FP-Radar: Longitudinal Measurement and Early Detection of Browser Fingerprinting

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Privacy Enhancing Technologies Symposium, 2022

UCDAVIS COMPUTER SCIENCE

PAUL G. ALLEN SCHOOL OF COMPUTER SCIENCE & ENGINEERING

Stateful

- Deterministic Identifiers
  - Cookies
  - Local Storage

- Progressively restricted by browsers

Stateless

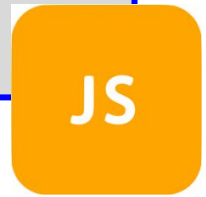
- Probabilistic Identifiers
  - Unique
  - Stable

- Not a static phenomenon

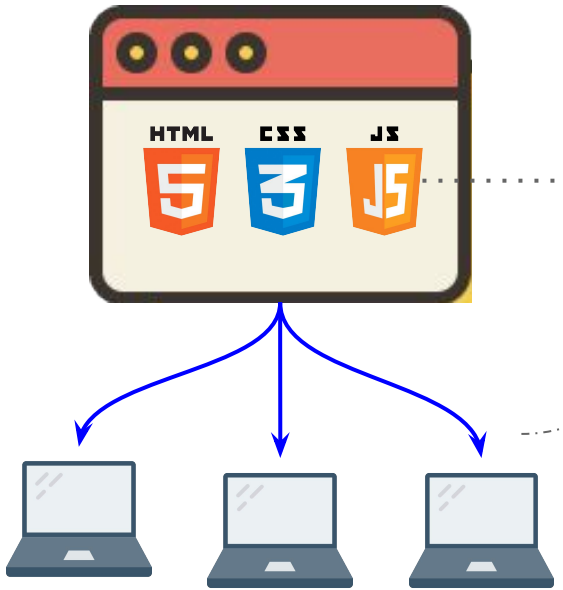
How to detect evolving fingerprinting techniques?

Fingerprinting Example

```
...
function getUserFingerprint() {
      navigator_ditc = {}
      navigator_ditc.cores = navigator.hardwareConcurrency,
      navigator_ditc.languages = navigator.languages,
      navigator_ditc.trackStatus = navigator.doNotTrack
      . . .
}
...
```



Server Side



Tracker Database

# Cores	Languages	doNotTrack
8	[“en-US”,“zh-CN”,“ja-JP”]	False
16	[“en-US”,“fa”]	True
8	[“tr”,“en-US”]	True

Background

State-of-the-art

FP-Radar

Measurement and Results

New Findings

Fingerprinting detection is not straightforward

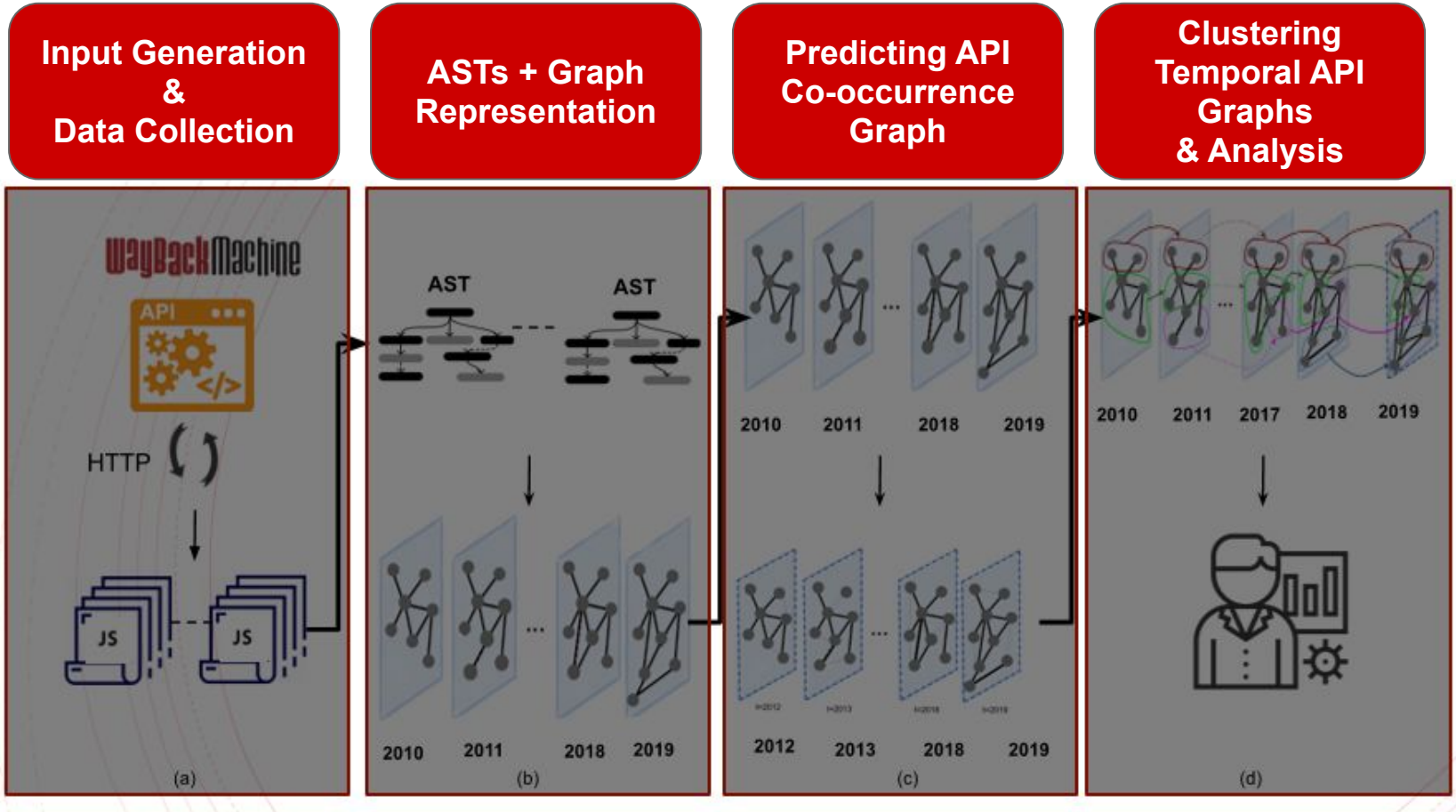
- **Heuristics:** pre-defined heuristics [1]
  - **Laborious and time consuming**
  - **Brittle**
  - **Don’t work for evolving/new APIs**
  - **Reactive detection**
- **ML Based:** Learn automatically [2]
  - **Automate and fast process**
  - **Flexible to minor changes**
  - **Don’t work for evolved/new APIs**
  - **Reactive detection**

1. "Online tracking: A 1-million-site measurement and analysis.", Englehardt, Steven, and Arvind Narayanan.
2. “Fingerprinting the Fingerprinters: Learning to Detect Browser Fingerprinting Behaviors.”, Umar Iqbal, Steven Englehardt, and Zubair Shafiq

Agenda

- Background
- State-of-the-art
- FP-Radar
- Measurement and Results
- New Findings

FP-Radar


Input Generation & Data Collection
ASTs + Graph Representation
Predicting API Co-occurrence Graph
Clustering Temporal API Graphs & Analysis
WayBackMachine
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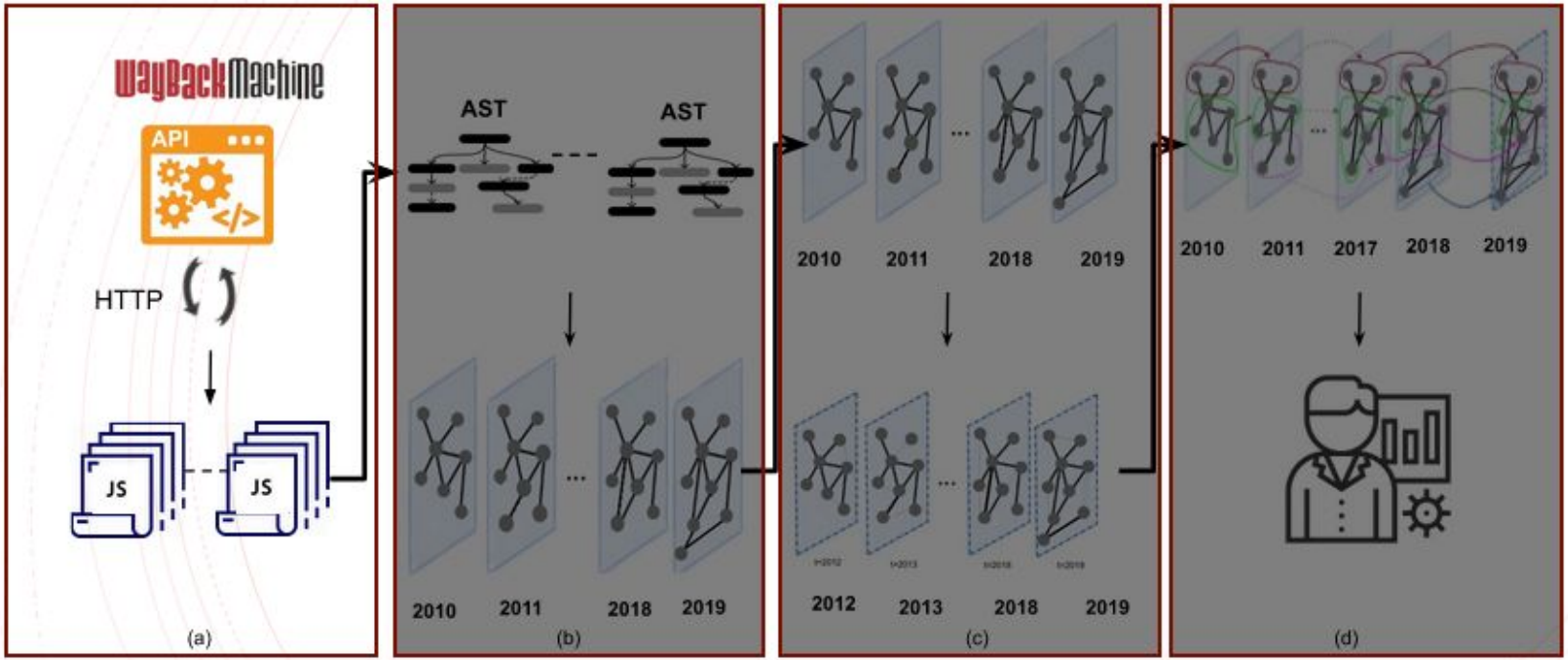
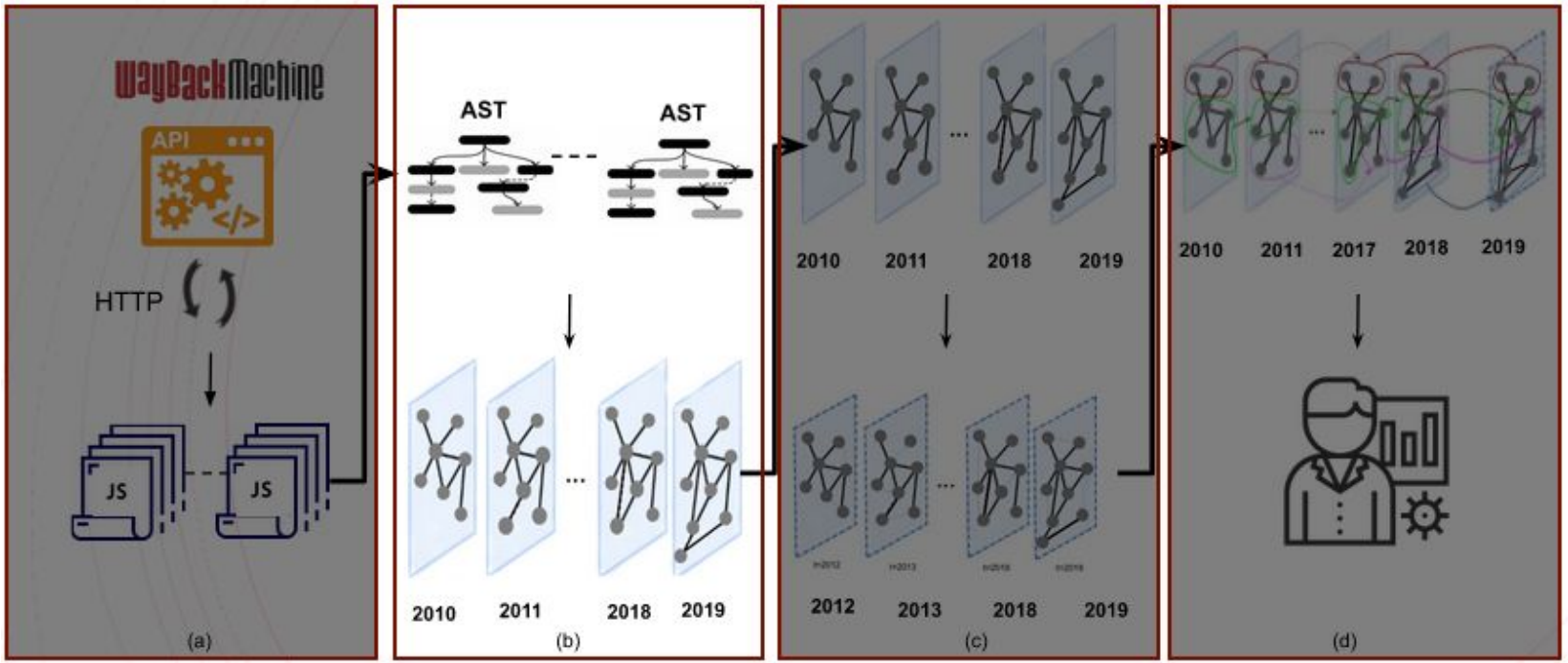
FP-Radar

Input Generation & Data Collection



FP-Radar

ASTs + Graph Representation



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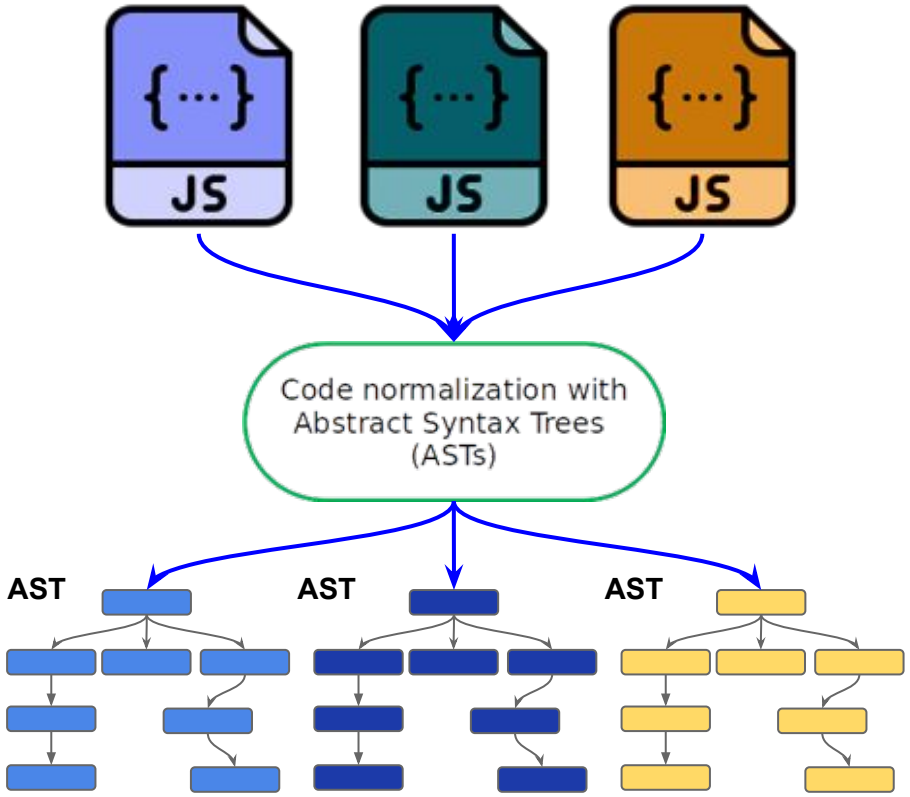
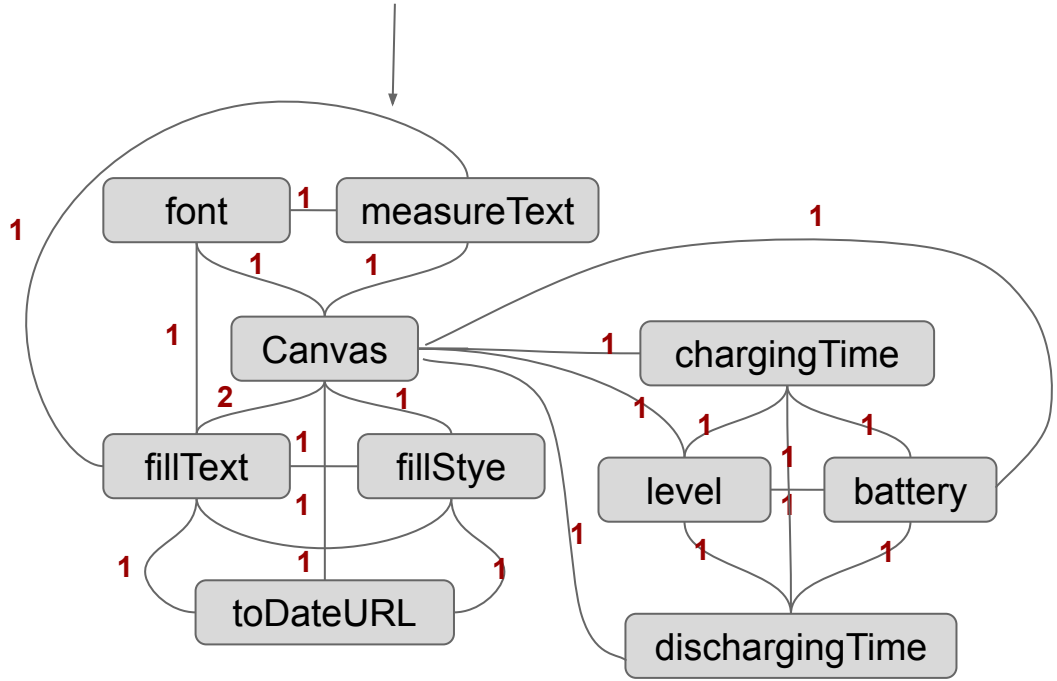


AST + Graph Representation

Script 1	Canvas	toDataURL	fillText	fillStyle	
Script 2	Canvas	Font	measureText	fillText	
Script 3	battery	chanchingTime	dischargingTime	level	Canvas



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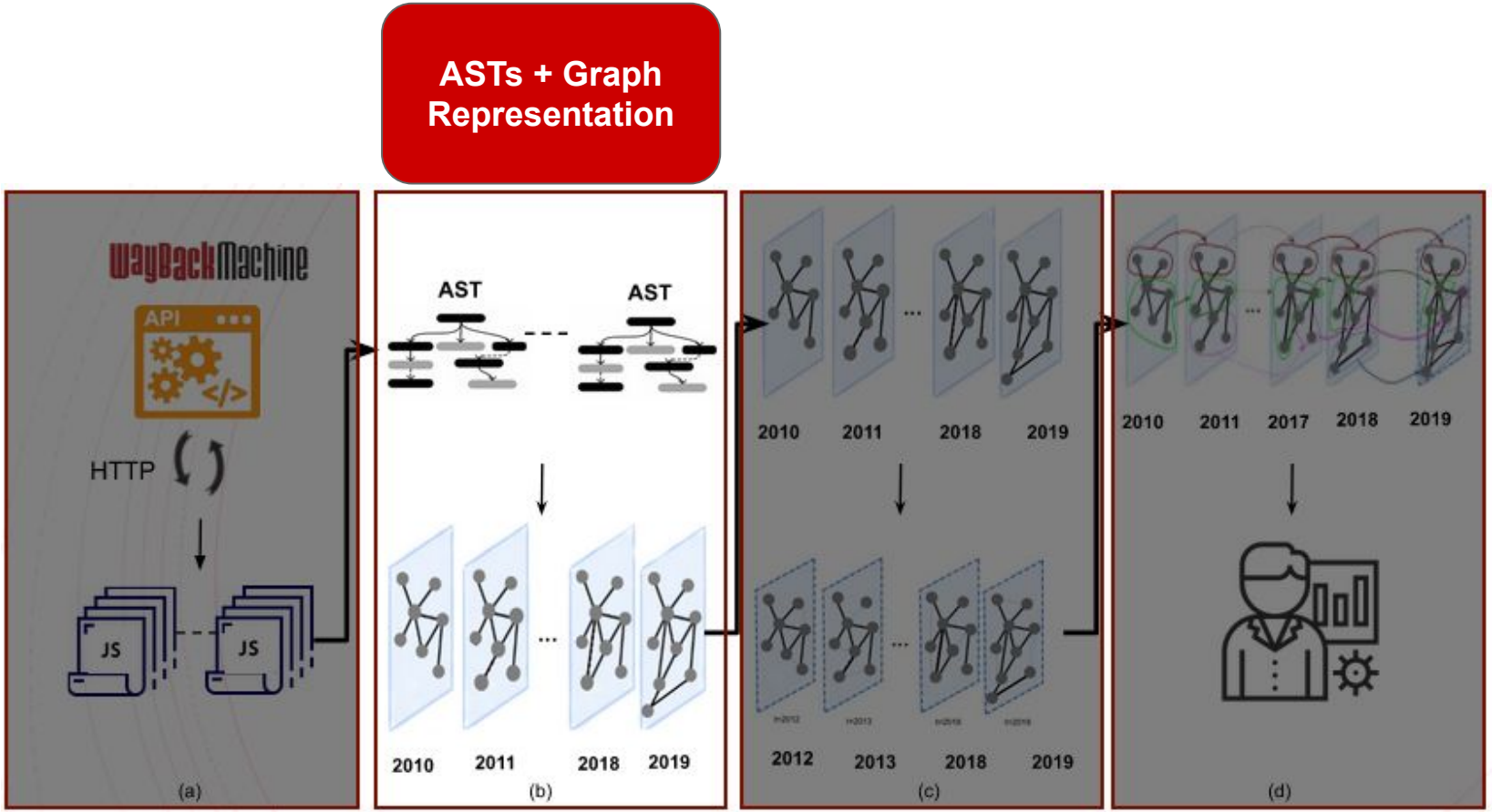
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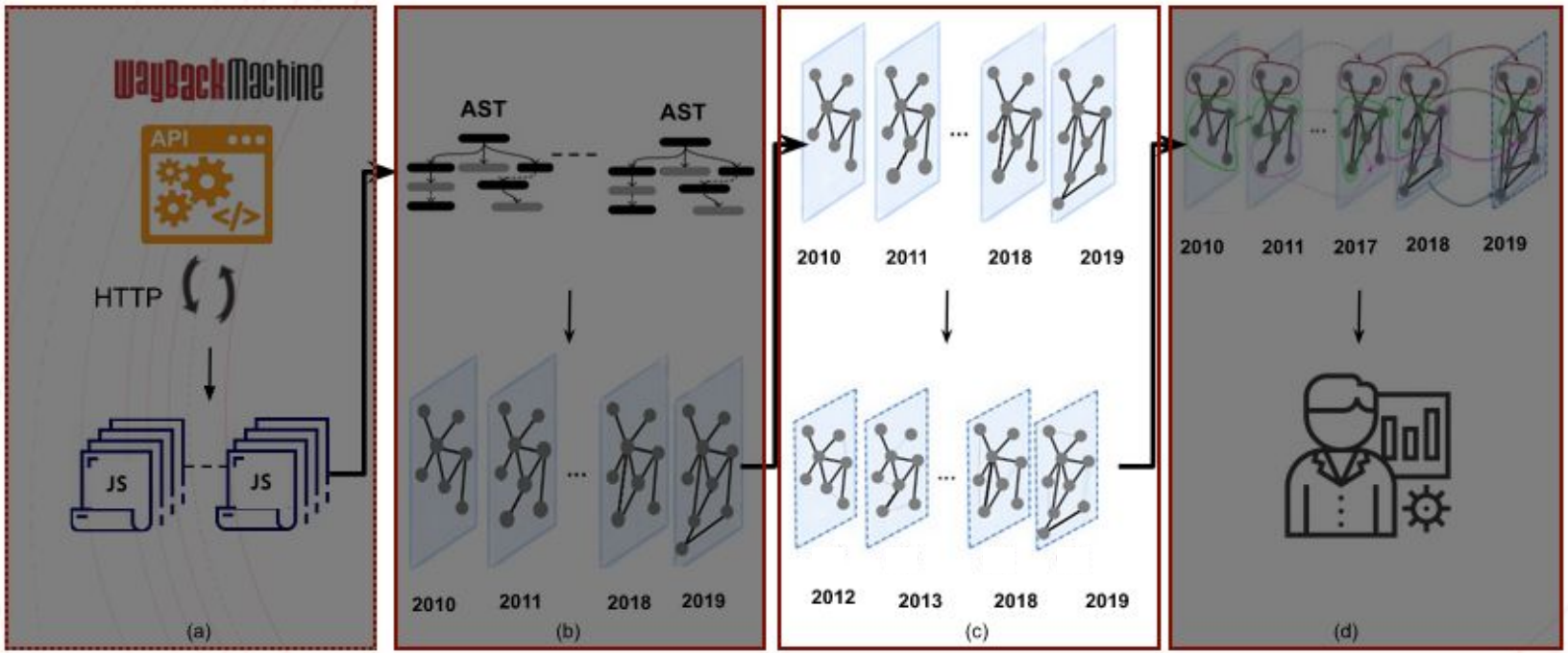
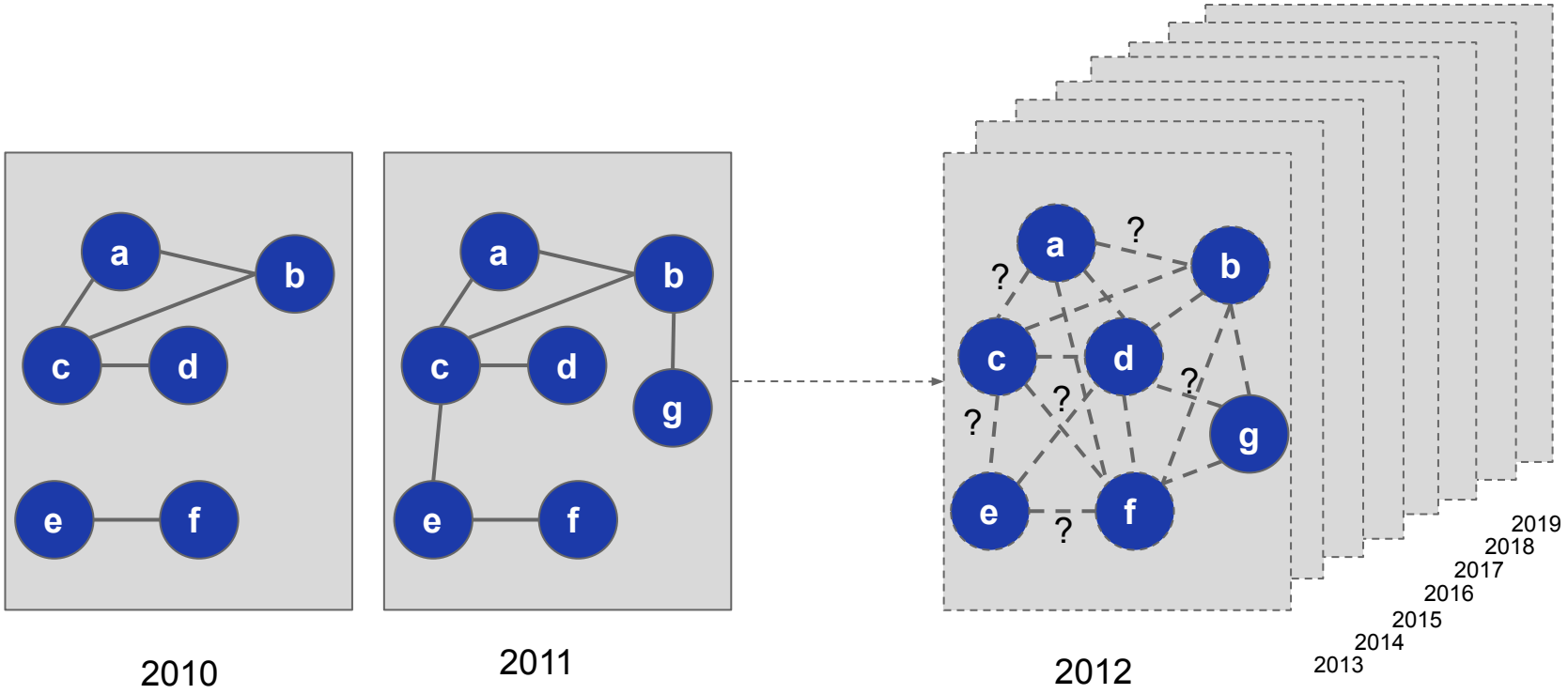
FP-Radar

Predicting API Co-occurrence Graph

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FP-Radar

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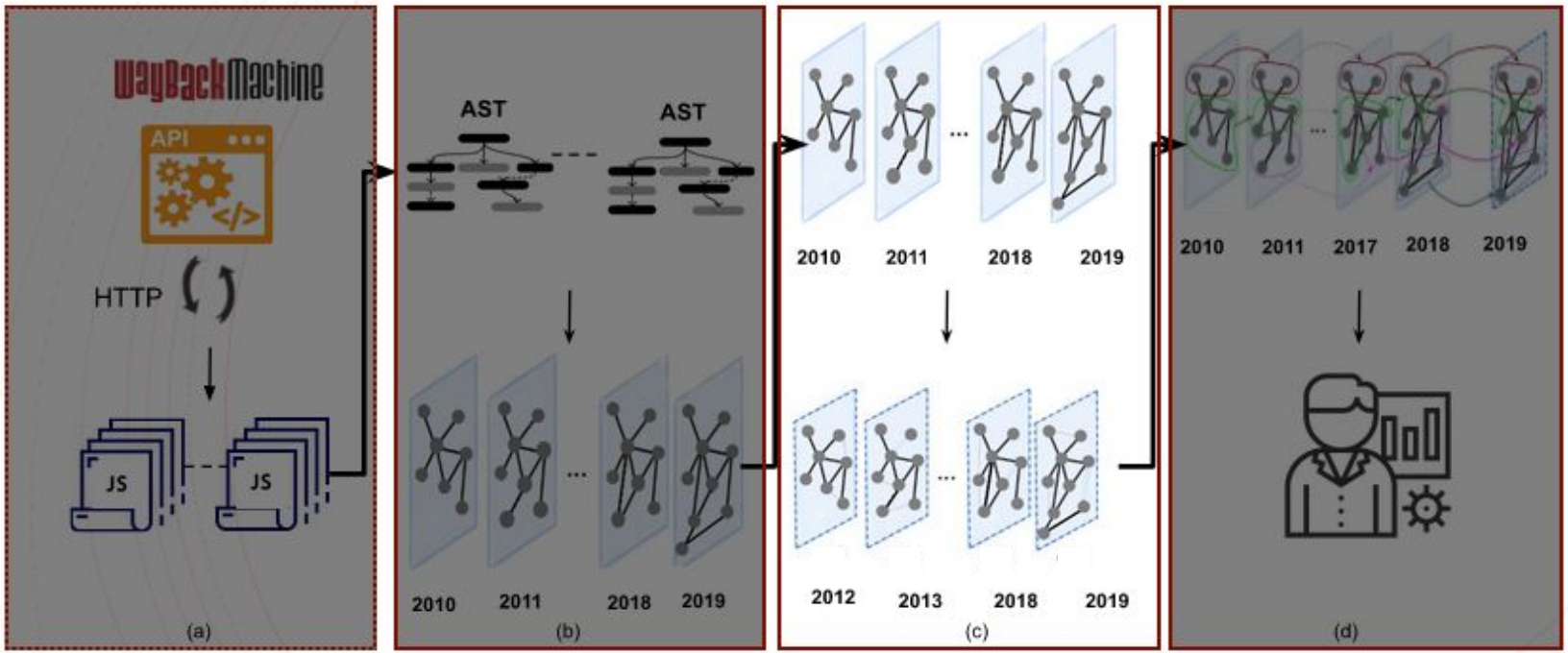

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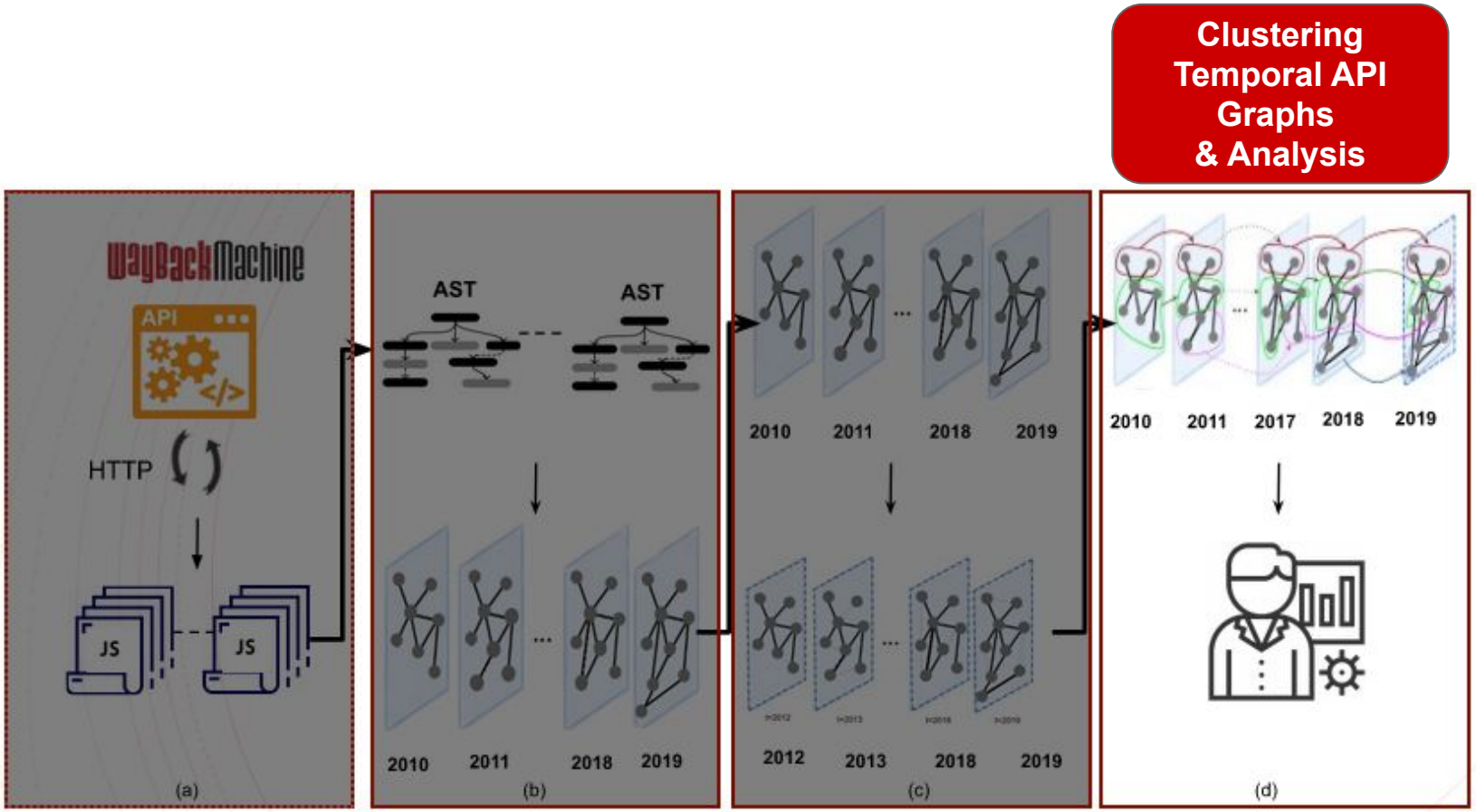
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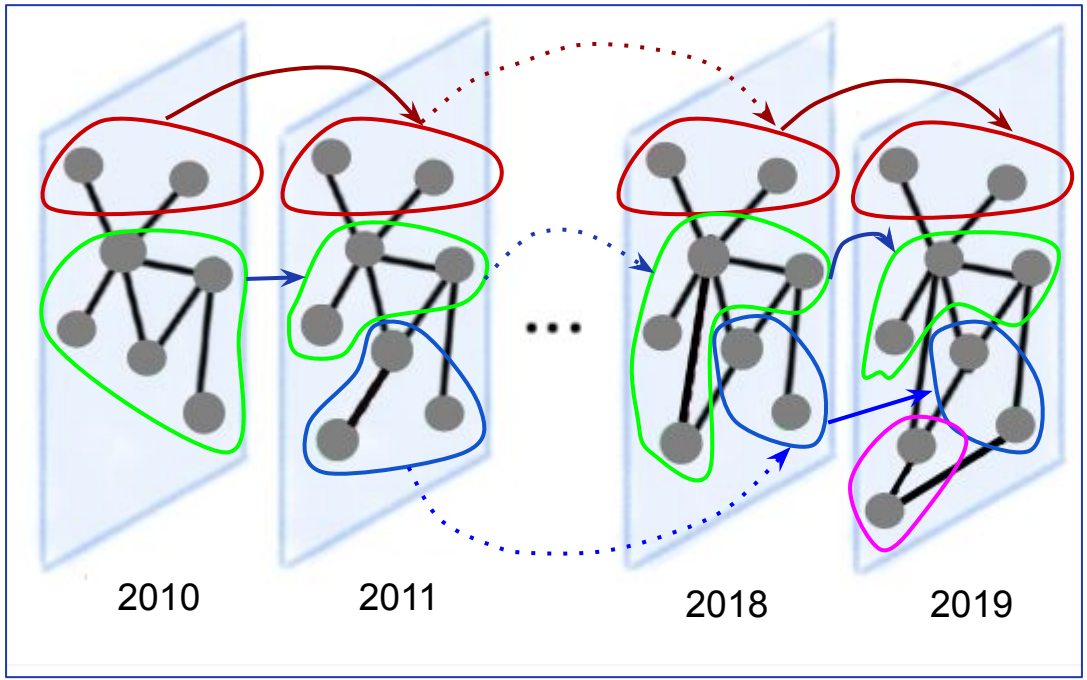
Temporal Clustering



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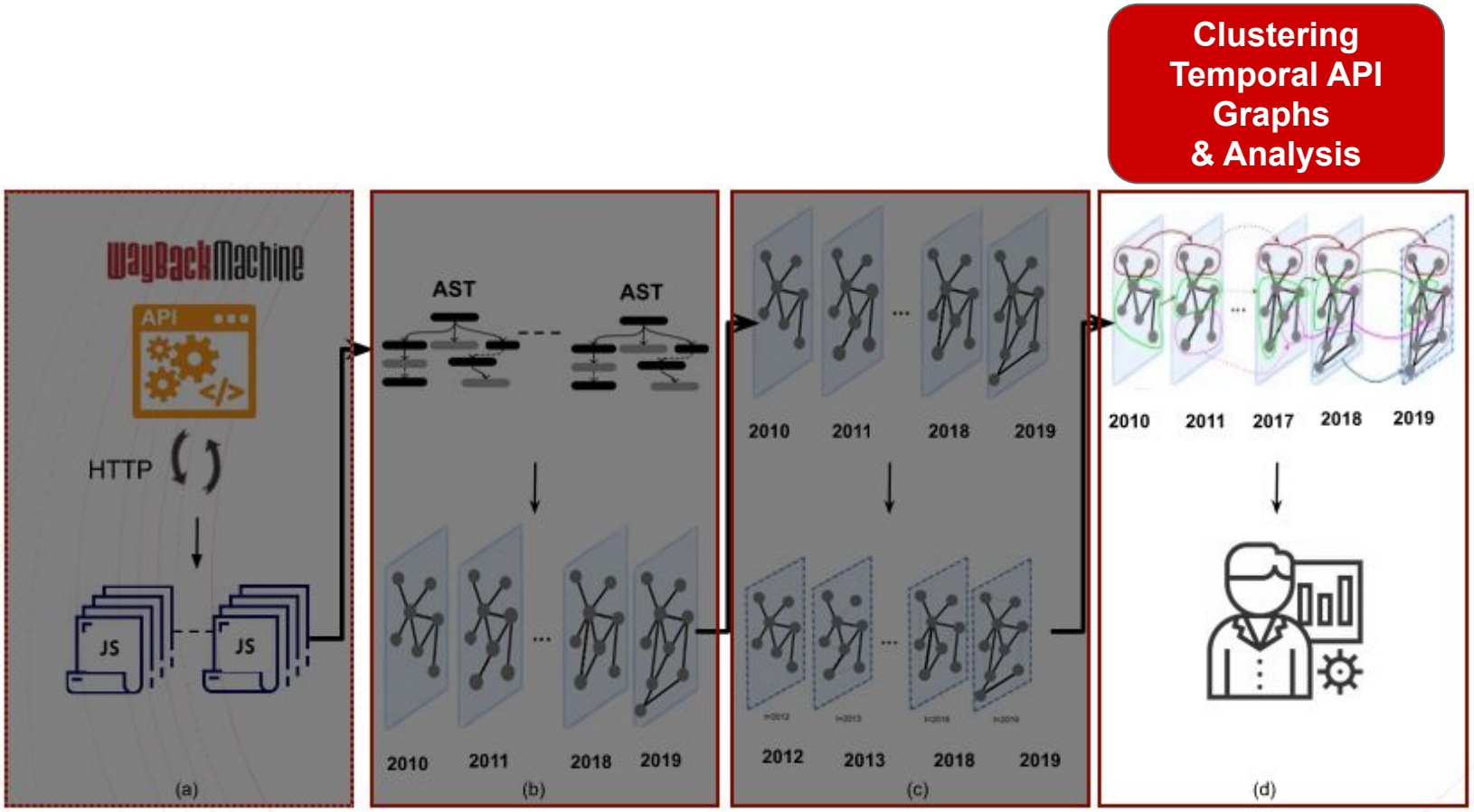
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Temporal Clusters

- **14** temporal clusters
- Detect the fingerprinting cluster(s) based on:
  - % keywords in **fingerprintjs2**
  - Ration of **known fingerprinting** keywords to non-fingerprinting keywords [1]
- **6** potential FP clusters
- The most **dominant cluster** has:
  - Life-span: **9 years**
  - % Common keywords with keywords in fingerprintjs2: **63%**
  - The ratio FP/non-FP: **26.85**

1. "Fingerprinting the Fingerprinters: Learning to Detect Browser Fingerprinting Behaviors.", Umar Iqbal, Steven Englehardt, and Zubair Shafiq

Time to detection

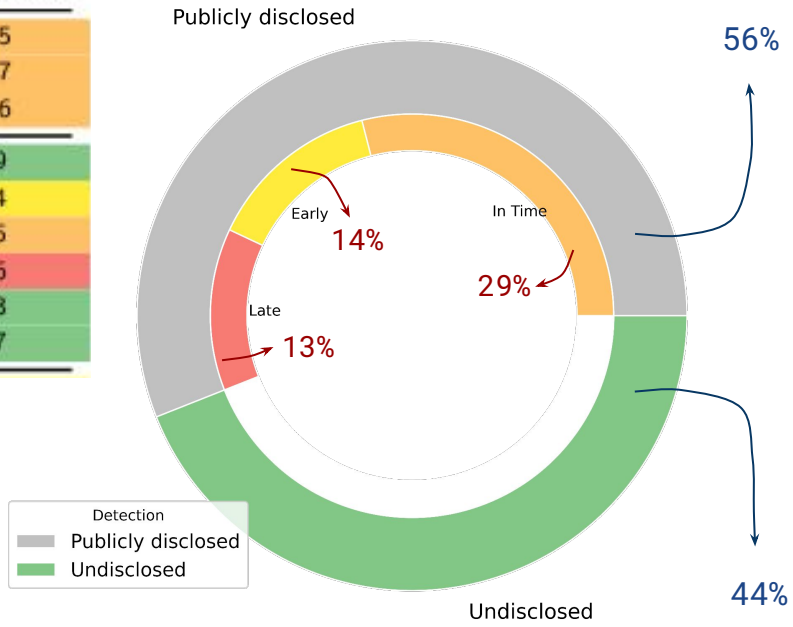
API Name	Keywords	Disclosure Date	Detection Date
Battery Status	chargingTime	2015 [91]	2015
	chargingchange	2015 [91]	2017
	dischargingTime	2015 [91]	2016
Navigator	deviceMemory	-	2019
	hardwareConcurrency	2017 [97]	2014
	oscpu	2009 [84]	2015
	plugins	2009 [84]	2016
	vendorSub	-	2013
	webdriver	-	2017

On-time Detection

Early Detection

Late Detection

Not-yet Disclosed



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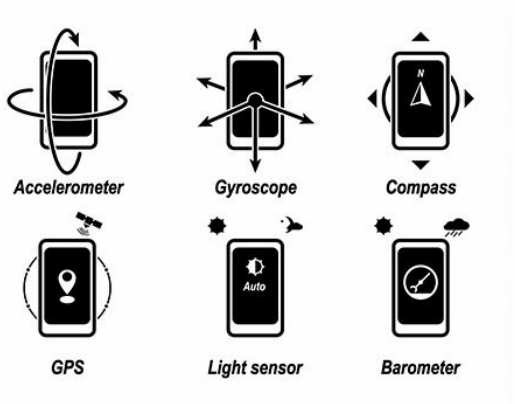
Sensor API

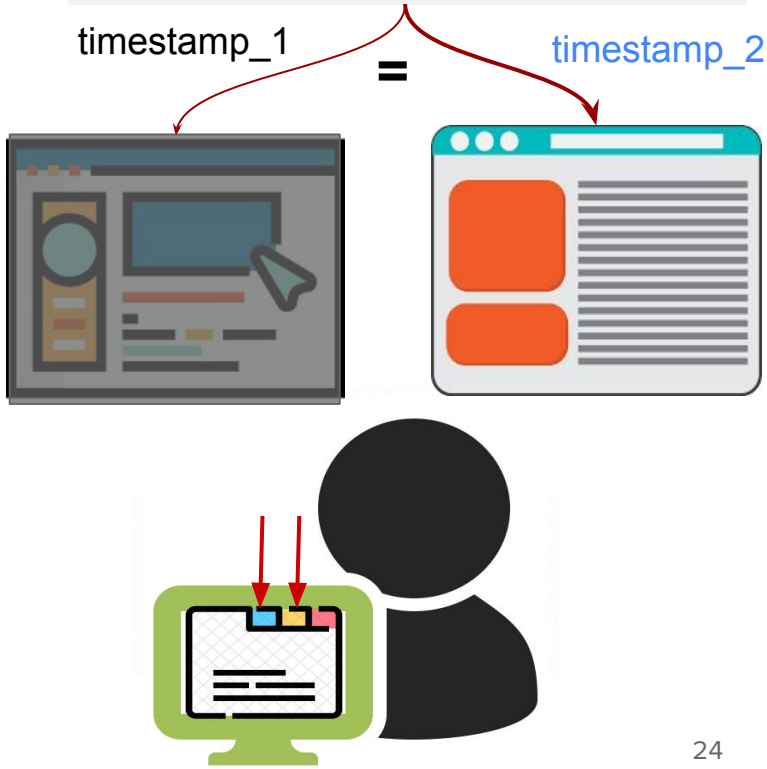
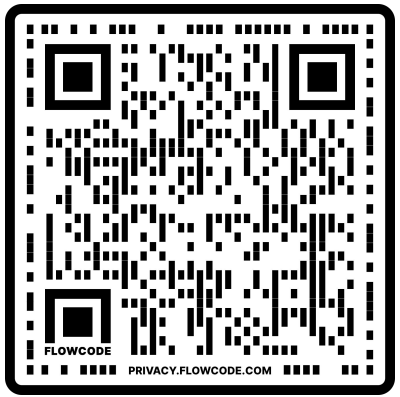
- `DeviceMotionEvent` and `DeviceOrientationEvent`
- Sensor API is continuously being updated
- FP-Radar detected it as early as 2017
- `AmbientLightSensor`
  - **not yet disclosed**



Page Visibility

- Released in 2013
- Provides visibility state
- Ephemeral fingerprinting
- Detected in 2013 by FP-Radar

```
// Capture current time & visibility state.
function An(e) {
  var t = e.type,
  n = {
    PX38: getVisibilityState(t),
    PX70: getCurrentTime()
  };
  return n;
}
```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