



# Rapid Detection of Constant-Packet-Rate Flows

Jing-Kai Lou, Kuan-Ta Chen

Institute of Information Science, Academia Sinica

# Talk Outline

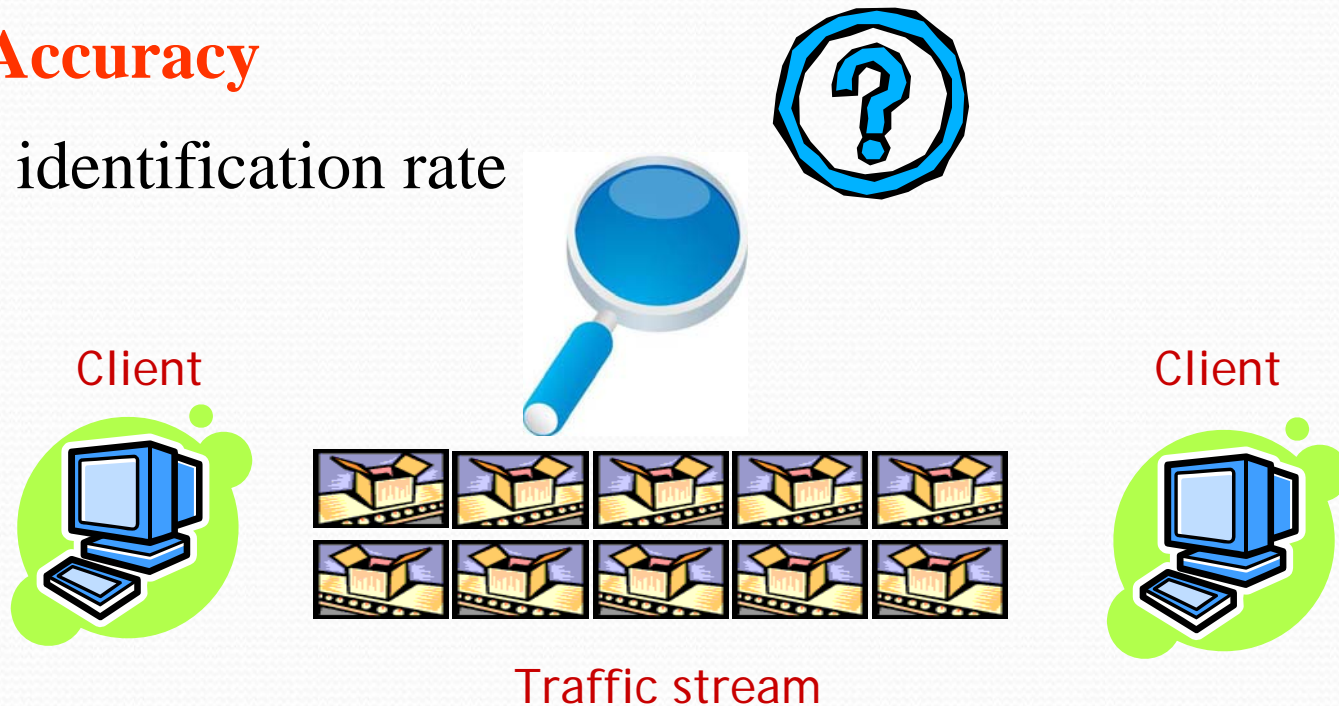
- Motivation
- Investigation
- Performance Evaluation
- Summary

# Motivation

- **Popular real-time and interactive applications:**
  - VoIP, Real-time network games
- **Traffic management →  
Need of flow identification**
- **A distinct characteristic of such traffic:**  
**Constant Packet Rate**
  - VoIP: Encoded continuous human voice
  - Real-time network game: game state updates
- **Key to identify VoIP and online gaming traffic:**
  - CPR flow identification

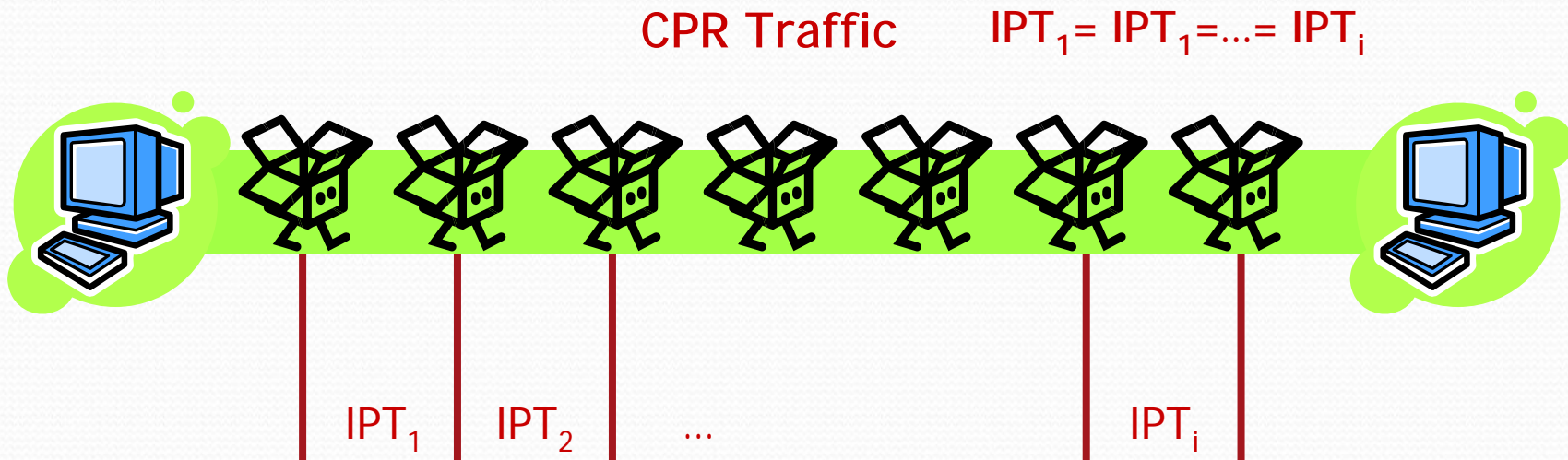
# Key Contribution

- A CPR traffic classifier
  - **Lightweight**  
10 successive inter-packet times
  - **High Accuracy**  
90% identification rate

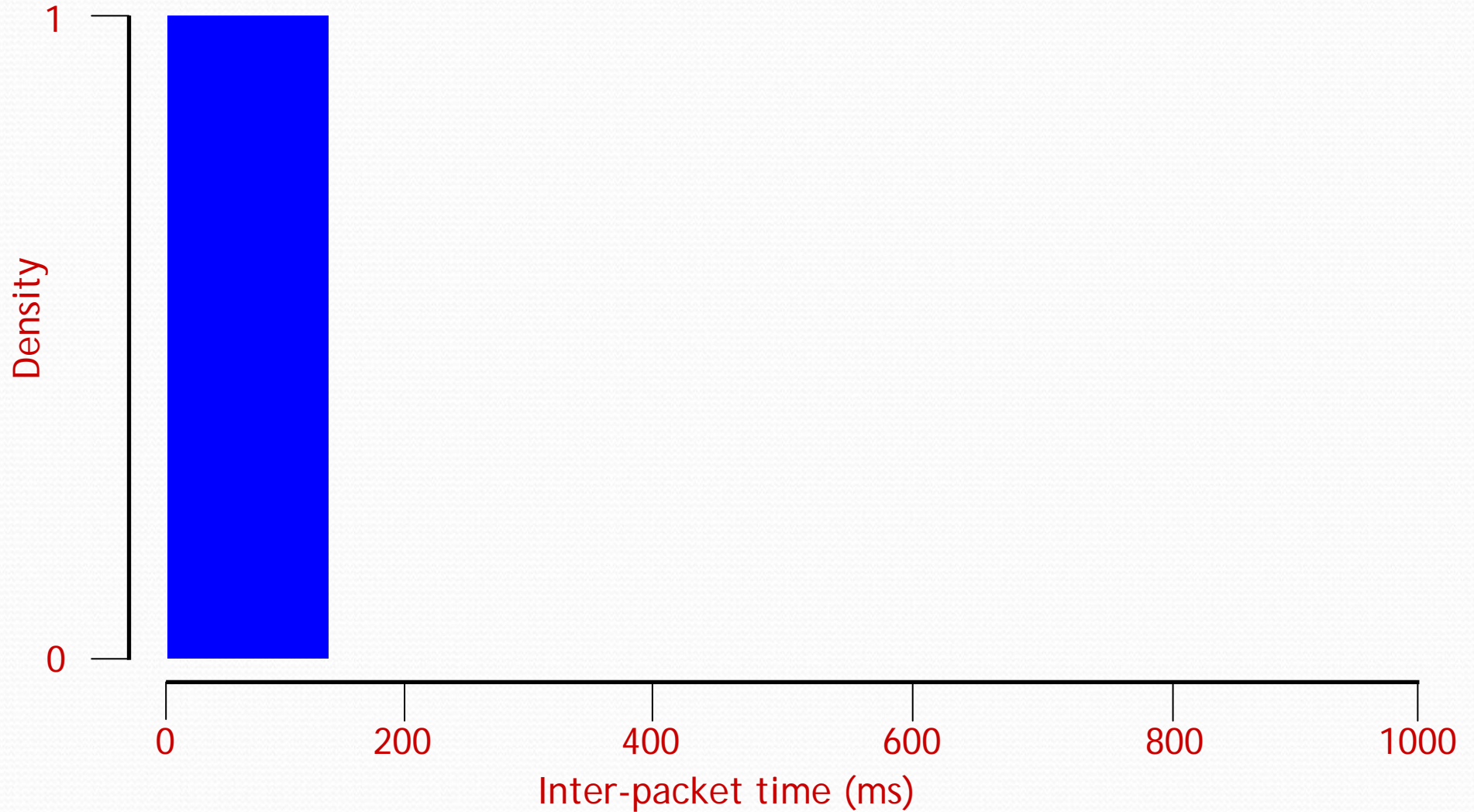


# A Naive Method

- **Coefficient of Variation (CoV)** of Inter-Packet Times (IPT)
  - IPT CoV small  $\rightarrow$  CPR
  - IPT CoV large  $\rightarrow$  non-CPR



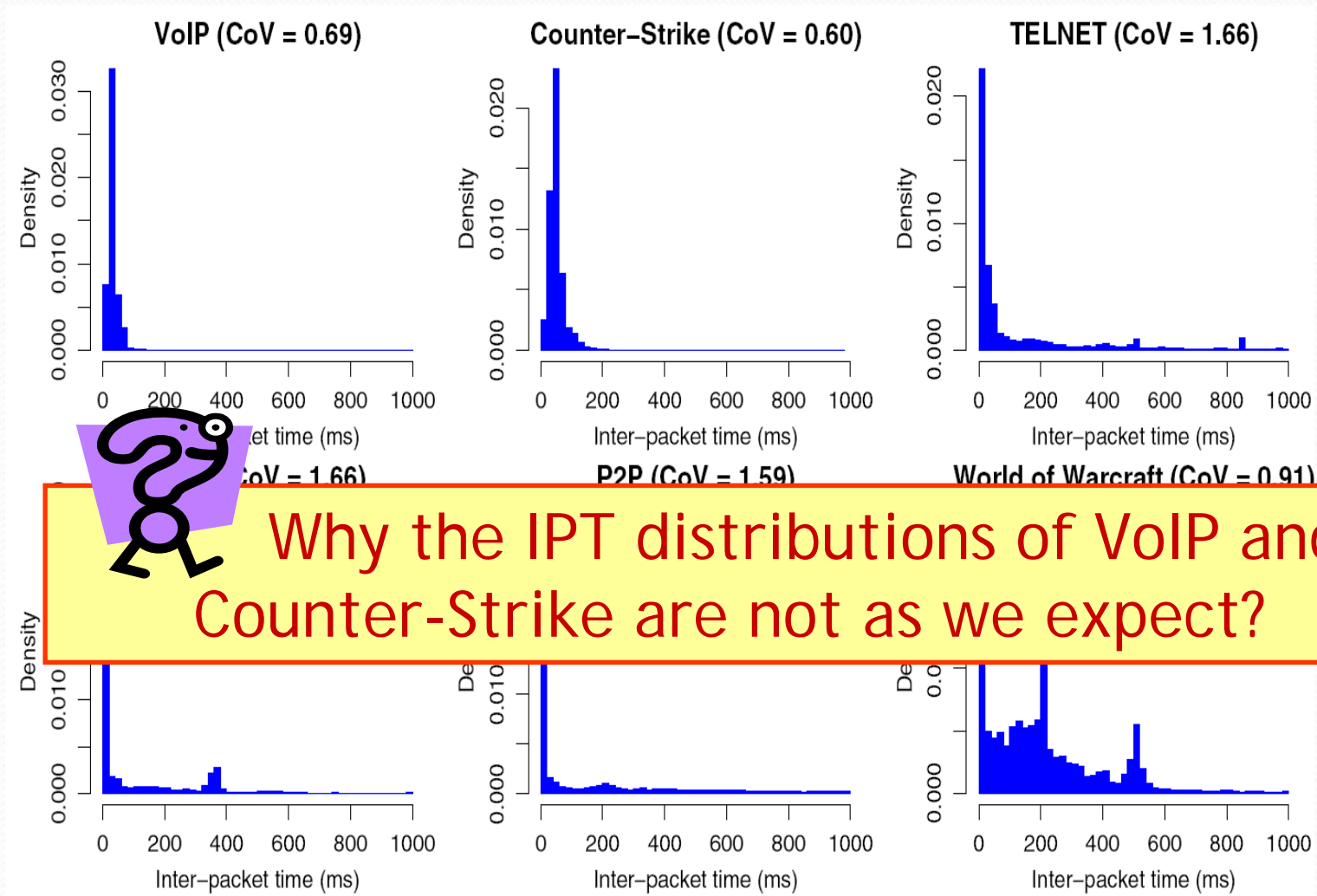
# Ideal IPT Distribution



# Collected Traces

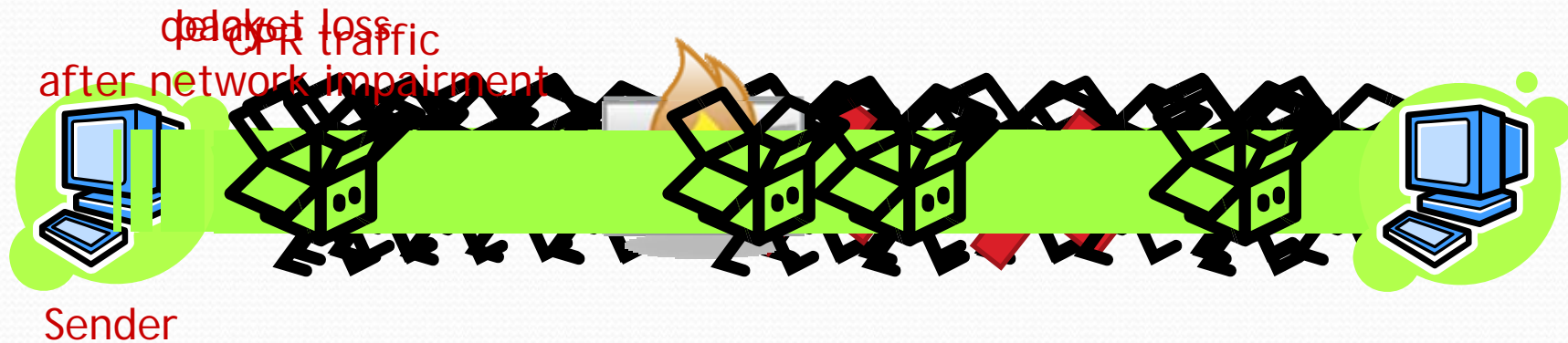
Trace	Flow	IPT CoV	Path Diversity
VoIP (Skype)	1739	0.37	1106 hosts / 1641 paths
Counter-Strike	1016	0.32	271 hosts / 270 paths
TELNET	276	1.53	140 hosts / 93 paths
HTTP	409	1.54	474 hosts / 325 paths
P2P	1303	1.63	645 hosts / 644 paths
World of Warcraft	1611	0.71	52 hosts / 39 paths

# Real IPT Distributions



# Difficulties: Network Impairment

- Host delay
- Channel delay
- Network queueing delay
- Network packet loss

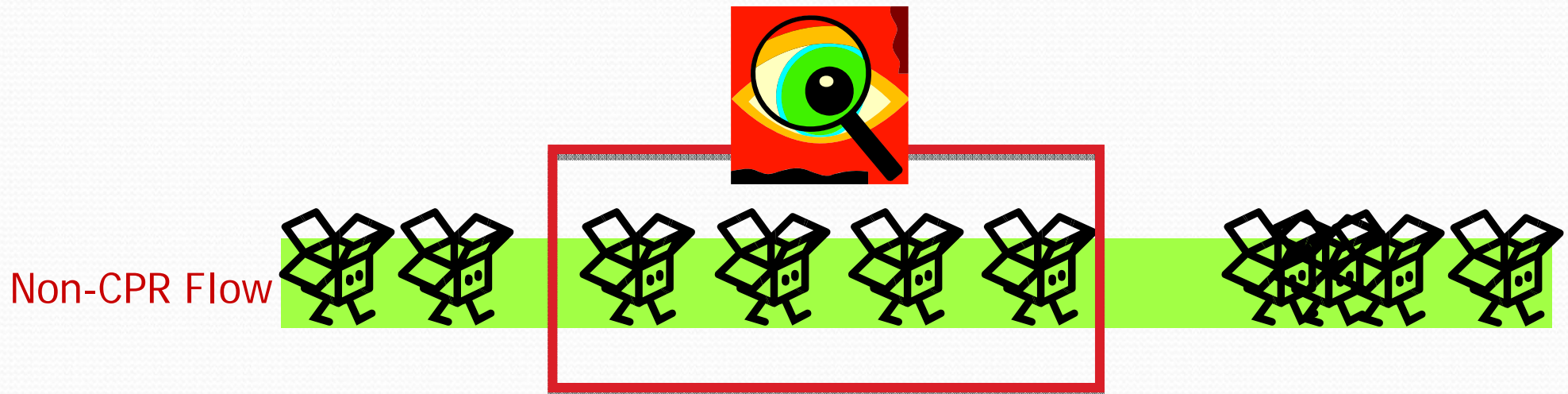


# More Difficulties

- **To do a decision with a few samples**
  - short time
  - few storage space



- **In short scale, non-CPR traffic could look like CPR**



# Refreshment

- **Our goal**
  - To search a good metric of IPT deviations for CPR detection
- **Challenges**
  - Network impairment
  - Need of small sample size

# Deviation Metric Design

- **Design factors for measuring variation**
  - **Function (FUN)**
  - **Sample Size (W)**
  - **Smoother Size (S)**

# Deviation Metric: Function (1/3)

- Standard Deviation (**SD**)

$$SD = \sqrt{\frac{\sum_{i=1}^N (IPT_i - \overline{IPT})^2}{N}}$$

- Coefficient of variation (**CoV**)

$$CoV = \frac{SD}{MEAN}$$

# Deviation Metric: Function (2/3)

- Mean absolute deviation (**MD**)

$$MAD = \frac{\sum_{i=1}^N |(IPT_i - \overline{IPT})|}{N}$$

- Median absolute deviation (**MAD**)

$$MAD = \frac{\sum_{i=1}^N |(IPT_i - \text{median}(IPT))|}{N}$$

# Deviation Metric: Function (2/3)

- Inter-quantile range (**IQR**)

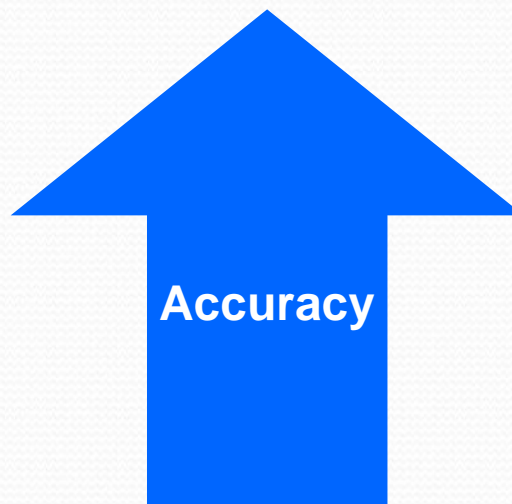
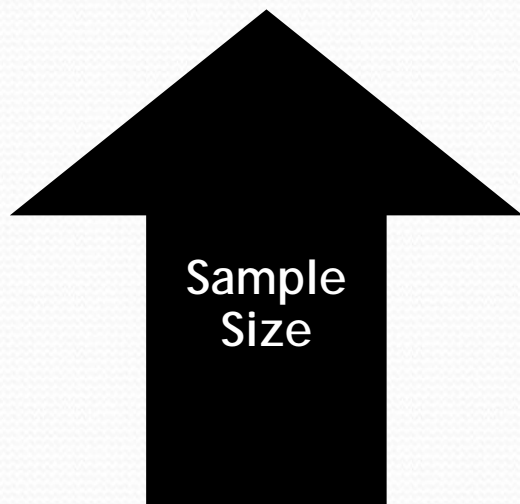
$$\text{IQR} = |\text{Upper Quartile (75\%)} - \text{Lower Quartile (25\%)}|$$

- **Range**

$$\text{Range} = \max(\text{IPT}) - \min(\text{IPT})$$

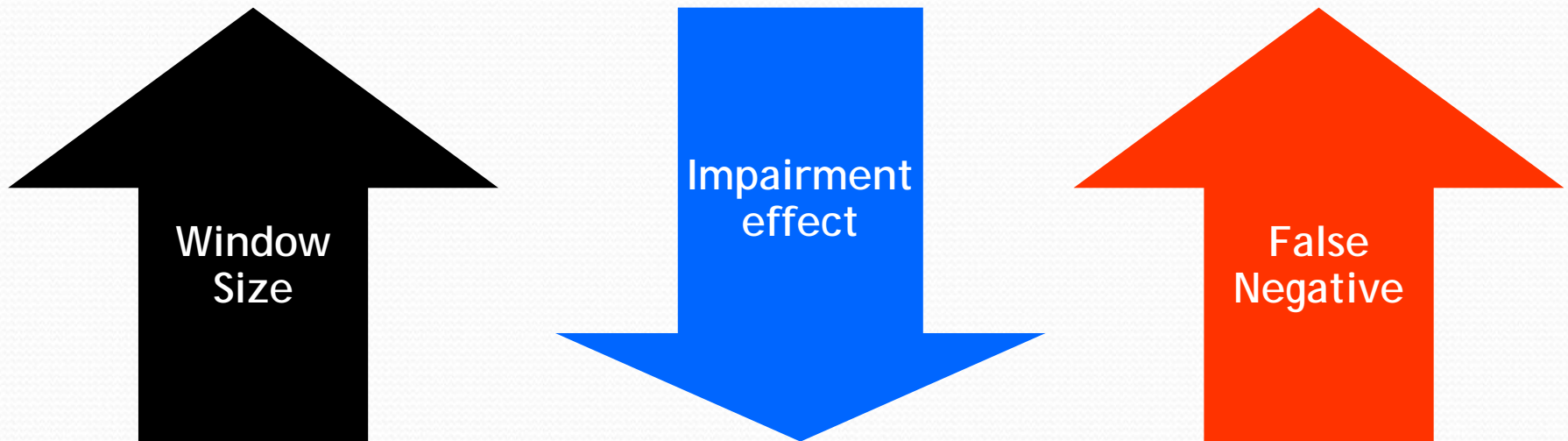
# Deviation Metric: Sample Size

- **Sample size ( $W$ ):** Number of IPT samples
- **$W$  increases →**
  - **Accuracy increases**
  - **Time/space complexity increases**

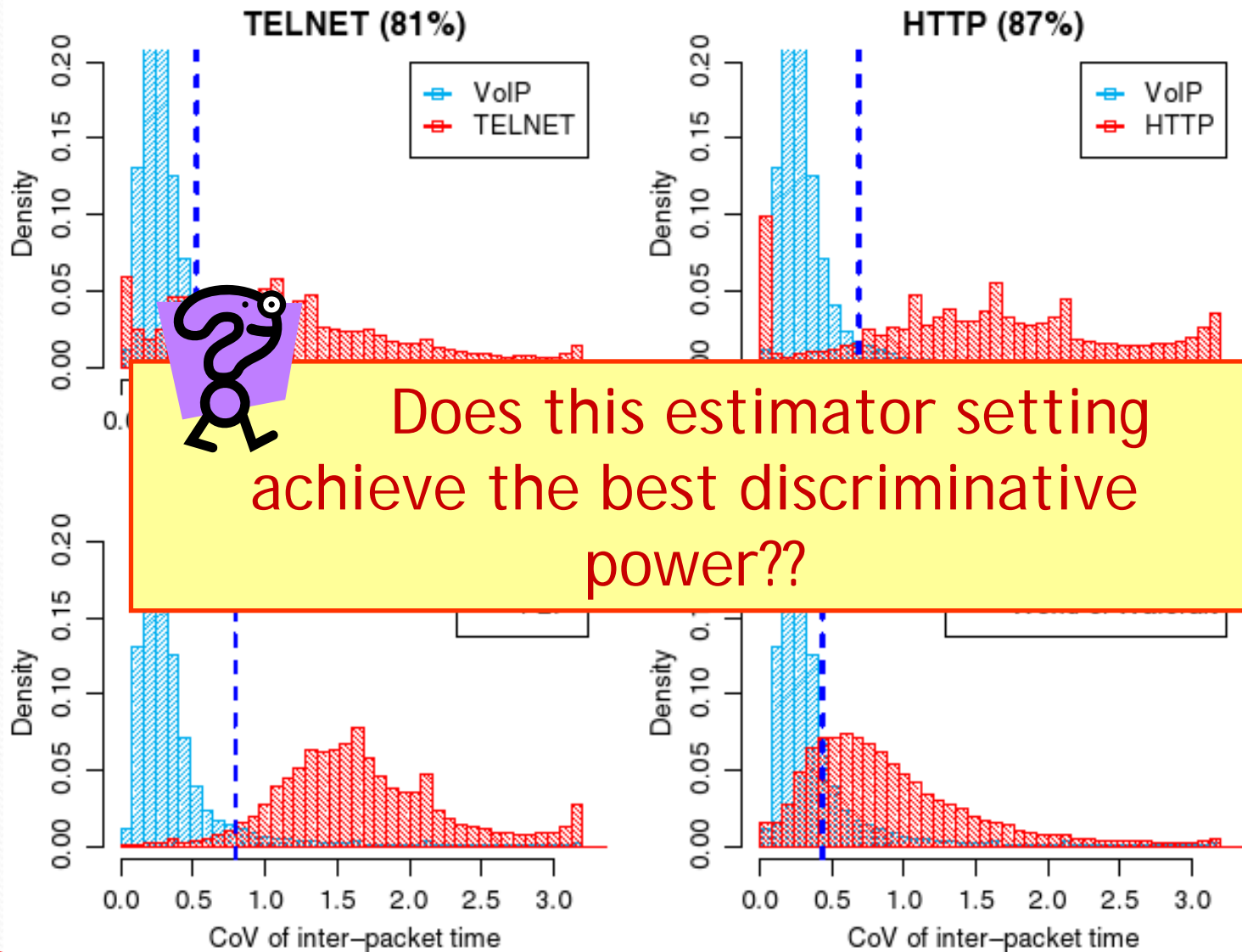


# Deviation Metric: Smoother Size

- Smoother size (S): Window size to smooth (mean)
- W increases →
  - Impairment effect decreases
  - False negative increases



**FUN=CoV, W=10, S=1**



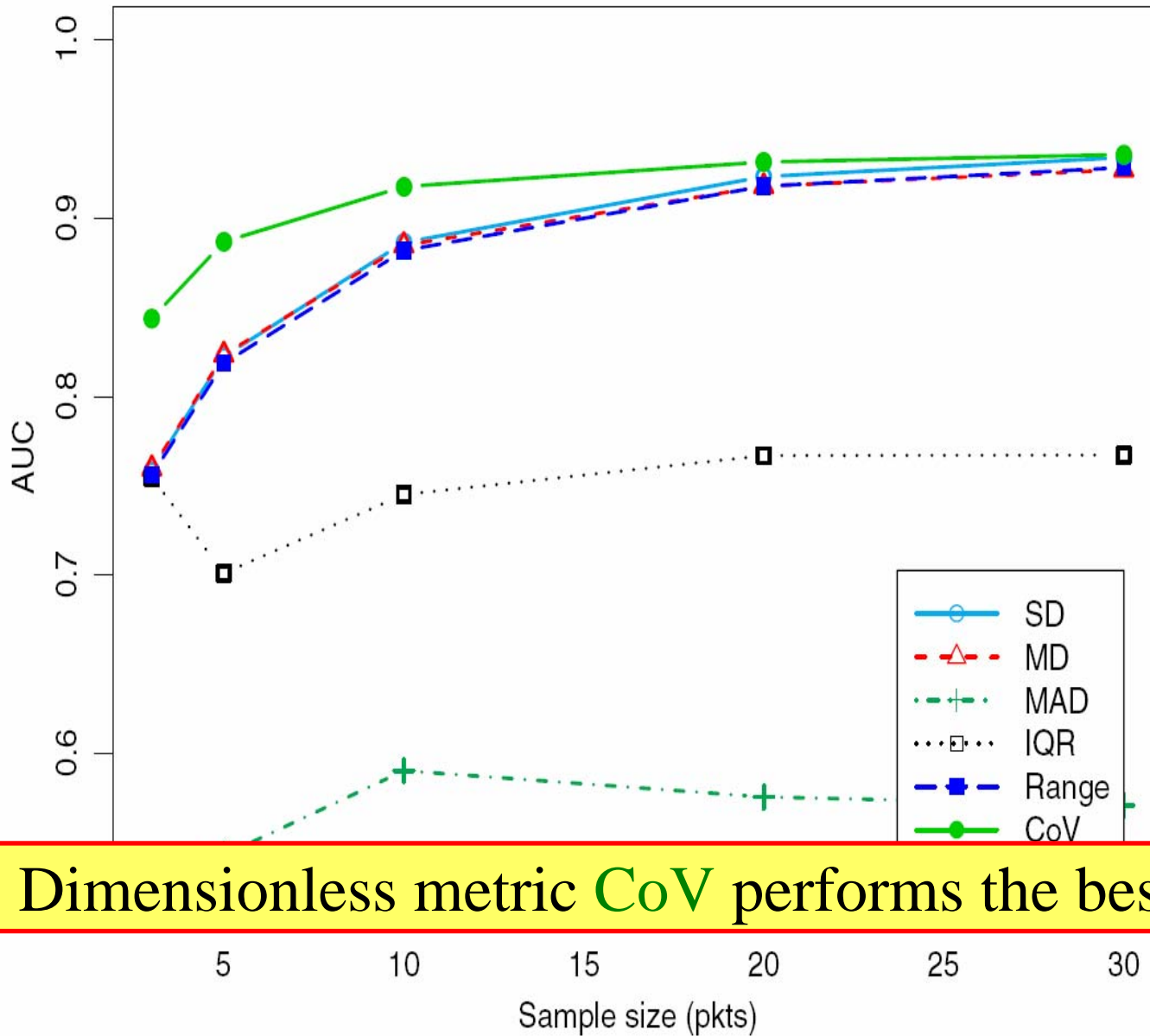


# Performance Evaluation

# Performance Metric

- **ROC** (Receiver Operating Characteristic):
  - **TPR**: ratio of true positive
  - **FPR**: ratio of false positive
- **AUC** (Area Under Curve): Area under the ROC curve
  - **AUC = 1**, perfect classification
  - **AUC > 0.8**, generally good
  - **AUC = 0.5** → random guess

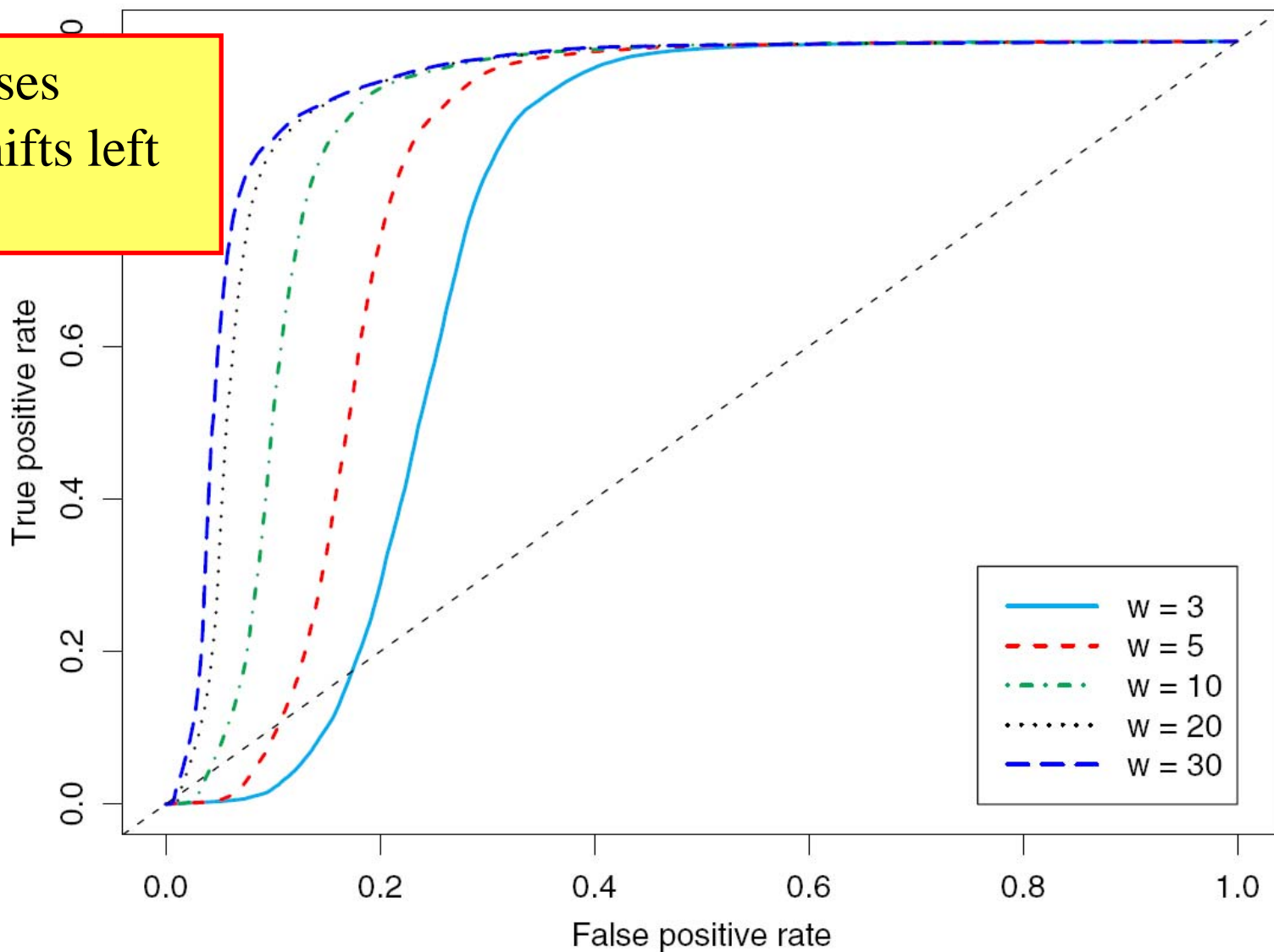
# Effect of Deviation Metric



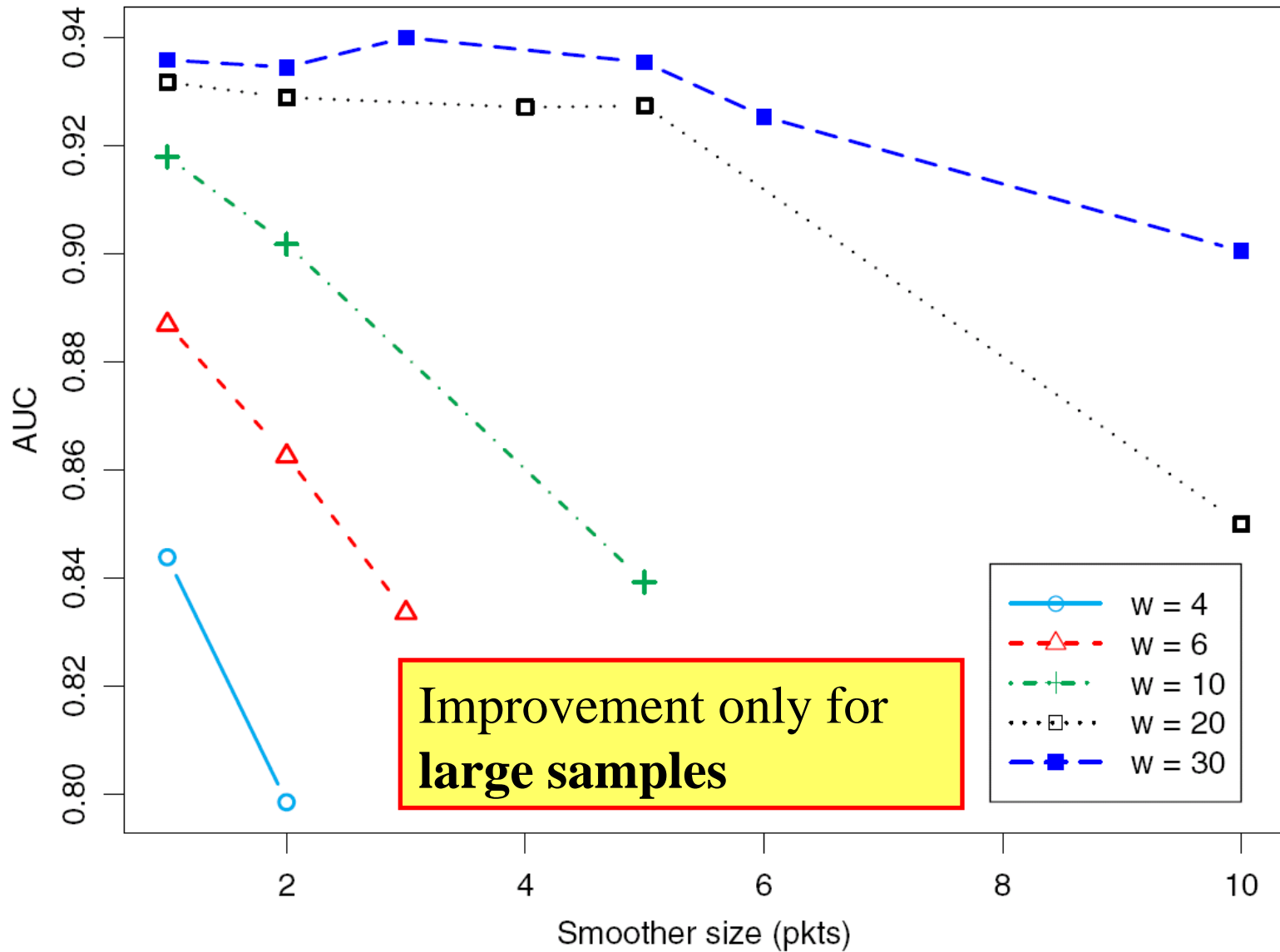
Dimensionless metric **CoV** performs the best!

# Effect of Sample Size

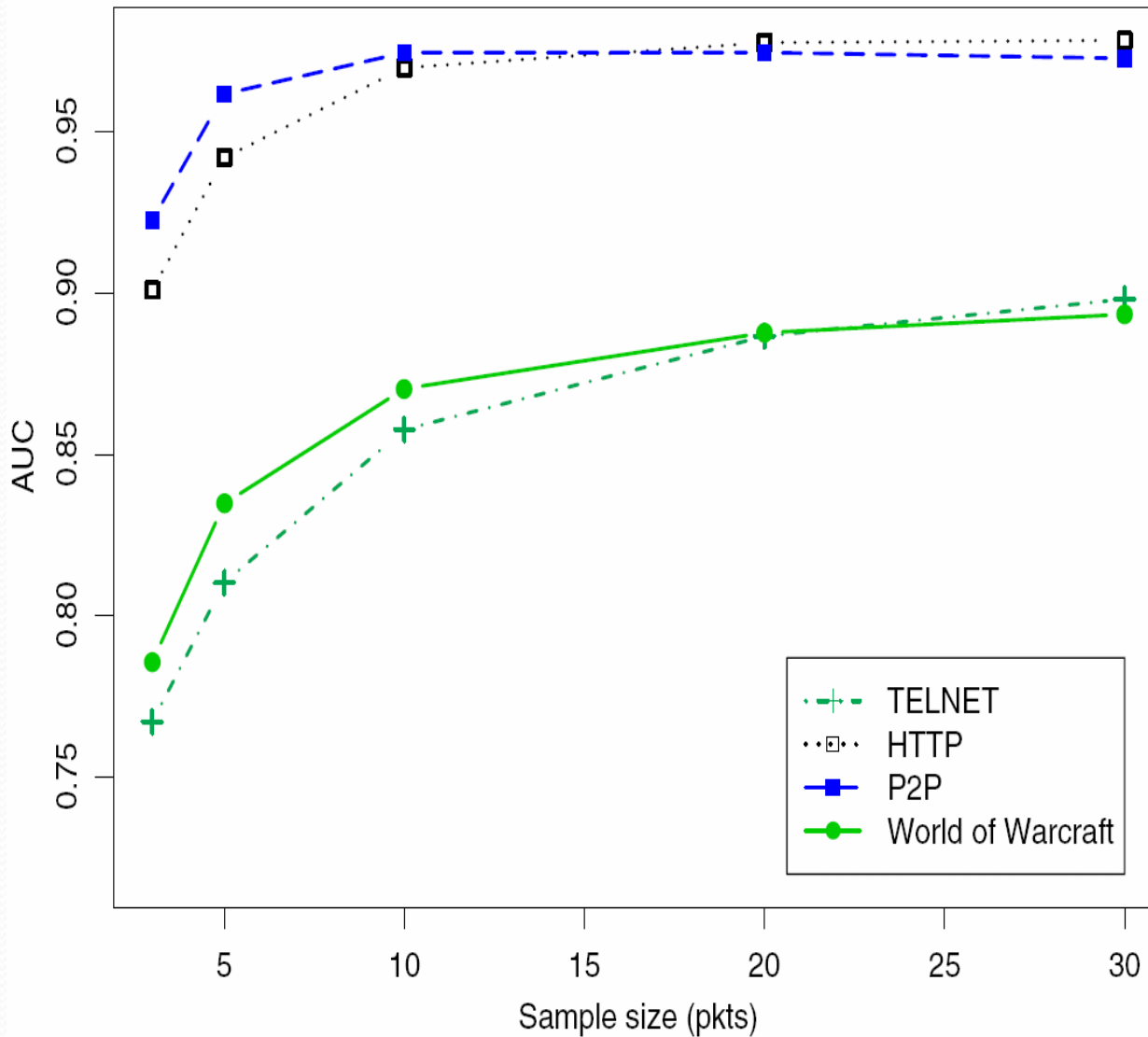
**Sample size increases**  
→ ROC Curve shifts left  
→ AUC increases



# Effect of Smoother Size



# Discrimination Performance



# Summary

- Proposed using IPT constancy to identify CPR flows
  - VoIP
  - Real-time gaming
- Studied various design issues of IPT deviation estimators
- Our classifier (**CoV-based**) yields an accuracy rate 90% with only **10 IPT samples**

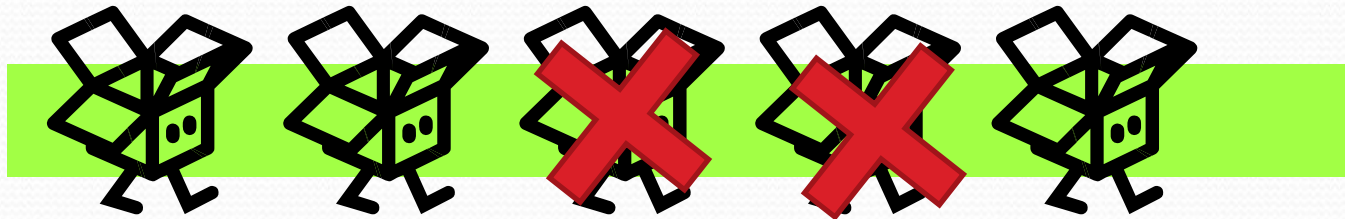


**Thanks for your listening.**

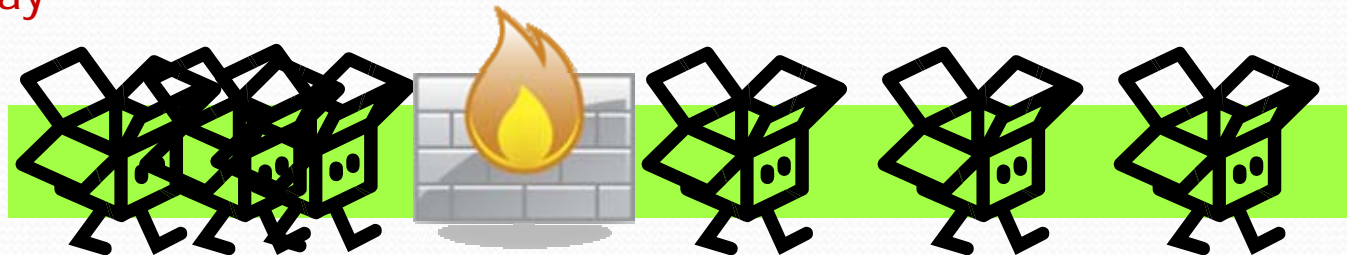


**BACKUP**

packet loss



delay



after network impairment

