Electrical Engineering Department
Electronics
Computers
Communications

SIPL SIGNAL & IMAGE PROCESSING LAB
Department of Electrical Engineering, Technion

MRL MOBILE RESEARCH LABS

People Metering Using Mobile Devices

Yehoraz Kasher Annual EE Projects Contest

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Outline

- People metering
- People metering using mobile devices
- Algorithm description
- Our innovations
- Conclusion

Rating Measurement

- Fast growing advertising market
- Based on rating data

"People Meter" - Drawbacks:

  - Designated hardware
  - Small control group
  - Hard to know who is watching what

People Metering Using Mobile Devices

BBC

CNN

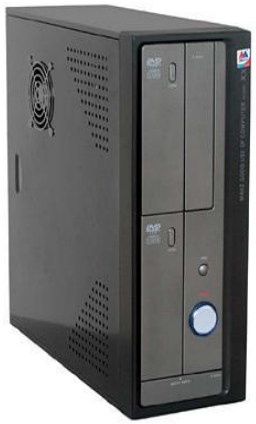
9

ישראל פלוס

ИЗРАИЛЬ ПЛЮС

Reference Fingerprint Creation

Matching



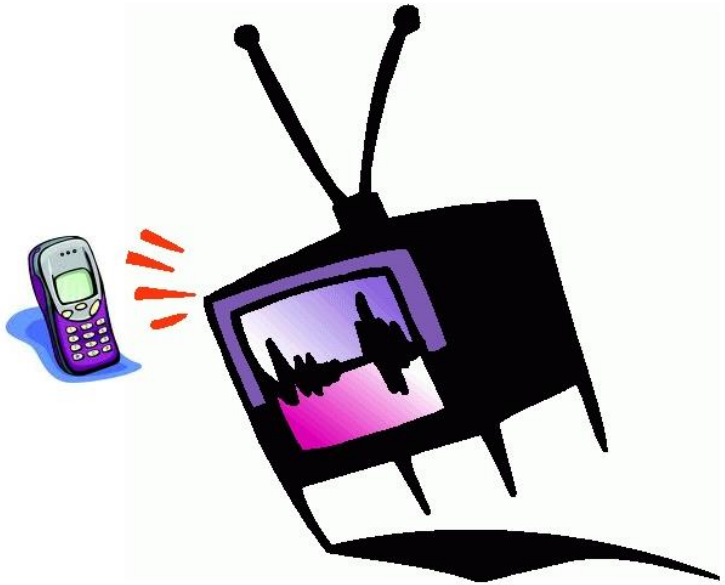
Matched Channel / No Match

People Metering Using Mobile Devices

- As suggested by MobileRL
  - Overcomes all "People Meter" drawbacks
  - Carried everywhere
  - Can also be used to monitor radio, video, music etc.

But -

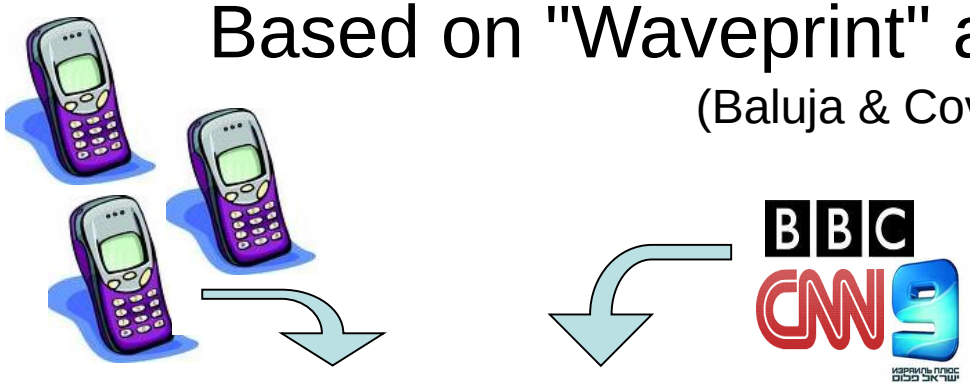
Privacy must be kept



System Layout

Based on "Waveprint" algorithm by Google

(Baluja & Covell, 2006)



Fingerprint Creation

Extracting significant data

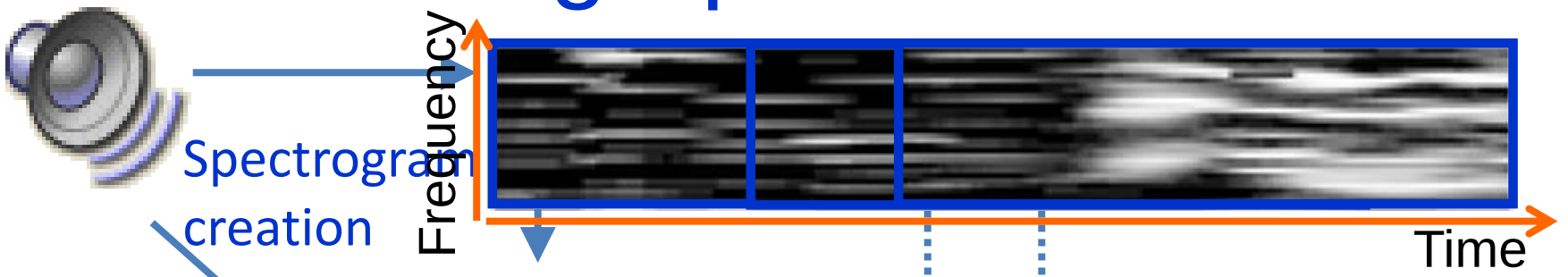
Fingerprints

Matching

Matched channel /

No match

Fingerprint Creation



Spectrogram creation

Spectrogram

Haar Wavelet Transform

Keeping strongest coefficients

Fingerprint

Wavelet Transform

Sub-Fingerprint #1 Sparse Binary Vector

Good for pointing out local data in images

Sub-Fingerprint #2

43	22	32	78	4

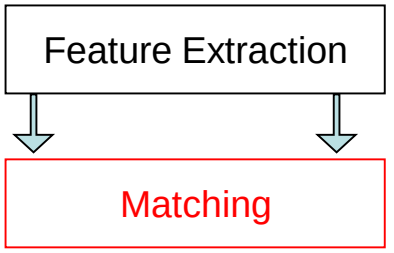
Min Hash Vector (*p* elements)

134	12	8	55	192

Sub-Fingerprint #3

23	48	72	122	34

Fingerprint Matching



Sub-Fingerprint

Sub-Fingerprints

Candidate Sub-Fingerprint Selection (LSH)

Query

Candidate References

Matching

Best Match

"Waveprint" Performance

System performance -

As described in the paper

However our problem is more difficult…

- Matching criterion is required
- Recordings in a noisy environment

Threshold Criterion - Metrics

Precision & Recall (per match grade threshold)

$$\text{Precision} \approx \frac{\text{True Identification}}{\text{All Identified}}$$

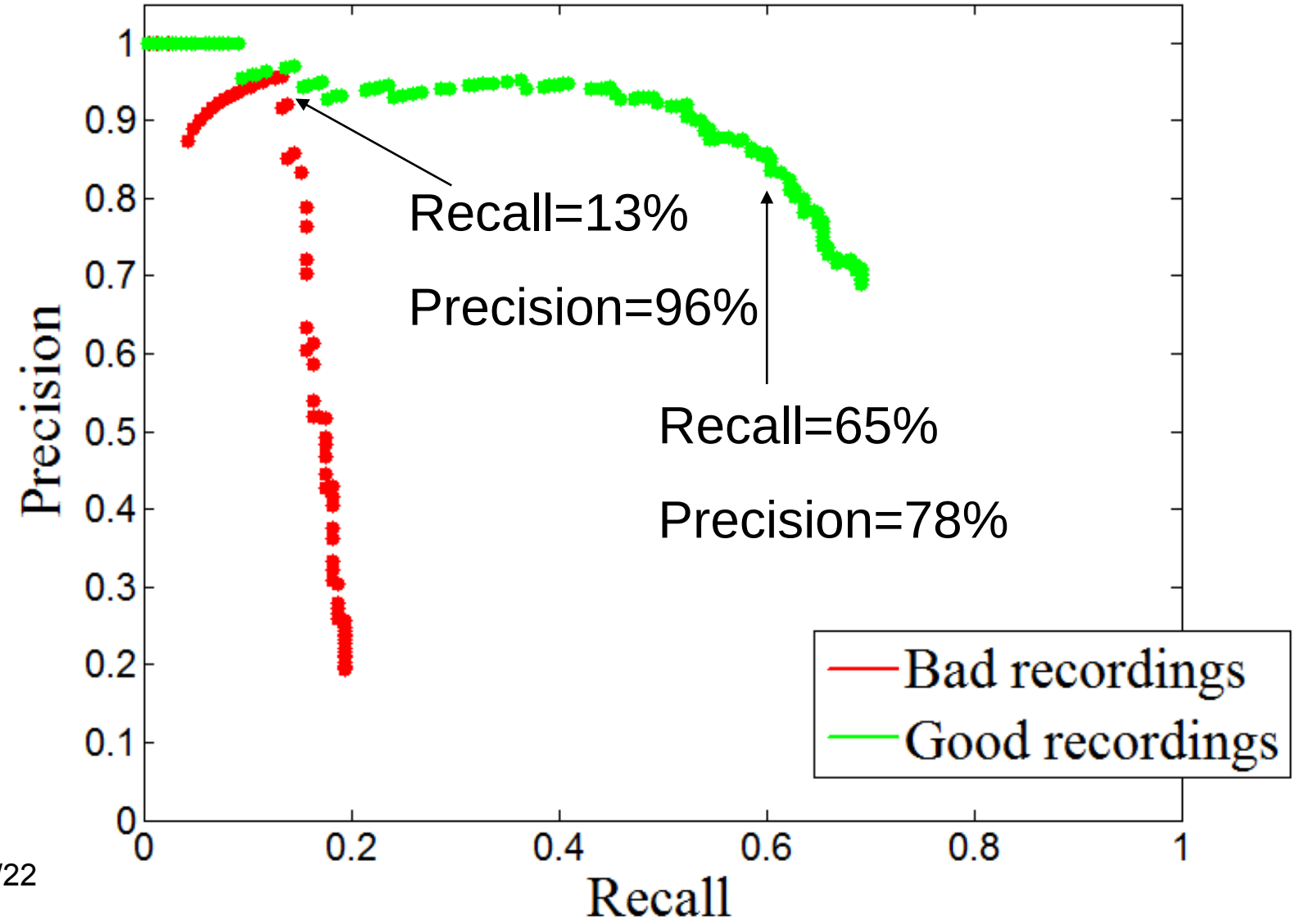
$$\text{Recall} \approx \frac{\text{True Identification}}{\text{All Queries}}$$

Datasets by

Two query types:

- Good Quality recordings
- Bad Quality recordings

Original Algorithm Results



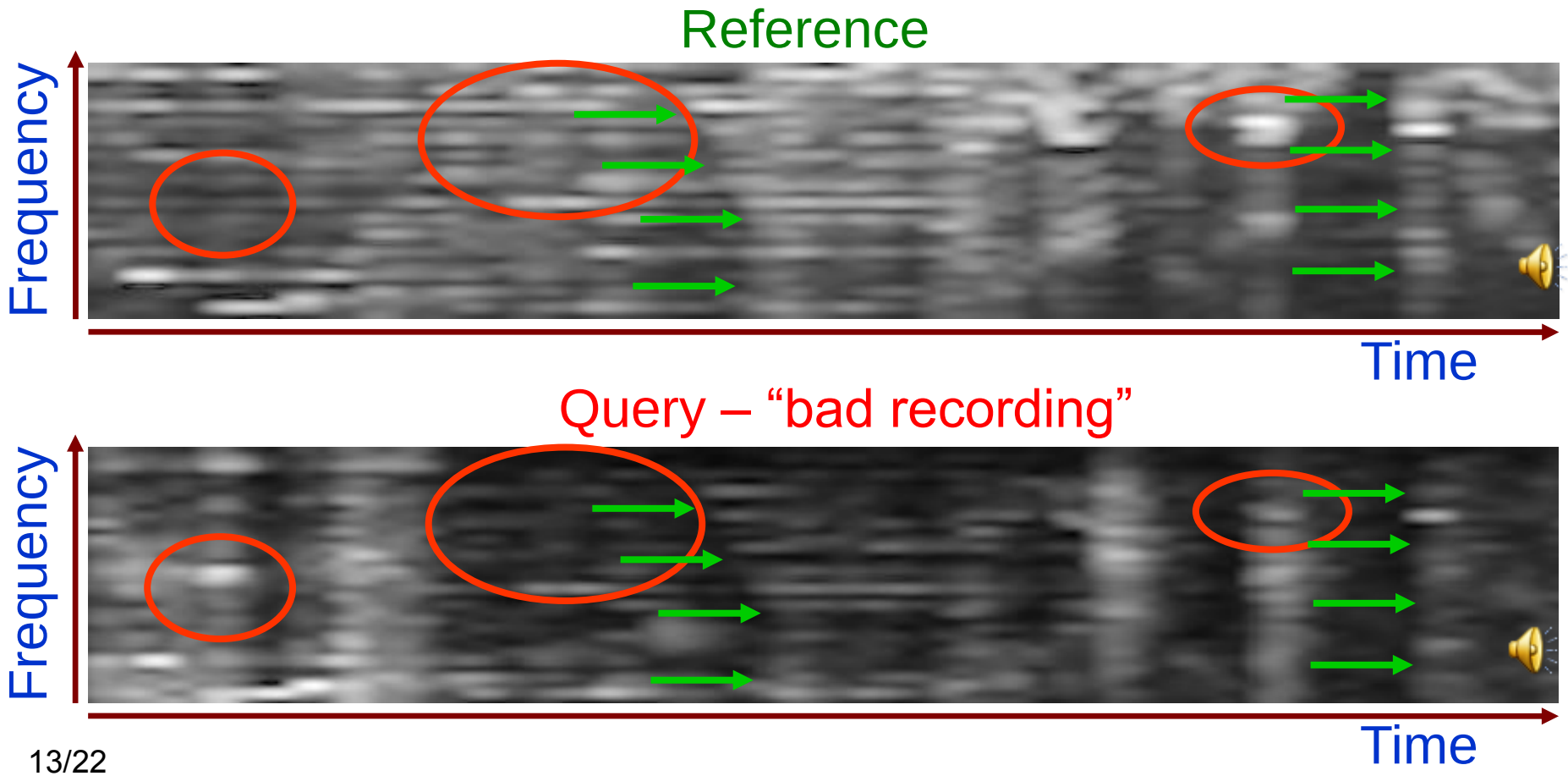
Problem:

Bad recordings - very low success rate

Let's have a closer look…

Success Rates Problem

- Main problem appears in “bad recordings”

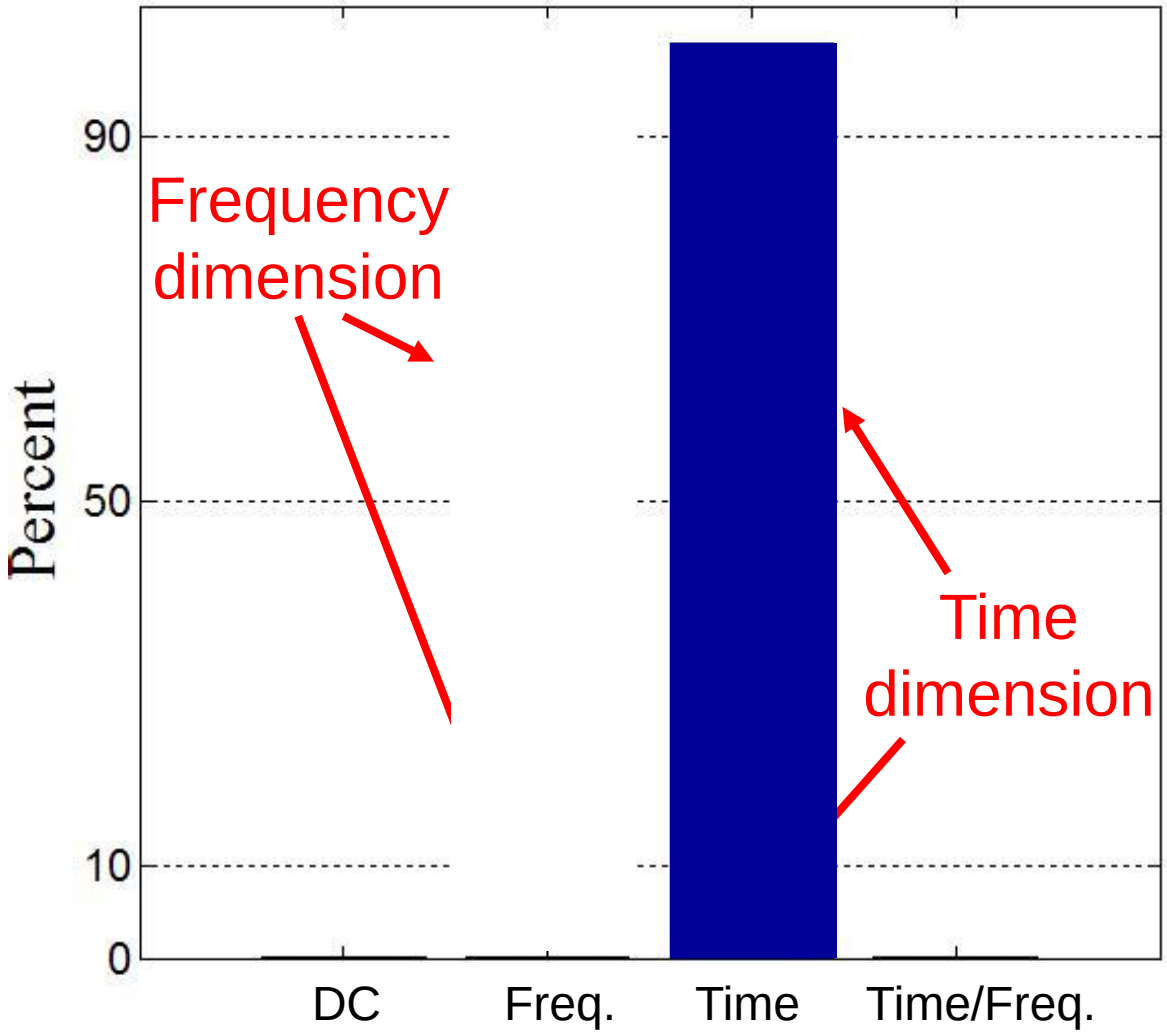


Innovation #1

Proposed Solution

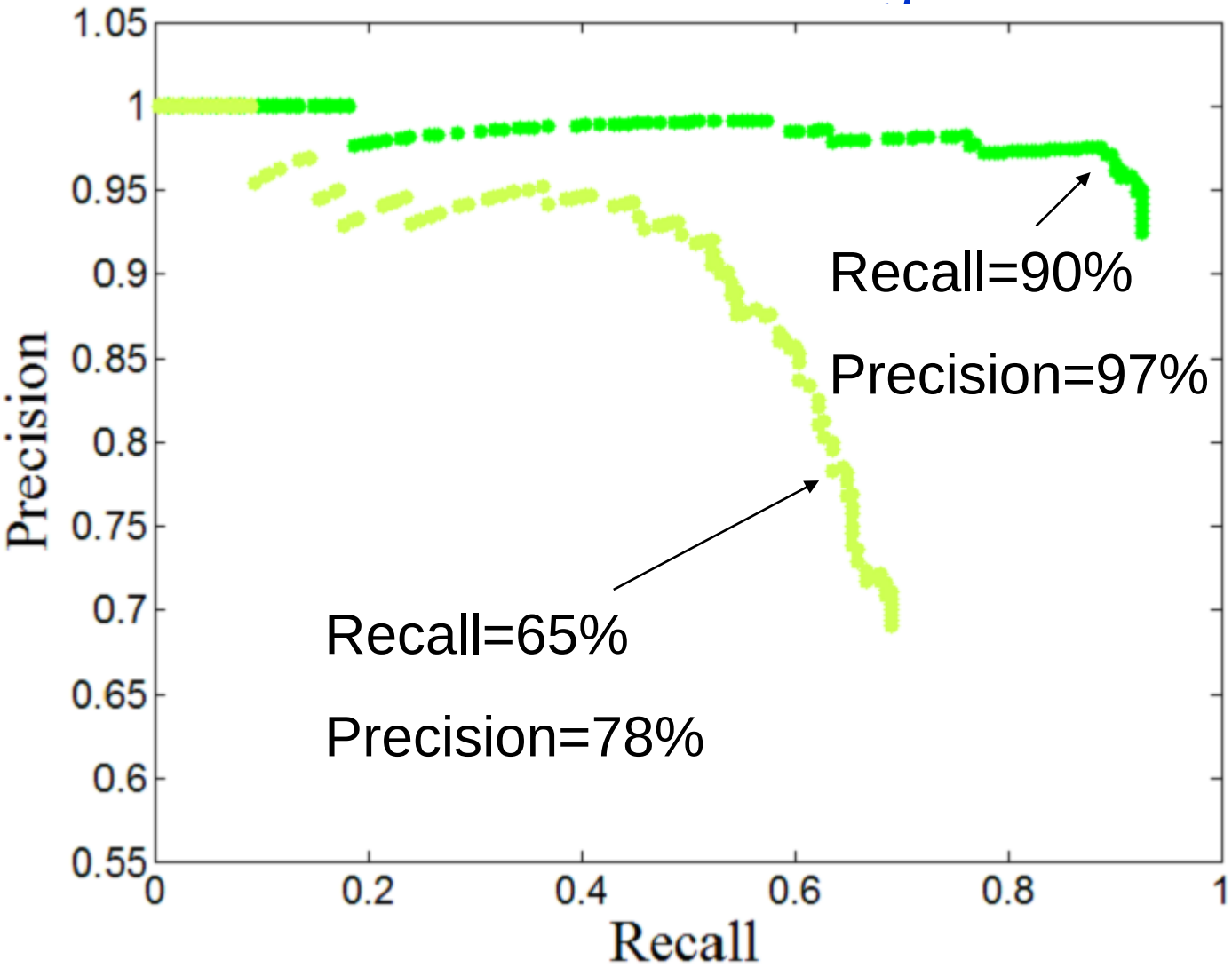
Biasing the wavelet picking

Strongest wavelets picking histogram



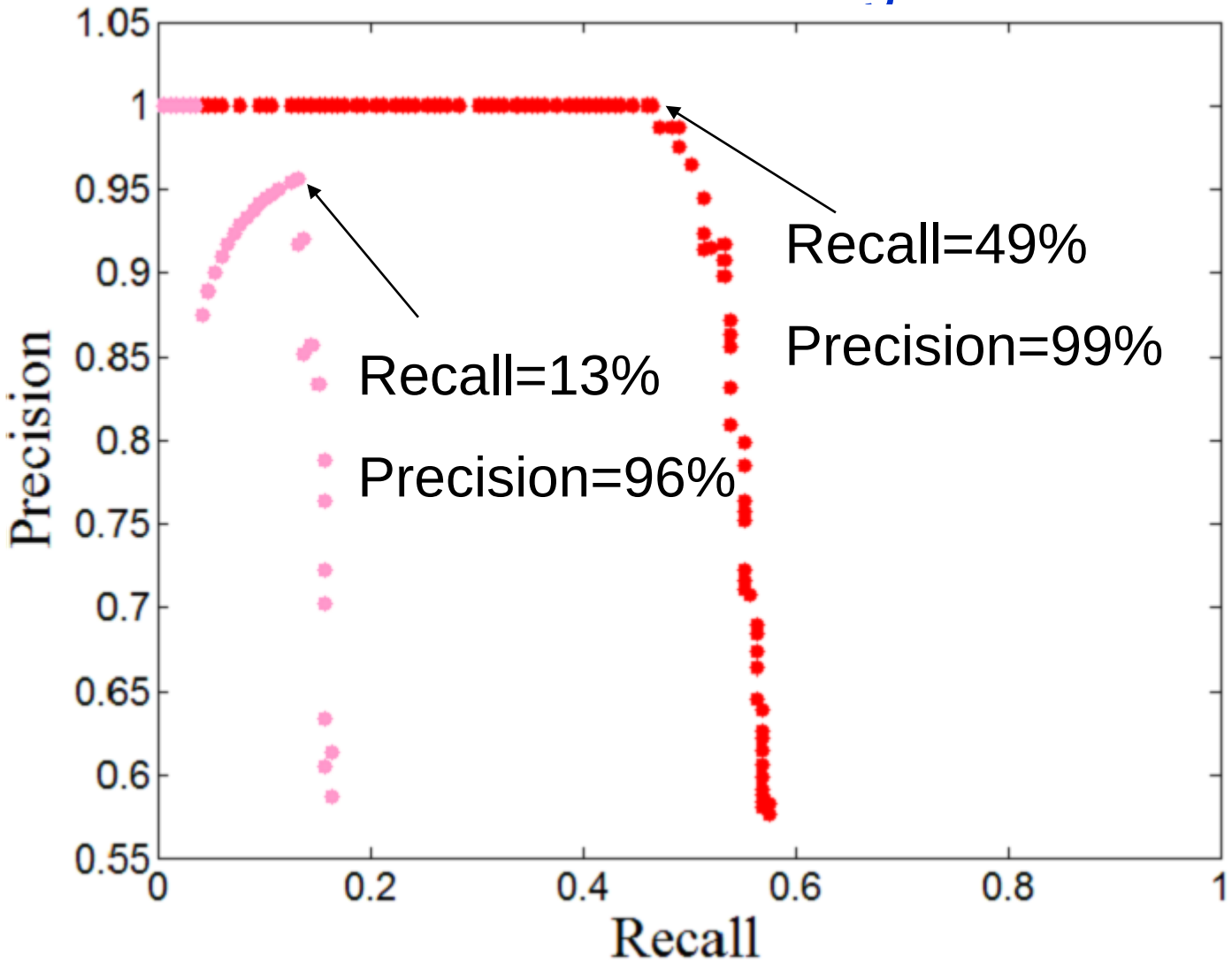
After Weighted Wavelet Picking

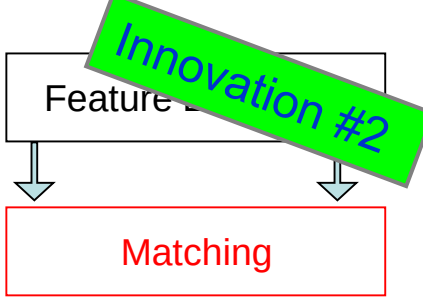
Good Recordings



After Weighted Wavelet Picking

Bad Recordings





Matching Criterion

Recurrence check

Demanding consistent matches in a sequence of queries

Advantages

- Increases success rates
- Overcomes sporadic noise

P_{true}=93% P_{false}=0.9%

For bad recordings!

But…

Increases size of sent data

Innovation #3

Reducing Signature Size – 1st Solution

Google's problem: Database Size Our problem: Sent Data Size

Adapting system parameters to our problem

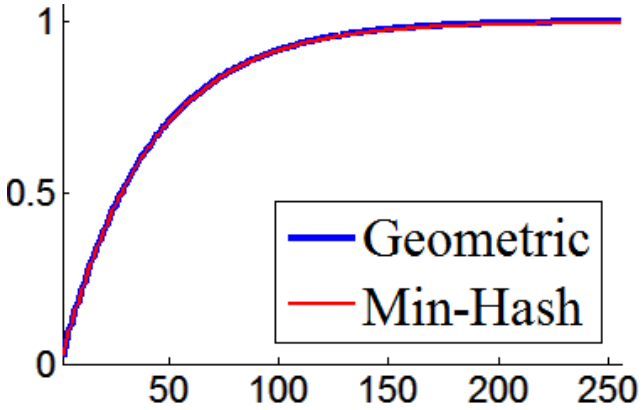
Sent query size $\times 0.1$

Innovation #4

Reducing Signature Size – 2nd Solution

Golomb-Rice coding (Golomb & Solomon, 1966)

Cumulative Distribution Function



~20% Compression

Conclusion

Implemented a people metering system using mobile devices

– Personal

– Carried everywhere

– Not only TV

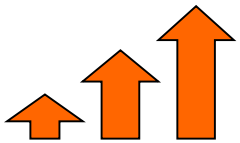
Conclusion

Based on "Waveprint" algorithm by Google

Innovation #1 Biasing the wavelet picking

- Match rates $\times \sim 3$

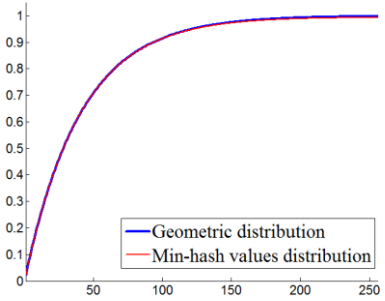
Innovation #2 Recurrence check

- Match rates 

Conclusion

Innovation #3 Reducing sent fingerprint size

Innovation #4 Compressing sent data



Single signiture size:

13.24 KB ➡ 1.32 KB ➡ 1.06 KB

Sent data size ×~0.08

Conclusion

- System is suitable for commercial use

  For example:

P_{true}=90%, P_{false}=0.9%, E[sent size] = ~9KB

- Supplied to MobileRL

- A paper in the writing

Acknowledgments

- Rafi Steinberg
- SIPL staff
  - Yair Moshe
  - Nimrod Peleg
- MobileRL
  - Aron Weiss, CTO