



CROSS-PLATFORM FEATURE MATCHING FOR WEB APPLICATIONS



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Linked in

facebook

twitter

tumblr

Blogger

ebay
amazon

Gmail
Windows Live
Hotmail

Google

Baidu 百度



flickr
YouTube



Google Docs

Microsoft
Office Live



EasyChair
The conference system

usbank

TurboTax

ACM DL DIGITAL LIBRARY

IEEE Xplore
DIGITAL LIBRARY

MULTIPLE PLATFORMS



Desktop version



Mobile version

Different User Interfaces for best user experience
Different Features (often missed unintentionally)

MISSING FEATURES



Desktop



Mobile

MyWordPress 6 0 + New View Post Howdy, admin

Dashboard

Posts

All Posts

Add New

Categories

Tags

Media

Pages

Comments

Appearance

Plugins 1

Users

Tools

Settings

Collapse menu

Edit Post [Add New](#)

Screen Options Help

Hello world!

Permalink: <http://apps.shauvik.com/wp/?p=1> [Change Permalinks](#) [View Post](#)

[Add Media](#) Visual Text

Welcome to WordPress. This is your first post. Edit or delete it, then start blogging!

Path: p

Word count: 15 Last edited on February 14, 2014 at 2:09 pm

Publish

[Preview Changes](#)

Status: **Published** [Edit](#)

Visibility: **Public** [Edit](#)

Published on: Feb 14, 2014 @ 14:09 [Edit](#)

[Move to Trash](#) [Update](#)

Format

Categories

All Categories **Most Used**

☒ Uncategorized

[+ Add New Category](#)

Tags

[Add](#)

Separate tags with commas

[Choose from the most used tags](#)

Tripleodeon

Just another WordPress weblog

[Overview](#) [New post](#) [Edit post](#) [Comments](#) [Switcher](#) [Settings](#) [Log out](#)

Edit post

Title:

Status:

Published

Content:

"How your mobile site may not be much more complicated than building one with a data API or AJAX"

[Apply](#)

You can use HTML tags to format your post. Use <!--more--> to indicate the end of the teaser.

Powered by the [WordPress Mobile Pack](#) | Theme designed by [rivot](#)

[Switch to our desktop site](#)

USER COMPLAINTS



jhannigan

Me

When adding a post via mobile device
I don't seem to see an option for adding media or



angeloca

Member

At this point I am sure that nobody
is supporting this plugin anymore.
I switched to WP-Touch several weeks ago



libbyh

Member

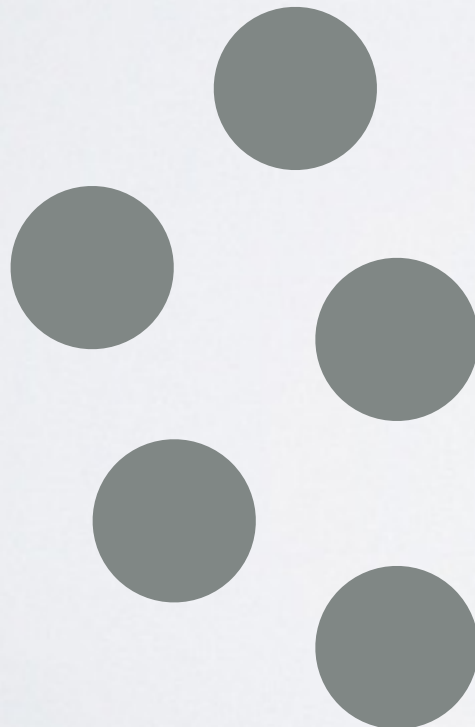
Is there a way ...? ... **the whole point of having a
mobile theme was to make mobile access easier.**

PROBLEM

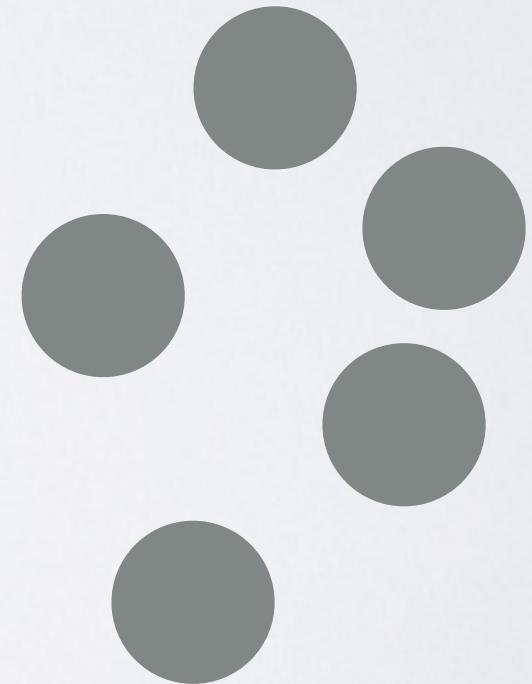
Find Missing Features



Desktop version



Mobile version



PROBLEM

Find Missing Features



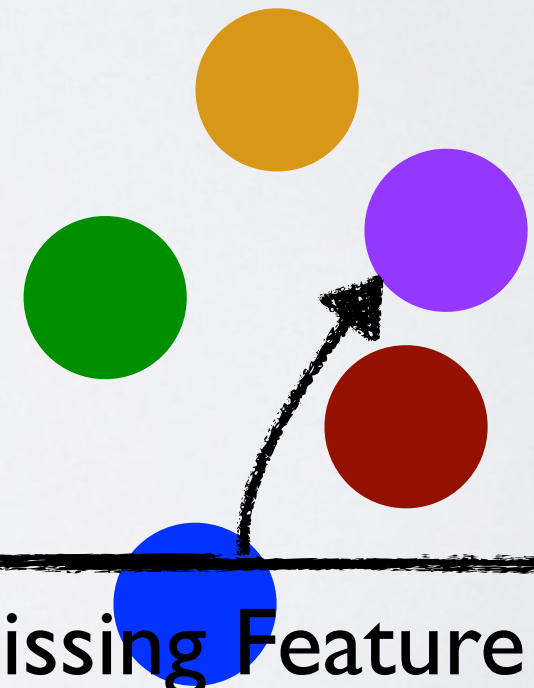
Desktop version



Missing Feature on Mobile

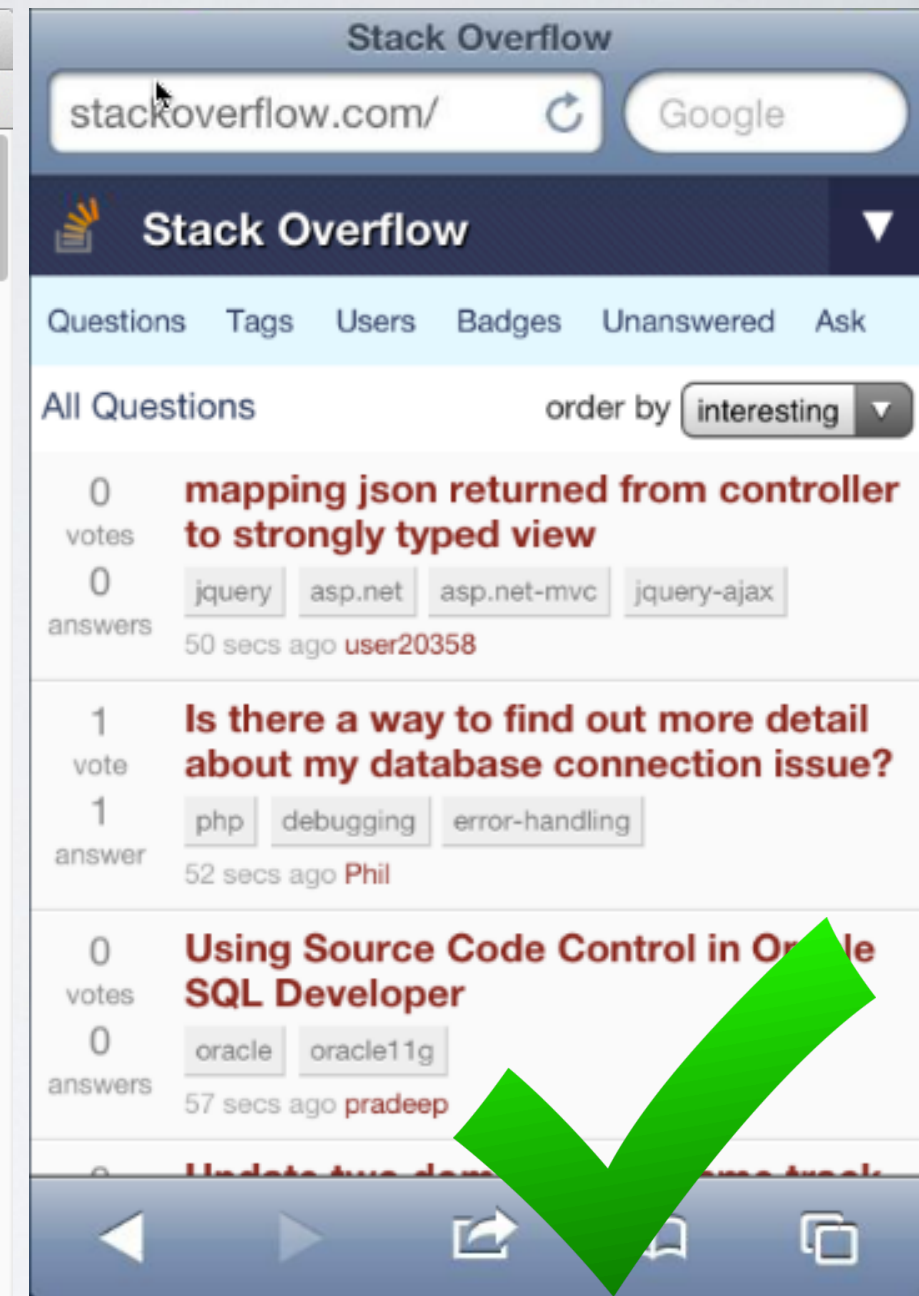
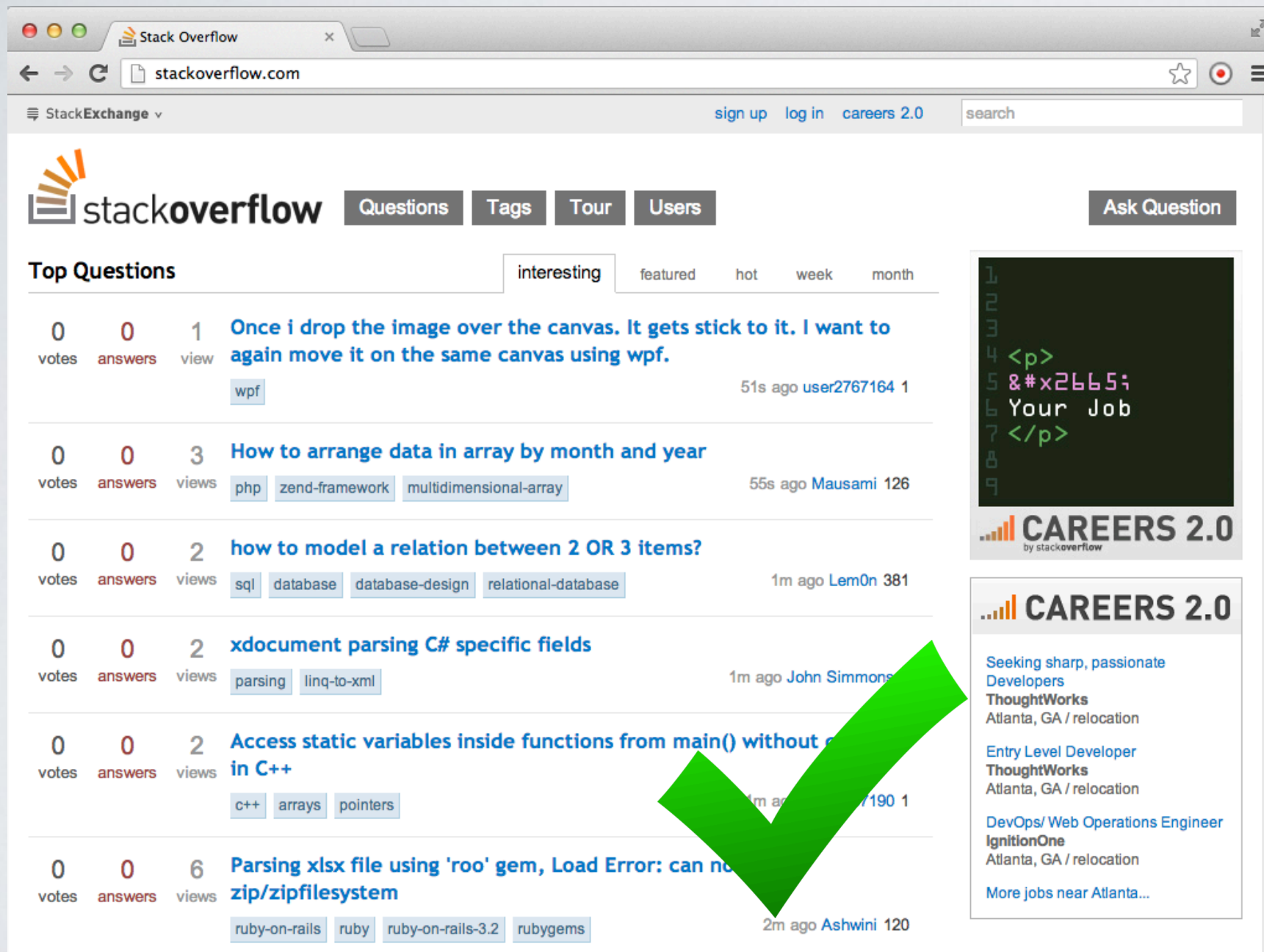


Mobile version



Missing Feature
on Desktop

CHALLENGE



Expected to look different

MOTIVATING EXAMPLE



Desktop Version

MakeMyPost.com

Username

Password

☒ Remember me

MakeMyPost.com

CREATE POST

Post Type ☒ Blog ☐ Pages



Mobile Version

MakeMyPost.com

Username

Password

MakeMyPost.com

▼

CREATE POST

MakeMyPost.com

▼

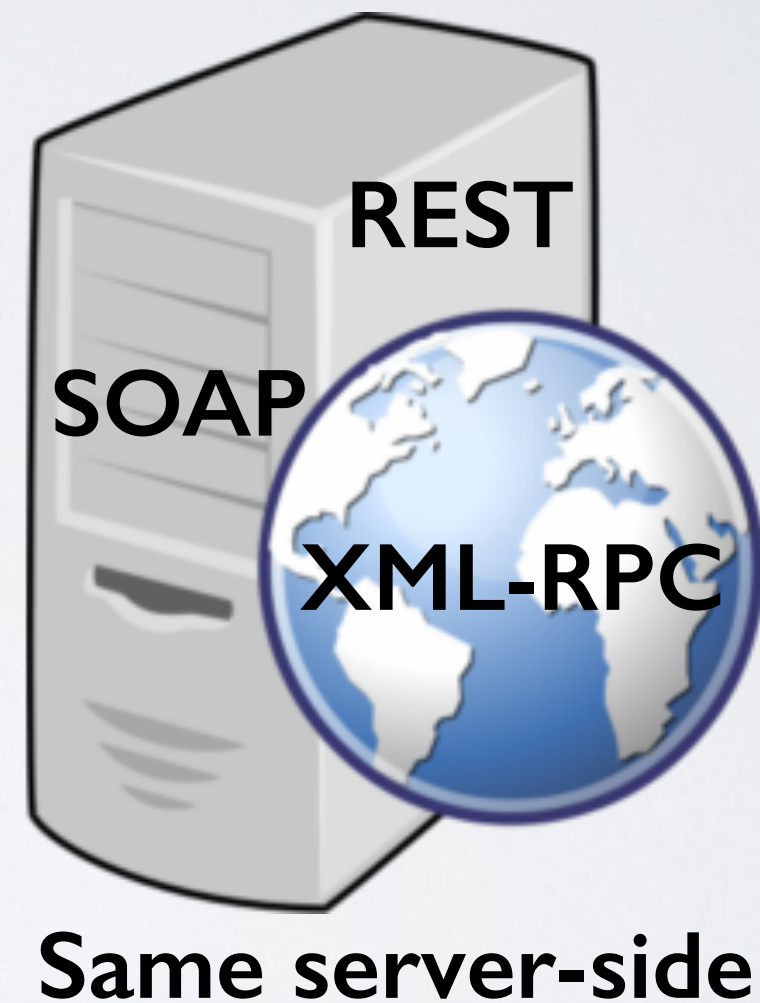
CREATE POST

Home

Blog

Post

OPPORTUNITIES



NETWORK TRACES

Desktop

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /style.css
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET /logo.png
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET /script.js
8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=user1&pass=..&sid=w2s3l
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

Mobile

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /mobile_style.css
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET /logo_small.png
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET /mobile_script.js
8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=myUser&pass=..&sid=d4sVW2
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

NETWORK TRACES

Desktop

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET **/style.css**
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET **/logo.png**
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET **/script.js**
8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: GET /user.php
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

Mobile

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET **/mobile_style.css**
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET **/logo_small.png**
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET **/mobile_script.js**
8. RESPONSE: 200 OK, 'text/javascript'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

Platform-specific resources

NETWORK TRACES

Desktop

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /style.css
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET /

Mobile

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /mobile_style.css
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET /

Generated or User Data

8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=**user1**&pass=..**sid=w2s3l**
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=**myUser**&pass=..**sid=d4sW2**
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

NETWORK TRACES

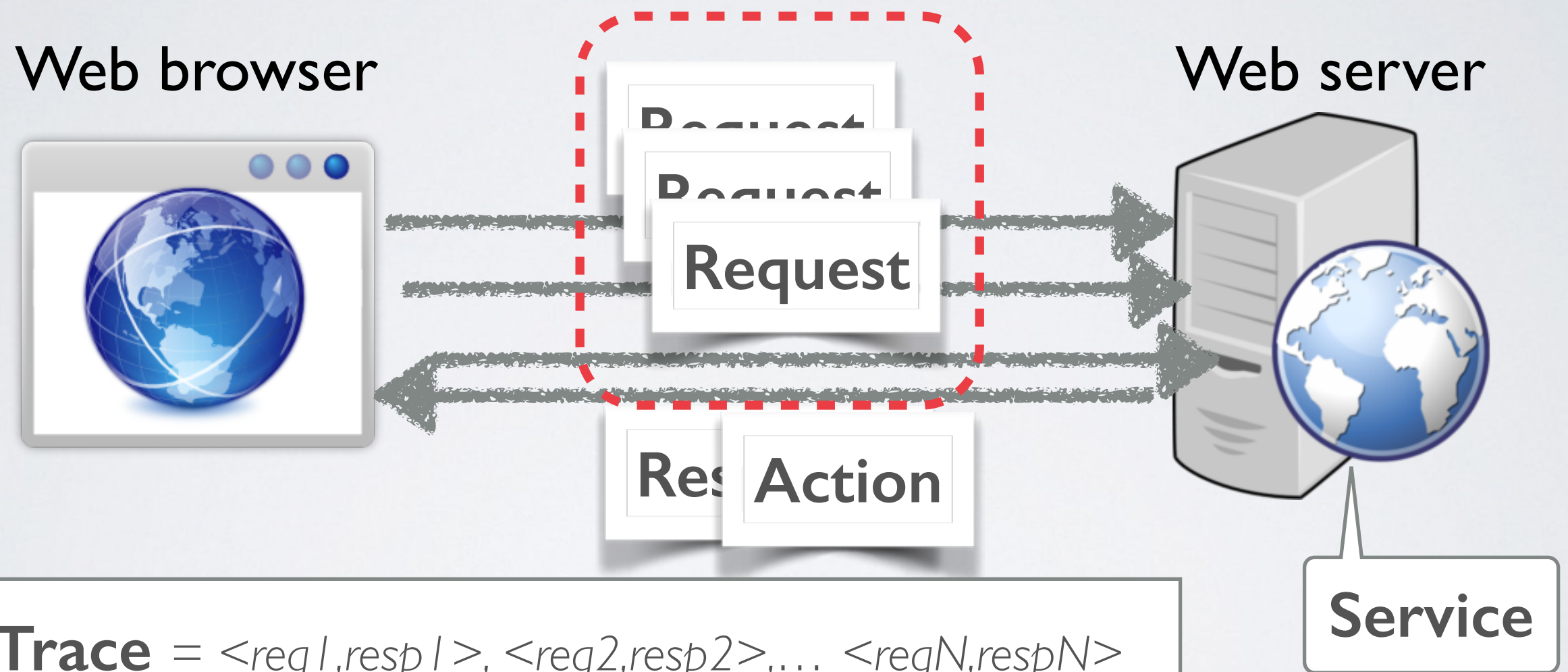
Desktop

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /style.css
4. REPONSE: 200 OK, 'text/css'
5. REQUEST: GET /logo.png
6. REPONSE: 200 OK, 'image/png'
7. REQUEST: GET /script.js
8. REPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=user1&pass=..&sid=w2s3l
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

Mobile

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /mobile_style.css
4. REPONSE: 200 OK, 'text/css'
5. REQUEST: GET /logo_small.png
6. REPONSE: 200 OK, 'image/png'
7. REQUEST: GET /mobile_script.js
8. REPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=myUser&pass=..&sid=d4sVW2
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

TERMINOLOGY



Feature = $Service1, Service2, \dots ServiceN$

FEATURE EQUIVALENCE

- Two features from different platforms are equivalent, if they exercise the same set of services in the same sequence.



Desktop

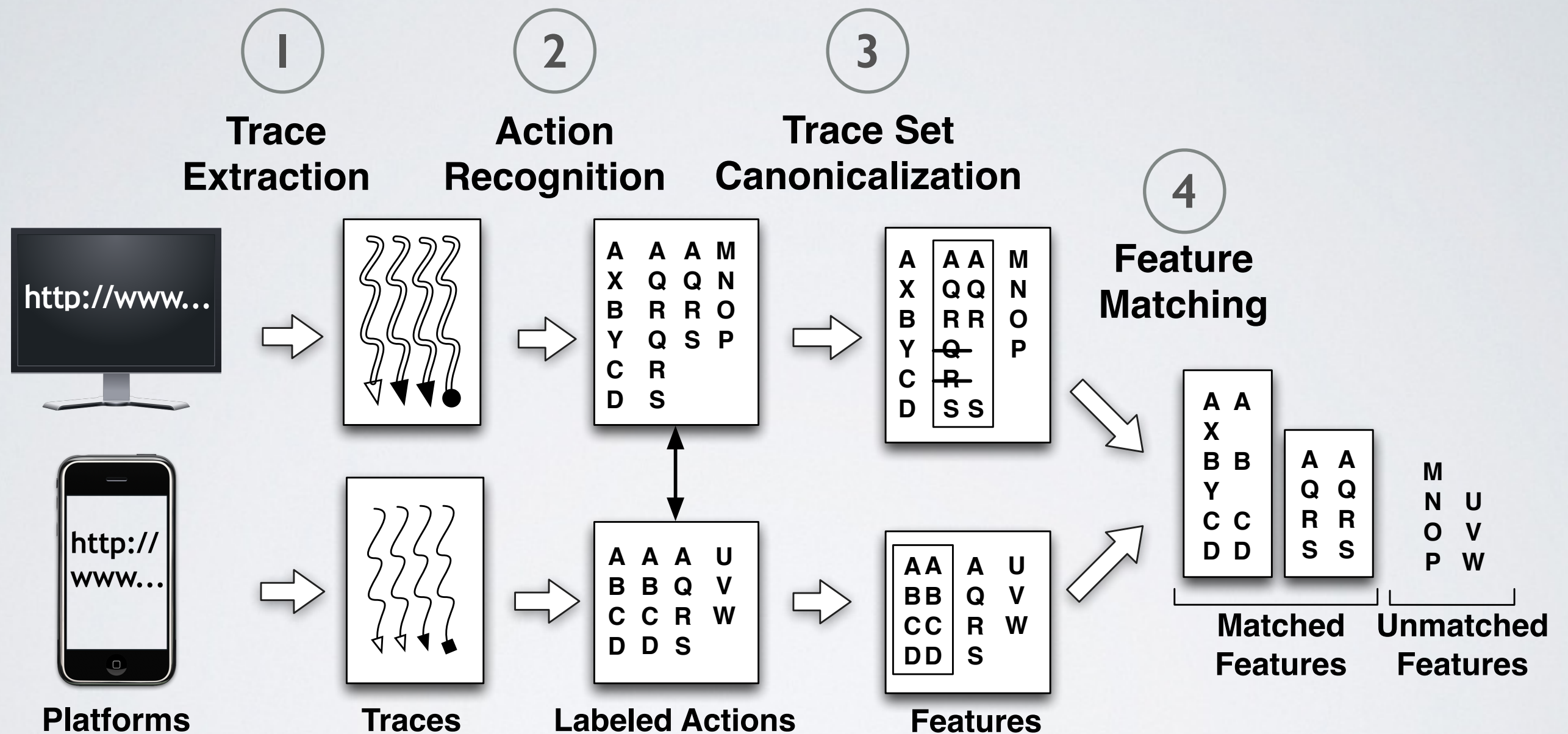
Action 1, Action 2, ... Action N
Feature = ~~Service 1, Service 2, ... Service N~~



Mobile

Action 1, Action 2, ... Action N
Feature = ~~Service 1, Service 2, ... Service N~~

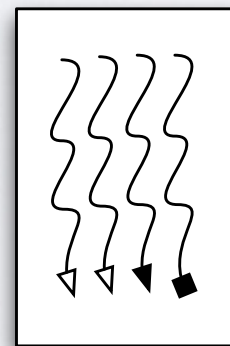
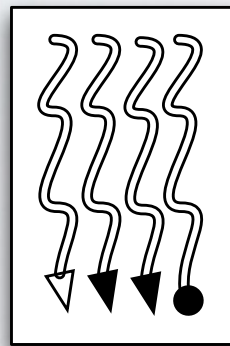
APPROACH OVERVIEW



APPROACH OVERVIEW



Trace Extraction



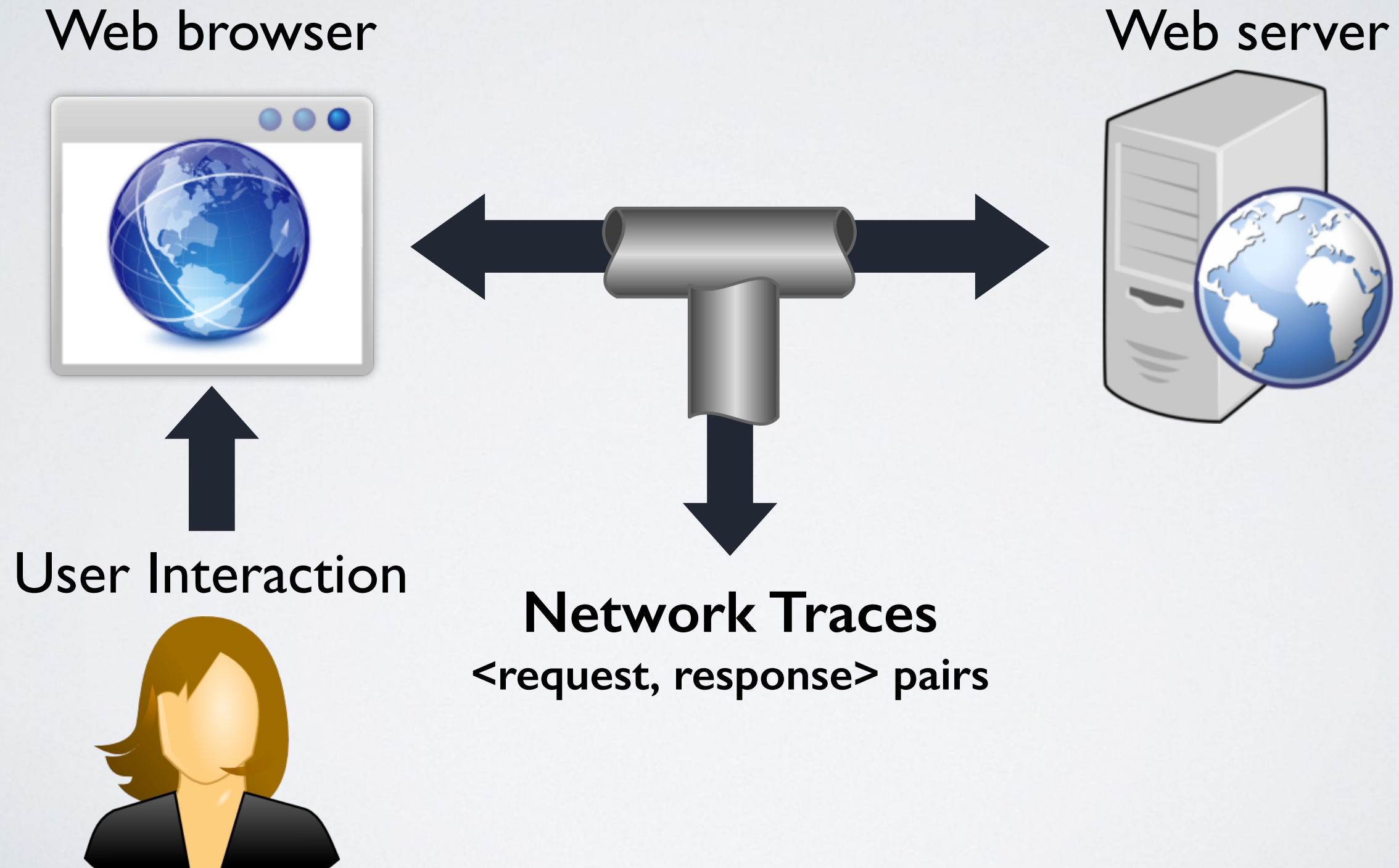
Platforms

Traces

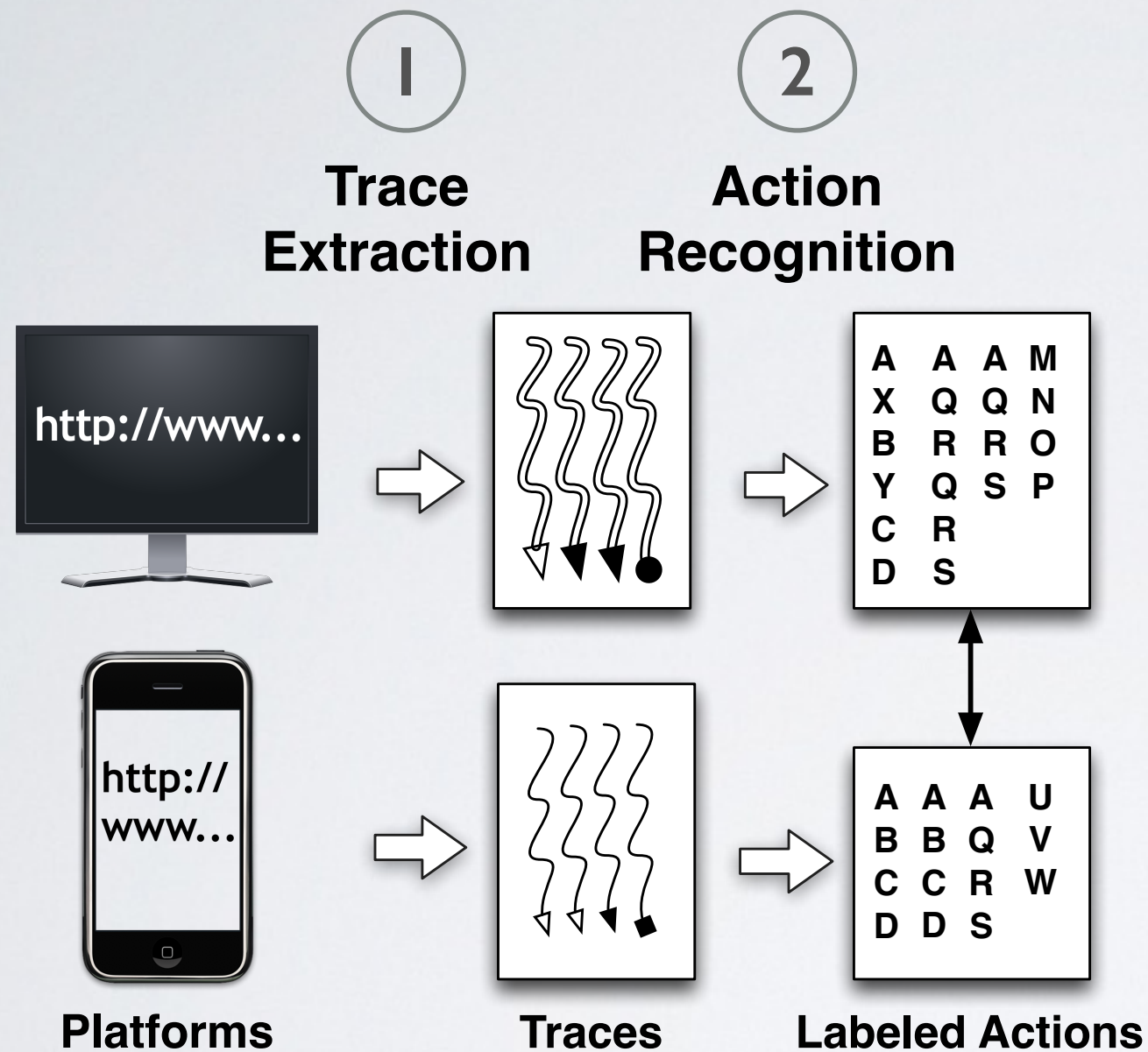
Goal:

Collect network traces for
feature matching

I. TRACE EXTRACTION



APPROACH OVERVIEW



Goal:
Recognize same
actions among
requests

2. ACTION RECOGNITION

1. REQUEST: GET /index.php
2. RESPONSE: 200 OK, 'text/html'
~~3. REQUEST: GET /style.css~~
4. RESPONSE: 200 OK, 'text/css'
~~5. REQUEST: GET /logo.png~~
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET /script.js
8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=user1&pass=..&sid=w2s3l
10. RESPONSE: 200 OK, 'text/html'
....
11. REQUEST: POST /create_blog.php
title=..&content=..
12. RESPONSE: 200 OK, 'text/html'

Ignore requests
to stylistic resources

Domain specific
vocabulary to identify
keywords in requests

2. ACTION RECOGNITION

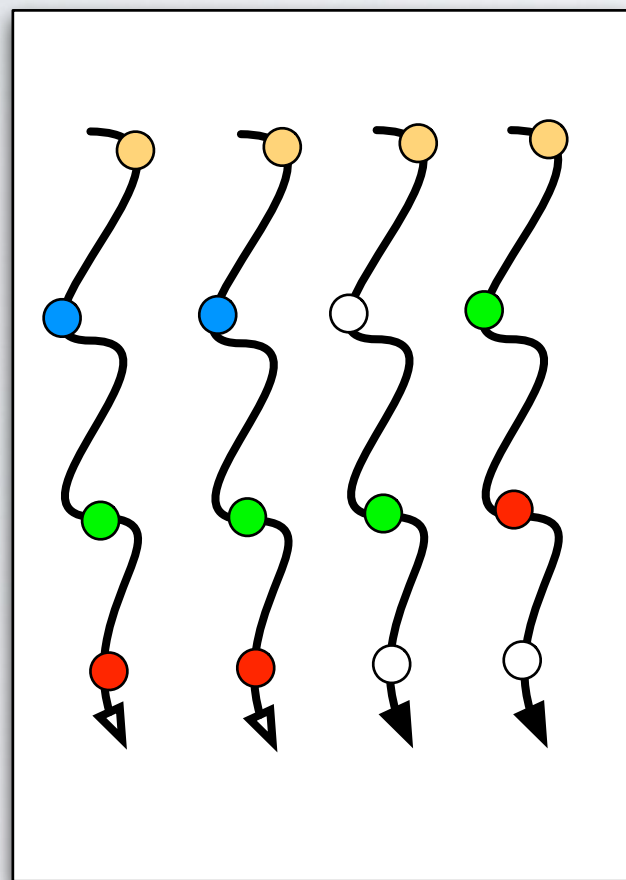
1. REQUEST: GET index.php
2. RESPONSE: 200 OK, 'text/html'
3. REQUEST: GET /style.css
4. RESPONSE: 200 OK, 'text/css'
5. REQUEST: GET /logo.png
6. RESPONSE: 200 OK, 'image/png'
7. REQUEST: GET script.js
8. RESPONSE: 200 OK, 'text/javascript'
9. REQUEST: POST /login.php
user=user1&pass=..&sid=w2s3l
10. RESPONSE: 200 OK, 'text/html'
11. REQUEST: POST /create_blog.php
title= content=..
12. RESPONSE: 200 OK, 'text/html'



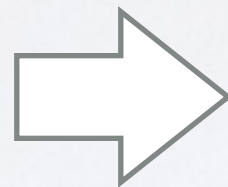
(‘index’),
(‘script’),
(‘login’, ‘user’, ‘pass’, ‘sid’),
(‘create’, ‘blog’, ‘title’, ‘content’)

Keywords

2. ACTION RECOGNITION



Traces



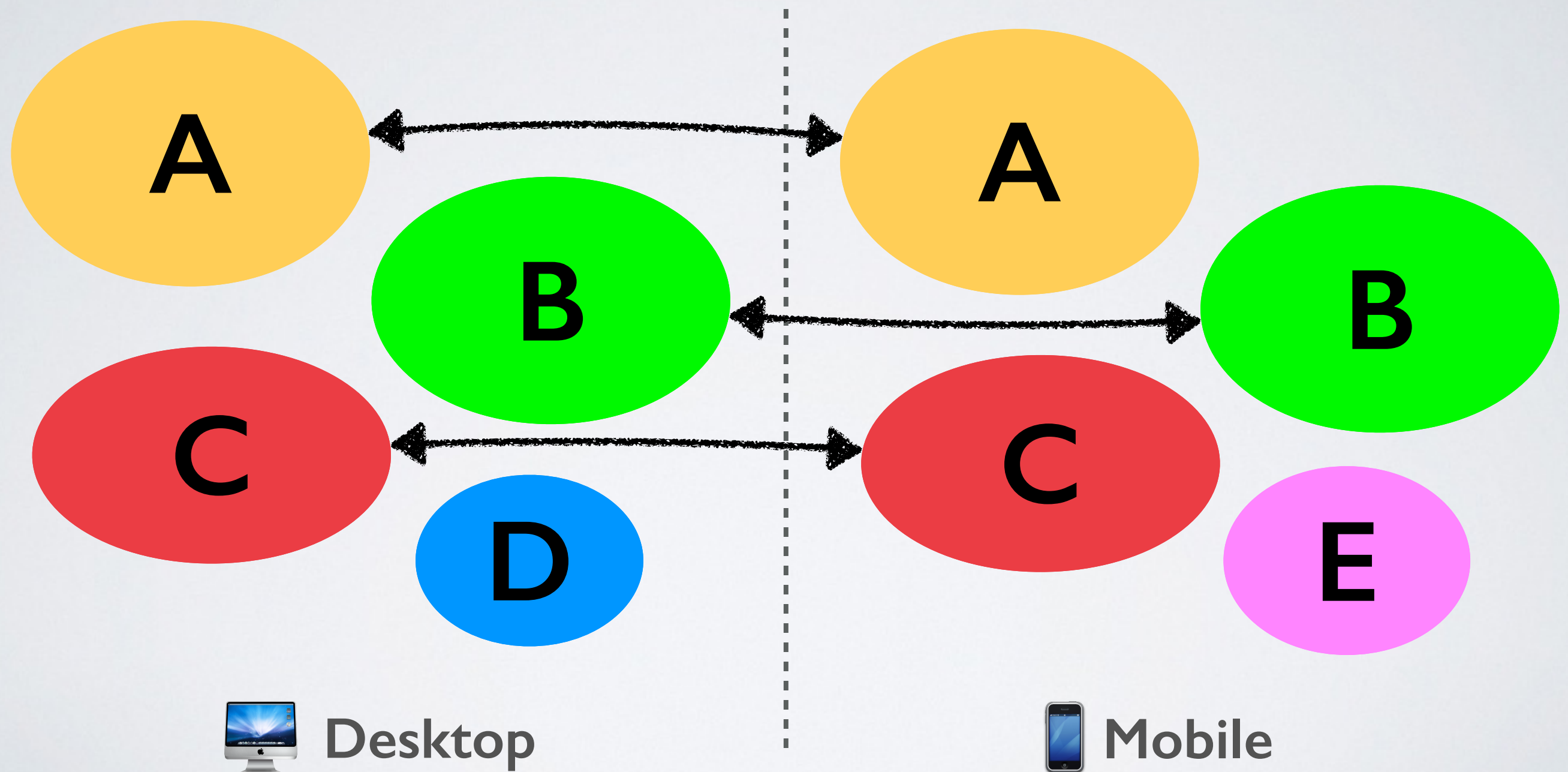
index

login, ..

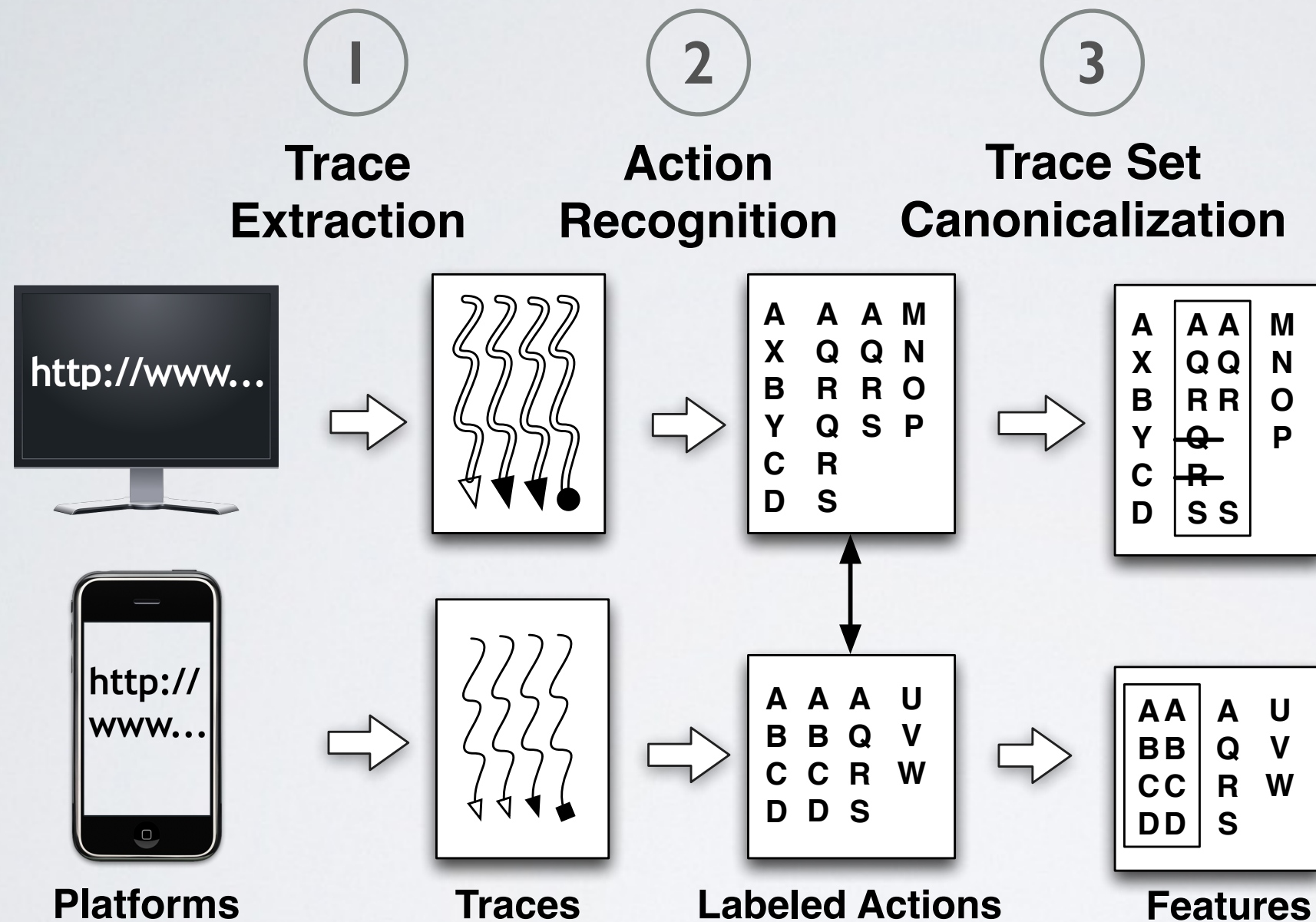
create, ..

script

2. ACTION RECOGNITION



APPROACH OVERVIEW



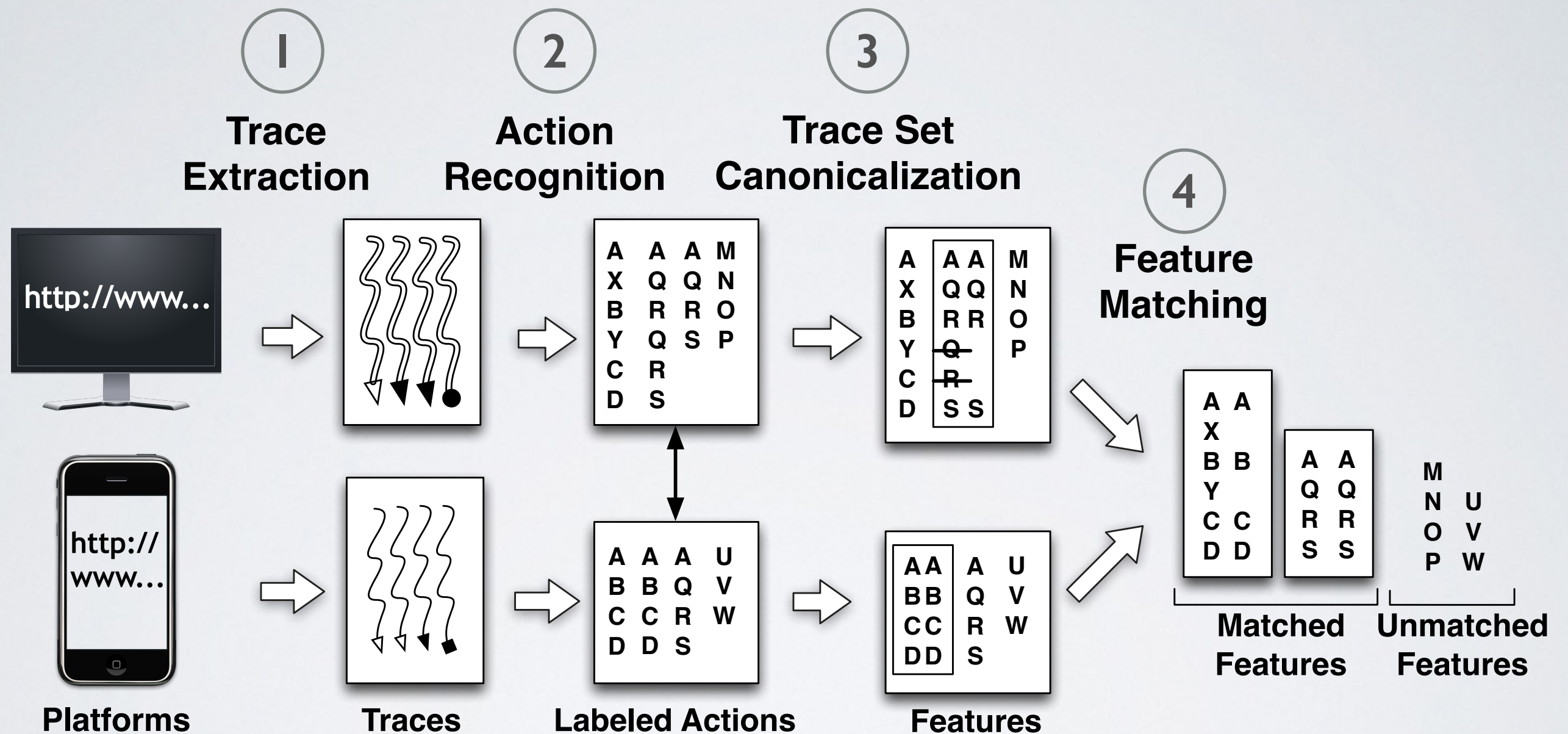
Goal:
Group similar
traces as
features

3. TRACE SET CANONICALIZATION



Tandem repeat: A set of two or more contiguous repetitions of a sequence (used in the context of DNA sequences)

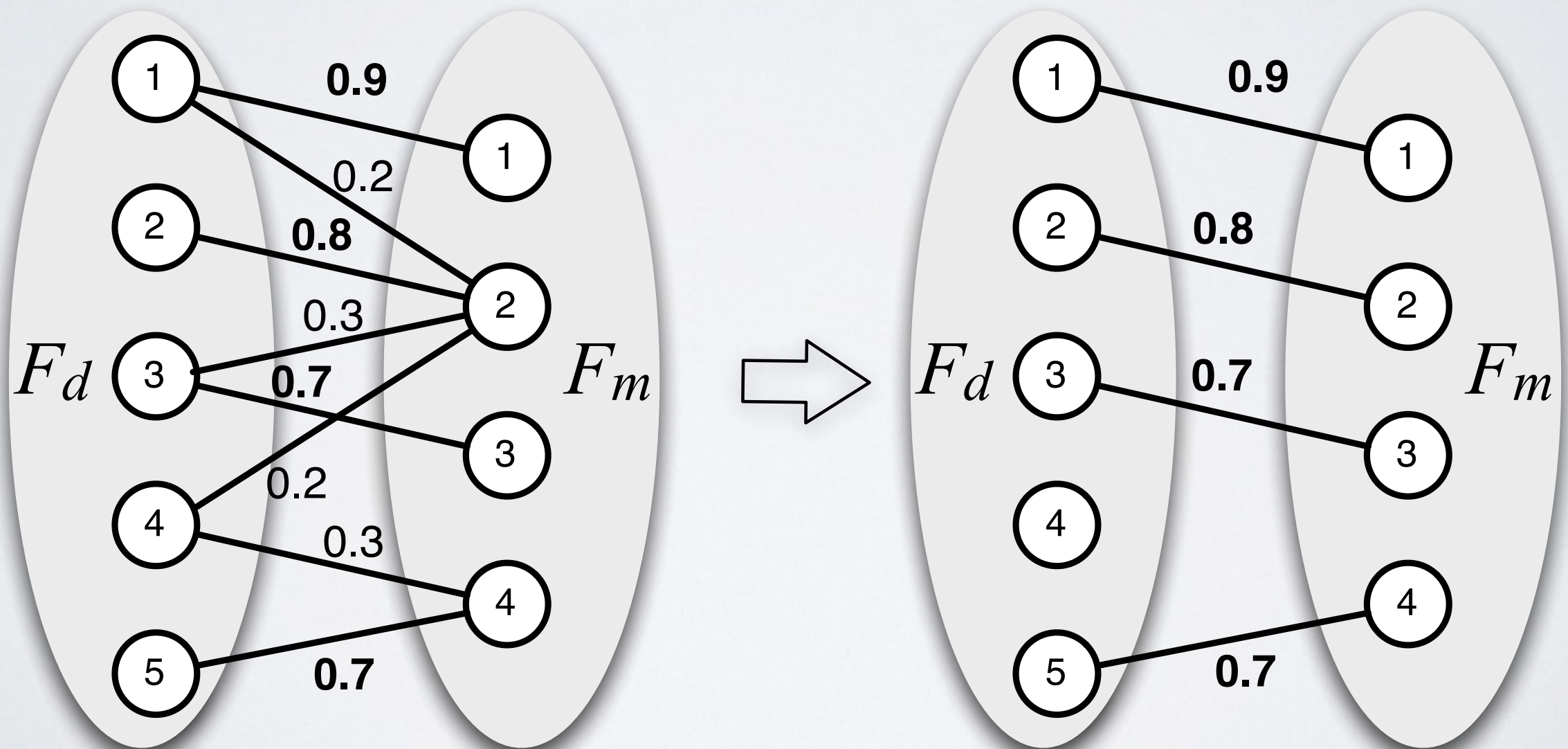
APPROACH OVERVIEW



4. FEATURE MATCHING

Maximum Weighted Bipartite Matching (MWBM) problem

Hungarian Algorithm [Kuhn 1955]



EMPIRICAL EVALUATION

- **Tool:** FMAP (Feature Matching Across Platforms)
 - a. HTTP trace capture browser extension
 - b. Feature matcher tool
- **Research Questions:**
 - **RQ1:** How effective is FMAP in recognizing web application actions?
 - **RQ2:** How effective is FMAP in matching features between the desktop and mobile versions of real web applications?

BASELINE

- **Current practice:** Developers manually keep track of features across platforms
- **Baseline tool:**
 - Action recognition using unique URLs
 - Trace set canonicalization using exactly matching sequence of actions
 - Feature matching using edit distance for MWBM

SUBJECT APPLICATIONS

6 open source and 3 public web applications

Criteria: Popular applications with significant different across mobile & desktop

Subject	Type	Mobile plug-in
wordpress	Blogging	wordpress mobile pack
drupal	Content Management	nokia mobile theme
phpbb	Forum	artodia mobile style
roundcube	Email	mobilecube theme
elgg	Social Networking	elgg mobile module
gallery	Photo Management	imobile theme
wikipedia.org	Wiki	-
stackoverflow.com	Q&A	-
twitter.com	Social Networking	-

PROTOCOL

1. Trace collection:

 $\times subjects \times (desktop \mid mobile)$

2. Feature matching using tool and baseline

3. Manually analyzed results to compute accuracy

$$F\text{-score} = 2 \times \frac{precision \times recall}{precision + recall}$$

RQ2: FEATURE MATCHING

BASELINE

Subject	Features		Matched	T Pos	F Pos	F Neg		T Neg		F-score
	D	M				D	M	D	M	
wordpress	29	8	8	3	5	2	1	21	1	48.0%
drupal	13	13	12	12	0	0	0	0	0	100.0%
phpbb	11	11	3	3	0	9	9	0	0	40.0%
roundcube	6	7	10	4	6	0	0	0	0	57.1%
elgg	9	7	9	2	7	4	0	0	0	30.8%
gallery	31	4	0	-	-	-	-	-	-	-
wikipedia.org	11	10	17	4	13	1	4	8	1	34.0%
stackoverflow.com	18	14	13	3	10	4	1	1	0	32.4%
twitter.com	16	11	0	-	-	-	-	-	-	-
Total	144	85	72	31	41	20	15	30	2	51.5%

RQ2: FEATURE MATCHING

FMAP

Subject	Features		Matched	T Pos	F Pos	F Neg		T Neg		F-score
	D	M				D	M	D	M	
wordpress	29	8	8	7	1	0	0	21	0	93.3%
drupal	13	13	12	12	0	0	0	0	0	100.0%
phpbb	11	11	10	10	0	1	1	0	0	95.2%
roundcube	6	7	4	4	0	2	3	0	0	76.2%
elgg	9	7	5	5	0	1	1	3	1	90.9%
gallery	31	4	3	2	1	1	1	26	0	66.7%
wikipedia.org	11	10	7	7	0	1	1	3	2	93.3%
stackoverflow.com	18	14	10	9	1	1	1	7	3	90.0%
twitter.com	16	11	2	2	0	8	8	6	1	33.3%
Total	144	85	61	58	3	15	16	66	7	86.3%

RQ2: FEATURE MATCHING

FMAP

RQ2: How effective is FMAP in matching features between the desktop and mobile versions of real web applications?

F-Score: 86.3% (FMAP)

51.5% (Baseline)

	Features	Reported	T Pos	F Pos	F Neg	T Neg	
stackoverflow.com	18	14	10	10	9	9	90.0%
twitter.com	16	11	2	2	2	2	33.3%
Total	144	85	61	61	58	58	86.3%

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**Missing features reported by FMAP
confirmed from user reports & software fixes**

LIMITATIONS AND FUTURE WORK

- **Trace Collection:**
 - General trace collection strategies
 - Broader user population
- **Intentionally omitted vs Missing features:**
 - Both currently reported as missing features
 - Study distribution & account for omitted features
- **White/Grey-box approach** to identify features

ARTIFACT



<http://gatech.github.io/fmap>

- ☑ Open source tool release
 - ▶ HTTP trace capture browser extension
 - ▶ Feature matcher tool
- ☑ Experimental data — Collected student traces
- ☑ Documentation and Validation URLs

RELATED WORK

- **Cross-Browser Testing**

[Roy Choudhary et. al., Mesbah et. al., Dallmeier et. al.]

➔ Both presentation & function expected to be identical

- **Inferring API Migration Mappings**

[Gokhale et. al., Zhong et. al., Robillard et. al.]

➔ Mapping atomic actions (functions) between API versions

➔ Input: population of pairs of equivalent traces

- **Reverse Engineering of Web Applications**

[Mesbah et. al., Schur et. al., DiLucca et. al., Elbaum et. al.]

➔ Generate model of web application

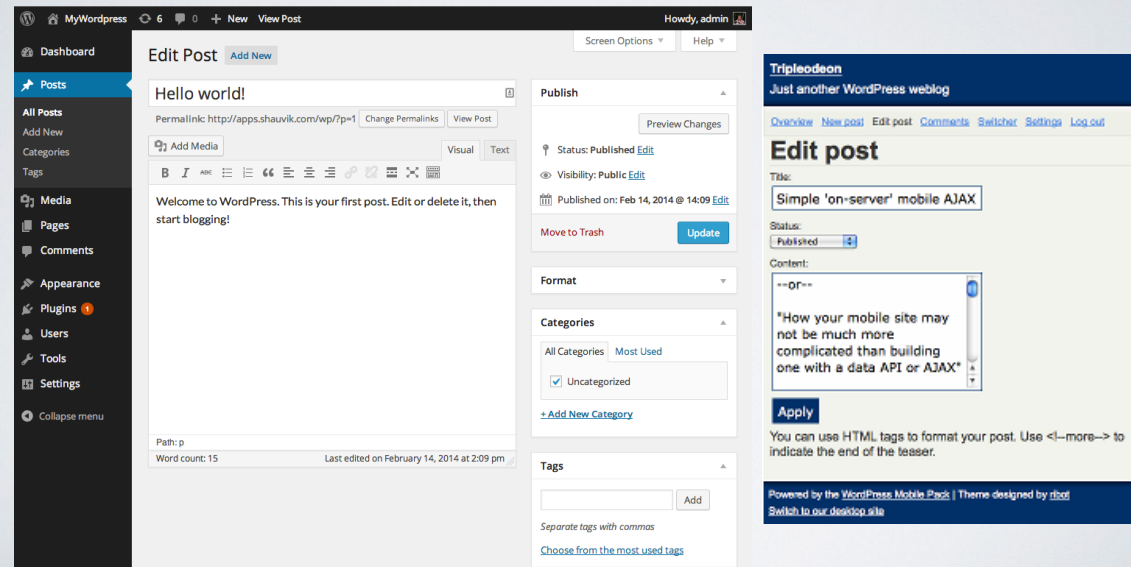
MISSING FEATURES



Desktop

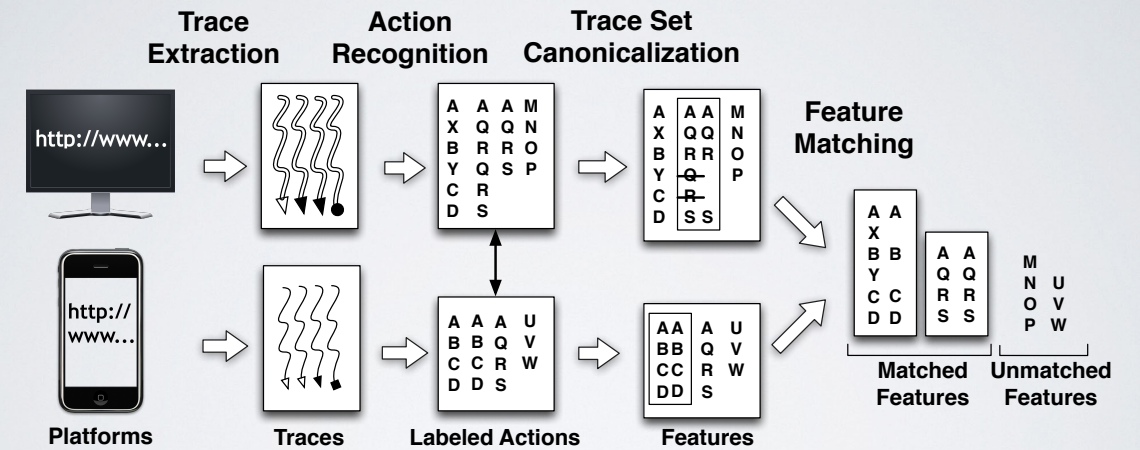


Mobile



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APPROACH OVERVIEW



RQ2: FEATURE MATCHING FMAP

RQ2: How effective is FMAP in matching features between the desktop and mobile versions of real web applications?

F-Score: 86.3% (FMAP)

51.5% (Baseline)

	Features	Reported	T Pos	F Pos	F Neg	T Neg	
stackoverflow.com	18	14	10	10	9	9	90.0%
twitter.com	16	11	2	2	2	2	33.3%
Total	144	85	61	61	58	58	86.3%

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ARTIFACT



<http://gatech.github.io/fmap>

- ✓ Open source tool release
 - ▶ HTTP trace capture browser extension
 - ▶ Feature matcher tool
- ✓ Experimental data — Collected student traces
- ✓ Documentation and Validation URLs

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