Adaptive Real-Time Routing in Polynomial Time

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CONTEXT

Safety-critical systems **must** be **validated for safety** prior to deployment, and **should** have **efficient** run-time implementations.

Pre-run-time validation may require large "**safety margins**" in system design. Hence safety and efficiency are contradictory goals.

One possible **paradigm** for reconciling these two goals:

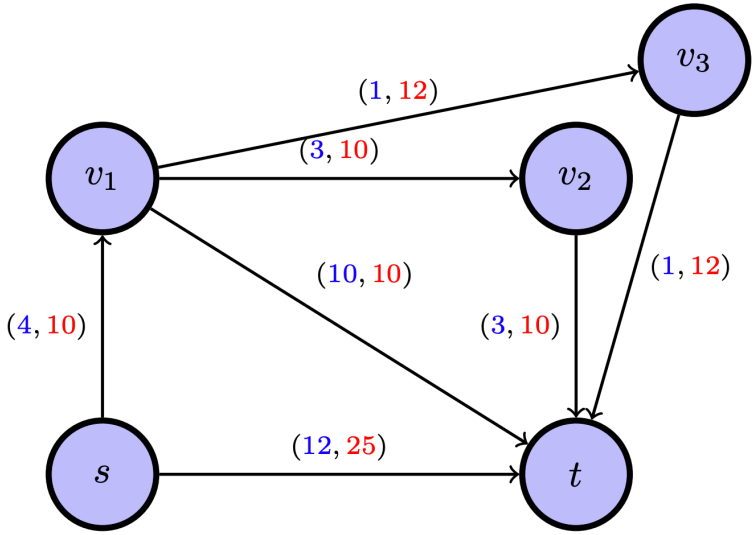
1. **Design for (*a priori* verifiable) safety** using a very conservative model.
2. **Optimize for performance** assuming a less conservative model.
3. **Use run-time monitoring** to reconcile differences between the model[s] and observed experience.

We **examined** this paradigm upon an illustrative example: **rapid routing with guaranteed delay bounds.**

BACKGROUND

Consider a **graph** of the kind shown below. The **red** (**blue**, respectively) edge-weights denote worst-case (typical, respectively) **estimates** of the actual **delays** encountered whilst traversing the edge.

- You seek to travel from vertex *s* to vertex *t* rapidly under typical circumstances.
- Additionally, safety considerations require you do so within 25 time units under all circumstances.
- The following strategy is **optimal** for meeting the safety requirement and minimizing delay under typical circumstances.



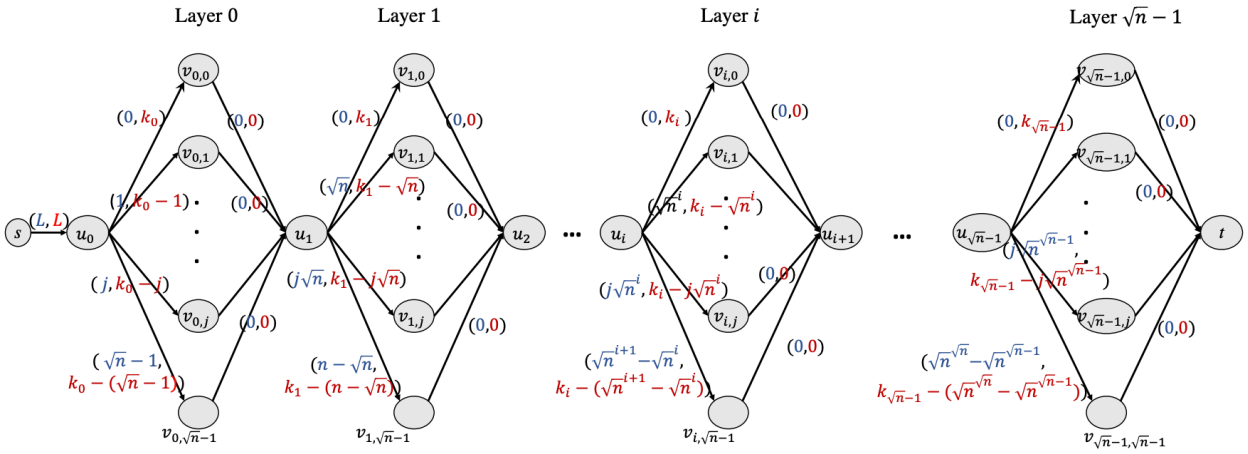
Traverse the edge $s \to v_1$
if (*the actual delay encountered is* ≤ 5 *time units*)
traverse the path $v_1 \to v_2 \to t$
else traverse the edge $v_1 \to t$

An algorithm is known* for devising such strategies, that constructs **routing tables** at each vertex of the graph beforehand. During traversal, these routing tables are used to determine the actual route optimally.

*Baruah (RTSS 2018). *Rapid Routing with Guaranteed Delay Bounds*

IN THIS PAPER…

1. We **showed** that the routing tables constructed by the previously-proposed algorithm* may be of size exponential in the number of vertices of the graph.



- Hence, the previously-proposed algorithm has exponential running time.

2. We **designed** a different algorithm for solving the problem.

- This required refinement of the notions of **adaptivity** and **semi**-adaptivity for on-line routing
- Our algorithm does not construct routing tables
- It has running time polynomial in the number of vertices of the graph and the number of edges traversed during the optimal route.

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*Baruah (RTSS 2018). *Rapid Routing with Guaranteed Delay Bounds*

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