E_{s \sim d_R}[\ell(\hat{\pi}(s); \pi^*(s))] \leq \varepsilon_M + \Theta(1/T)\]

Solution

Offline training/design

Network traces

Sophisticated ABR model (e.g., DNN, ILP)

train

Decision tree

bitrates

Online deployment

Network traces

Decision tree

bitrates

Evaluation

RobustMPC [SIGCOMM’15]  HSDPA  Lin
HotDASH [ICNP’18]  Oboe  HD

Cooming soon

Explaining Complex Networked Systems
Decision trees are not only lightweight, but also explainable.
Partial results are online at arXiv:1910.03835.

Coming soon

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