**Project #1: Web Performance Bottlenecks**

- **Problem:** Mobile browsing is an order-of-magnitude slower compared to desktop browsing.
- **Research Question:** Are the bottlenecks in mobile browsing similar to desktop browsing? Can the same kinds of optimizations be applied?

**WProf-M: Understanding Mobile browser bottlenecks**

- The page load process involves both computation and network activities that are inter-dependent.
- The relations between these activities form a dependency graph.
- WProf-M: Uncovers the dependency graph and bottlenecks in mobile browsers. The bottleneck (or critical path) is shown in red in the figure.

**Key Result:** Computation is the bottleneck in mobile browsers. On desktops, network is the bottleneck.

Figure shows the CDF of the fraction of compute and network activities on the critical path.

WProf-M published at WWW 2016

**Ongoing work**

- Design WProf-X, a visualization tool that will allow Web page developers to easily detect bottlenecks and perform what-if analysis.
- Study the page load bottlenecks when loading a page in developing regions.

Project Webpage: wprof.x.cs.stonybrook.edu

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**Project #2: Modeling**

- **Problem:** Energy consumption of mobile Web performance is critical, but not well studied.
- **Optimizations:** Improvements that improve page load time (PLT) may affect energy differently because PLT depends on the critical path, while energy depends on all page load activities.

**RECON: Modeling Energy Consumption of Web Pages**

**Idea:** App Semantics + Resource Monitoring

- Extract low-level page load semantics from WProf-M
- Keep track of coarse-grained resource consumption
- Combine the two for accurate energy modeling

**Evaluation:** We used RECON to predict energy consumption for 80 Web pages. Mean prediction error less than 10%.

**Explanatory power:** RECON can explain why energy consumption changes.

Example: After inlining, energy increases but PLT decreases. Why?

Because HTML parsing is power hungry, and inlining increases parsing energy.

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**Project #3: Improving Web QoE**

- **Question:** Are traditional Page Load Time (PLT) metrics such as OnLoad measuring user Quality of Experience (QoE)?
- **Our Approach:** Define user-perceived PLT (uPLT) as the time when users perceive the page to be loaded.

User study across 50 users and 45 Web pages show that uPLT and OnLoad poorly correlate.

**WebGaze: Improving QoE using Gaze**

**Insight:** Loading objects on the page that are “interesting” to the user can improve user QoE.

**WebGaze idea:** Identify “interesting” objects on the Web page by leveraging gaze information across large number of users.

**Gaze user study:** 50 users, 45 Web pages, using commodity tracker.

**Key Takeaway:** Gaze track across users form a pattern. Regions of high collective fixation (fraction of users who fixate on a region) and low collective fixation exist.

**WEBGaze:** Server pushes objects with high collective fixation to load first.

Evaluation: User study with 300 users show QoE improvements.

WEBGaze published at NSDI 2017

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**TCP Throughput Modeling (Ongoing)**

- TCP Throughput model unchanged since 1998.
- Existing models make assumptions (for eg., that the congestion window and loss rate are independent) that is no longer true.
- Our goal is to design a new TCP throughput model and use it to predict the throughput of HTTP/2 versus HTTP.

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**Ongoing work**

- Define and measure uPLT for mobile browsing.
- Design a new metric that can be measured systematically (without user studies) that correlates well with uPLT.

Project Webpage: gaze.cs.stonybrook.edu