Khameleon: Continuous Prefetch for Interactive Data Applications

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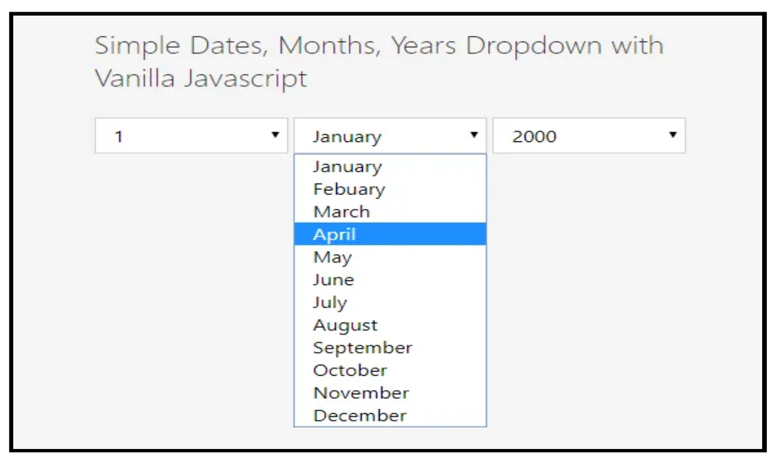
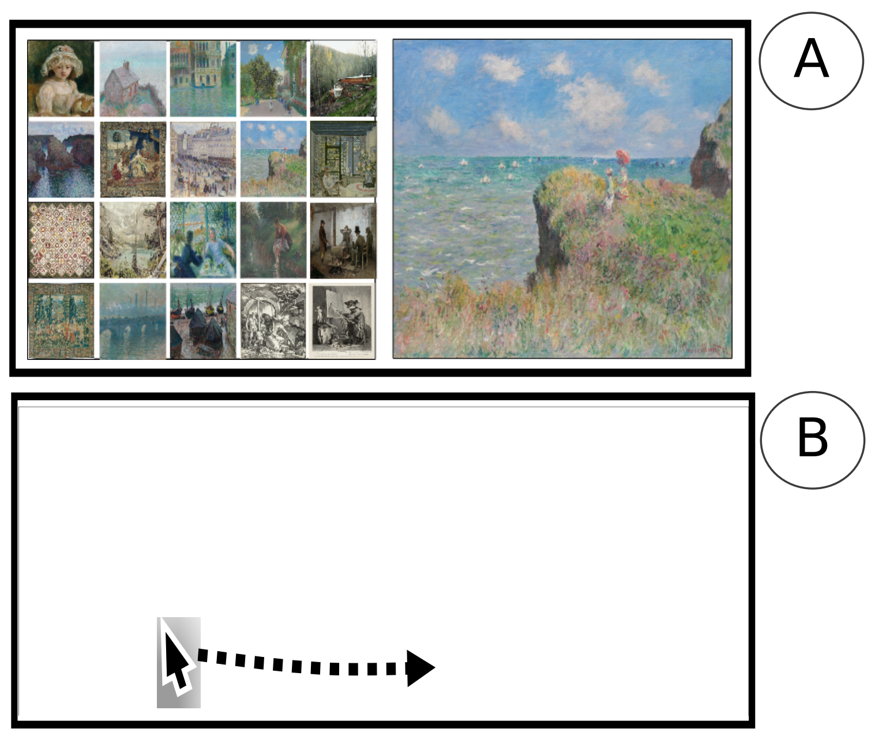
Problem

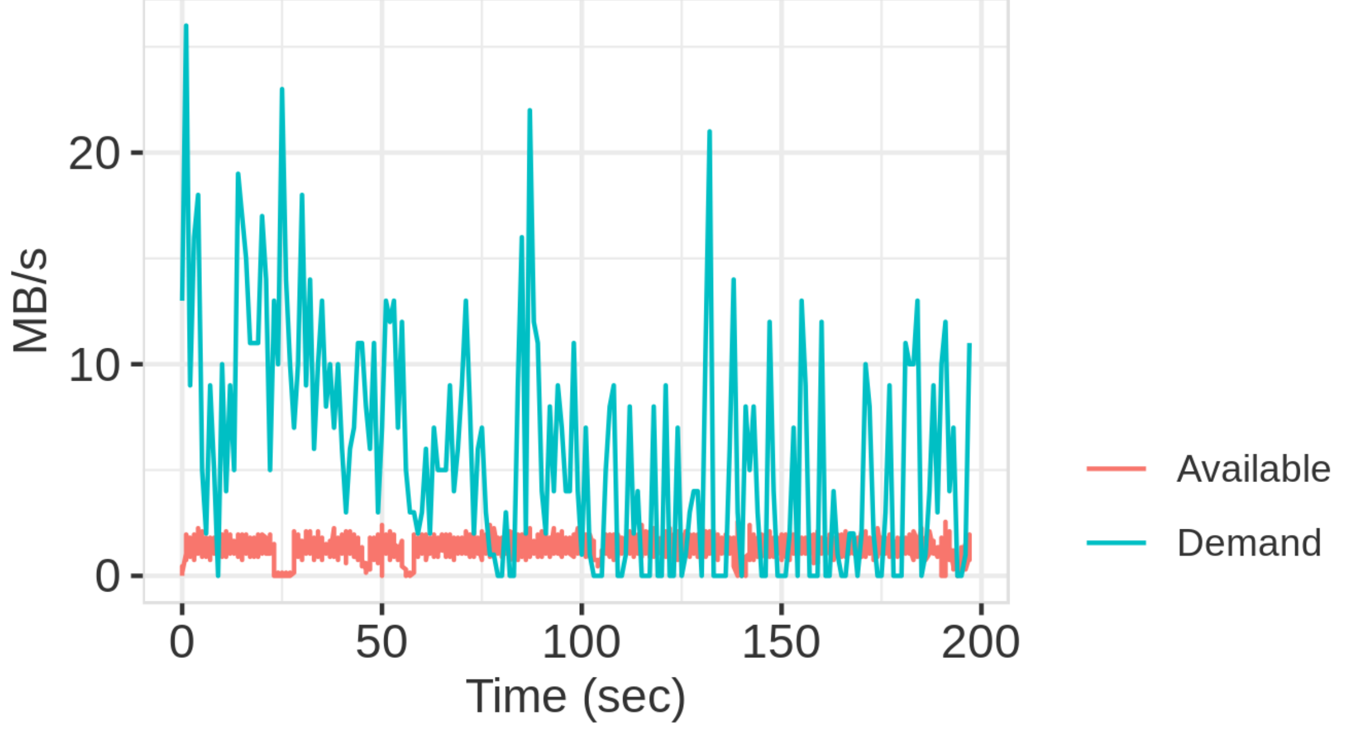


Simple Dates, Months, Years Dropdown with Vanilla Javascript

Traditional Application



Example of two Interactive Applications
(A) Image Exploration, (B) Data Vis. (Falcon)



(red) shows sample from real mobile network trace and
(blue) shows required bandwidth for an interactive application

Unlike traditional applications (left), Interactive Applications (right) have large requests space and large response size
-> Caching all requests at the client is hard

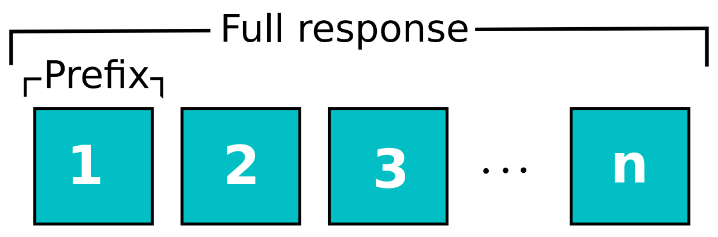
Simple interactions can generate a burst of request
-> As more applications move to the cloud, it's hard to maintain interactivity since requests burstiness and large response sizes can exceed available bandwidth.

Main Approach: Prefetching

- The client predicts future requests and asks for it ahead of time.
- Prefetching can exacerbate network congestion

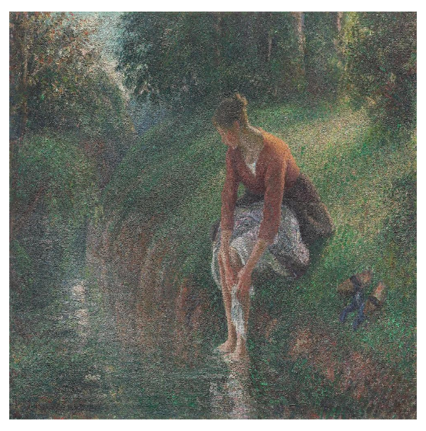
Interactive applications: approximation tolerant

- A flexible tradeoff between latency and quality
- Progressive encoding: group bytes into chunks so that each chunk is sufficient to show information

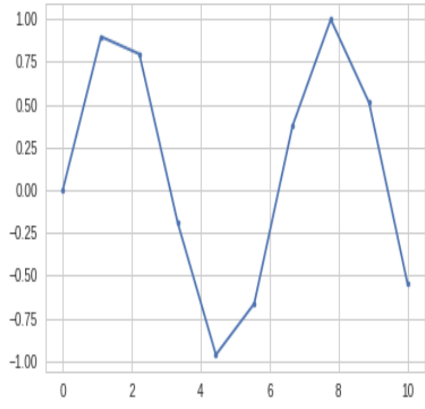


1 Prefix

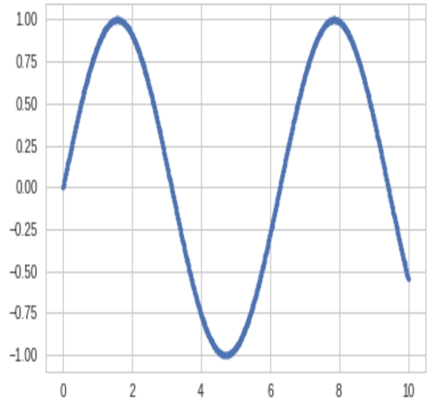
Full Response



1 Prefix



Full Response

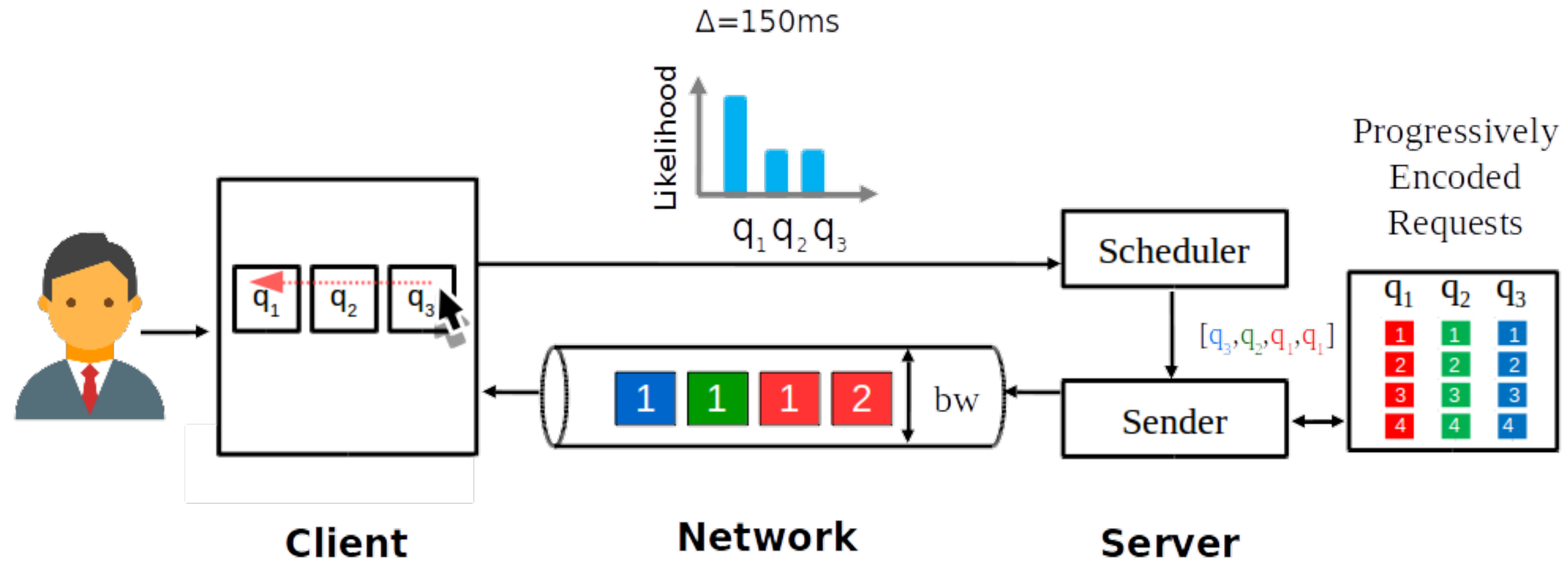


Enables new Prefetching Policies

- Prioritize Responsiveness: send a small prefix from every possible request
- Prioritize Quality: send full response for few requests

How to balance between responsiveness and quality?

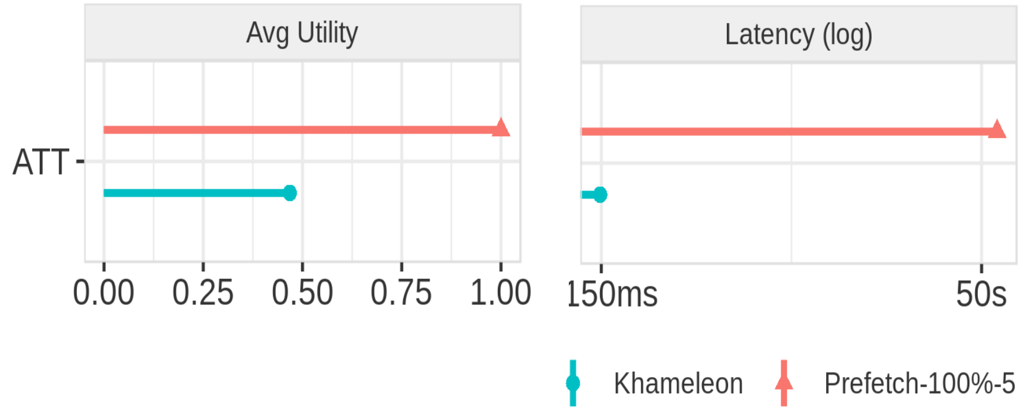
Quality vs Responsiveness



- Allocate bandwidth proportional to future likelihood
- Future likelihood distributions are given by the client

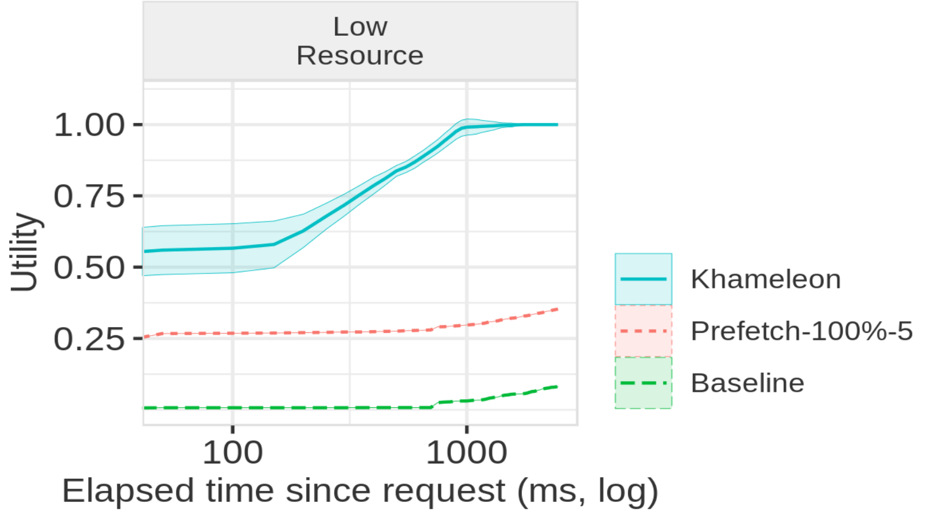
  The server continuously runs scheduler to decide what to send

Prelimnary Results



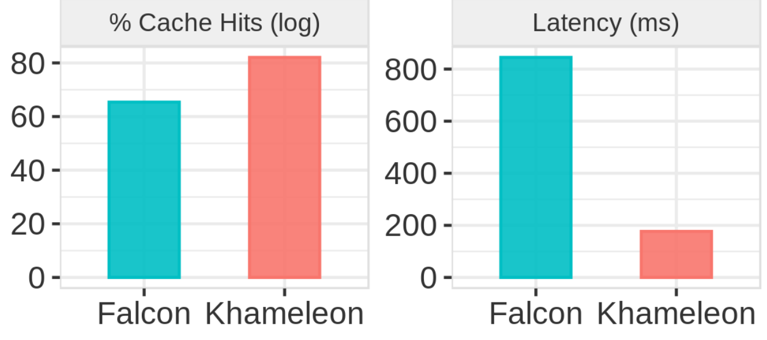
Setting: Image Exploration with 10k requests

Khameleon outperforms classic prefetching approaches by up to 3 orders of magnitude.



Porting Falcon to Khameleon

- Falcon is a prefetching application for visualization
- < 100 lines to port
- It makes it easy to replace prediction policy
- **2.6X** win over Falcon's prediction policy



Acknowledgements

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[1] D. Moritz,ꝿB. Howe, and J. Heer. Falcon: Balancing interactive latency and resolution sensitivity for scalable linked visualizations. 2019.