

Information Flow Experiments

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Motivation

Ads are omnipresent on the web.

[All-Gay Cruises](#)

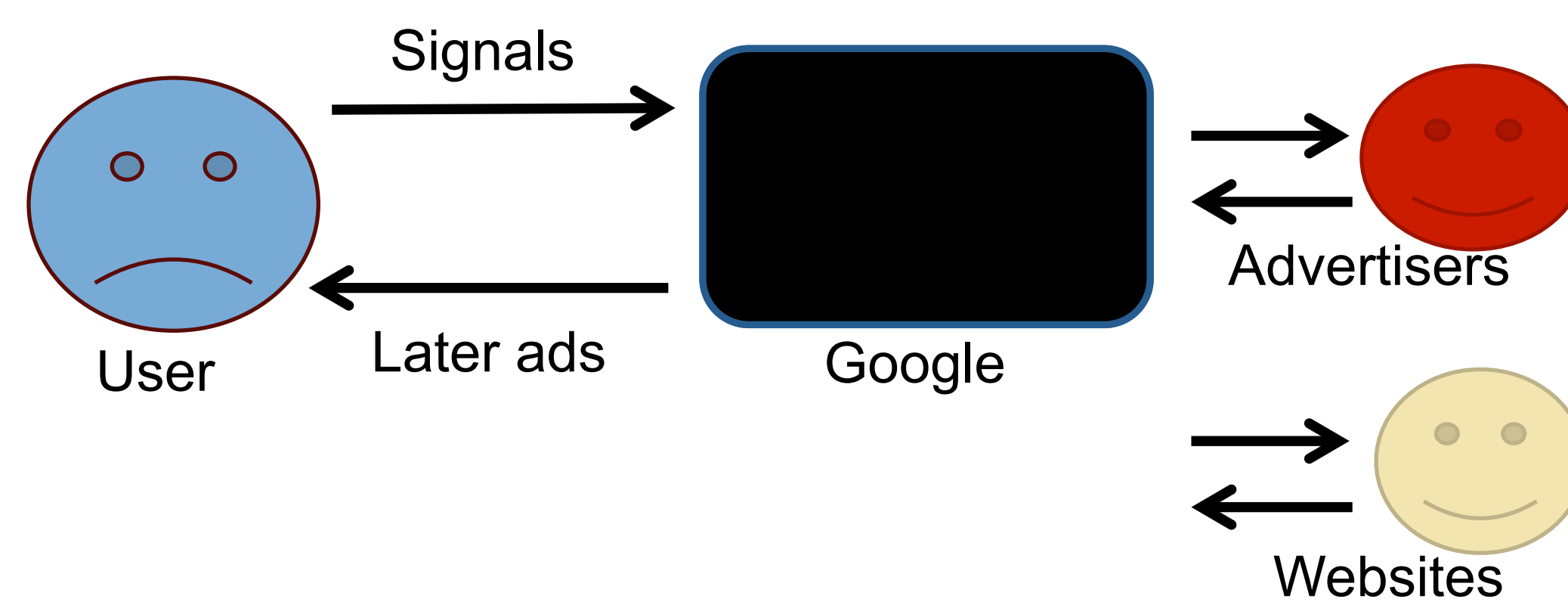
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Cheeseburgers



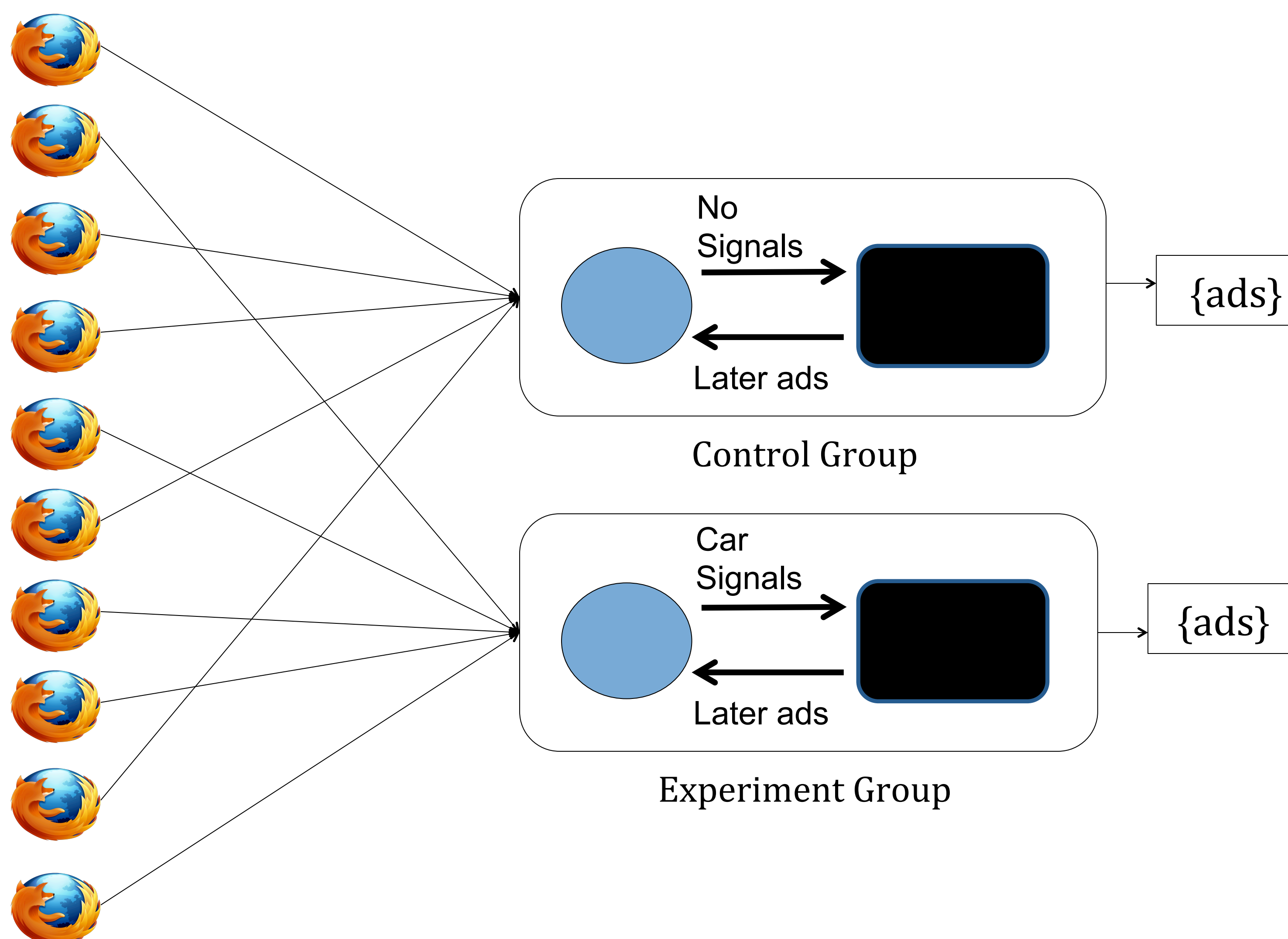
When you're in the mood for a hamburger with some cheese on it, there's nothing better than a cheeseburger.



Goals

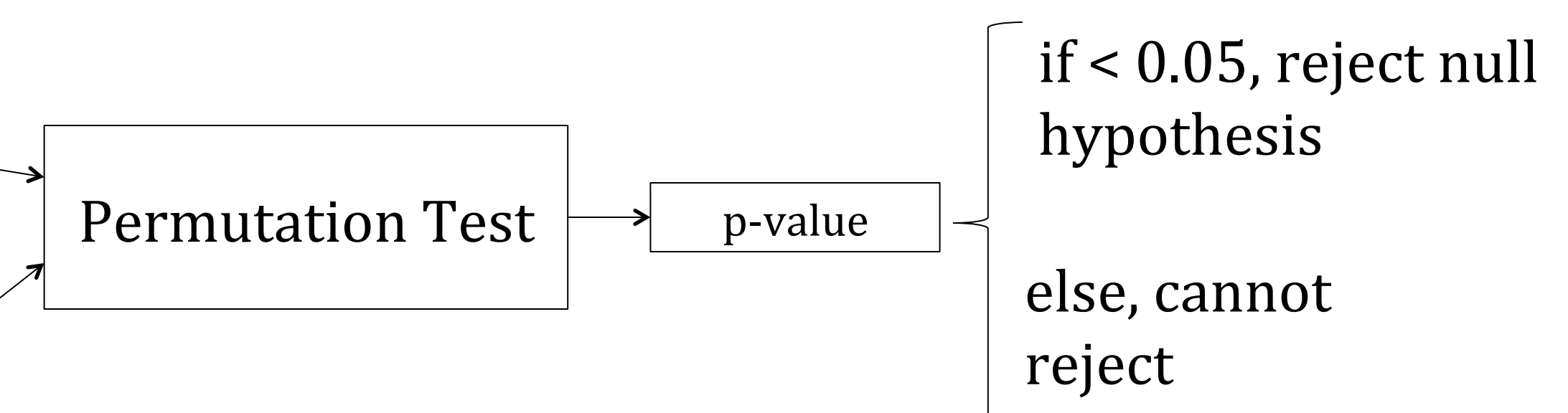
- Design experiments to detect information flows.
- Develop a statistical theory that supports our experimental design and allows us to draw useful conclusions.

Experiments



Statistics

- Non-parametric statistical tests make no assumptions about the ad distributions.
- Null hypothesis: Both ad sets come from the same distribution.



	Cosine Similarity	Keyword Analysis	χ^2
control-experiment	18/20	18/20	20/20
control-control	1/20	1/20	12/20
experiment-experiment	0/20	1/20	5/20

- Our tests perform better than the χ^2 test in appropriately rejecting the null hypothesis.

Rounds	Unique ads in isolation	Unique ads in parallel
10	37	25
10	46	33
20	58	47
20	57	52

- We observed a cross-browser effect among the different instances running together.
- Permutation tests for observing effect does not require lack of cross-unit effects.
- Statistical tests allow us to show **interference** exists. Coupled with the theorem:

Interference \iff Causal Effect

we conclude *'the signals have a causal effect on the ads'*.

Related Work

- [Guha et. al, 2010](#): Developed techniques for measuring online advertising systems: cosine similarity, display URL.
- [Balebako et. al, 2012](#): Analyzed effects of privacy tools in limiting behavioral advertisements: Ghostery, DoNotTrack, OptOut, etc.
- [Wills and Tatar, 2012](#): Miscellaneous studies on online advertisements: multiple signals, keywords.
- [Sweeney, 2013](#): Discrimination in online ad delivery: correlation in racially stereotypical names and the term 'arrest'.
- [Acquisti, 2013](#): Hiring discrimination via social networks.