# Community Epidemic Detection Using Time-Correlated Anomalies

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# Today's Talk

1. Intrusion Detection
2. Syzygy
3. Deployments

(1)

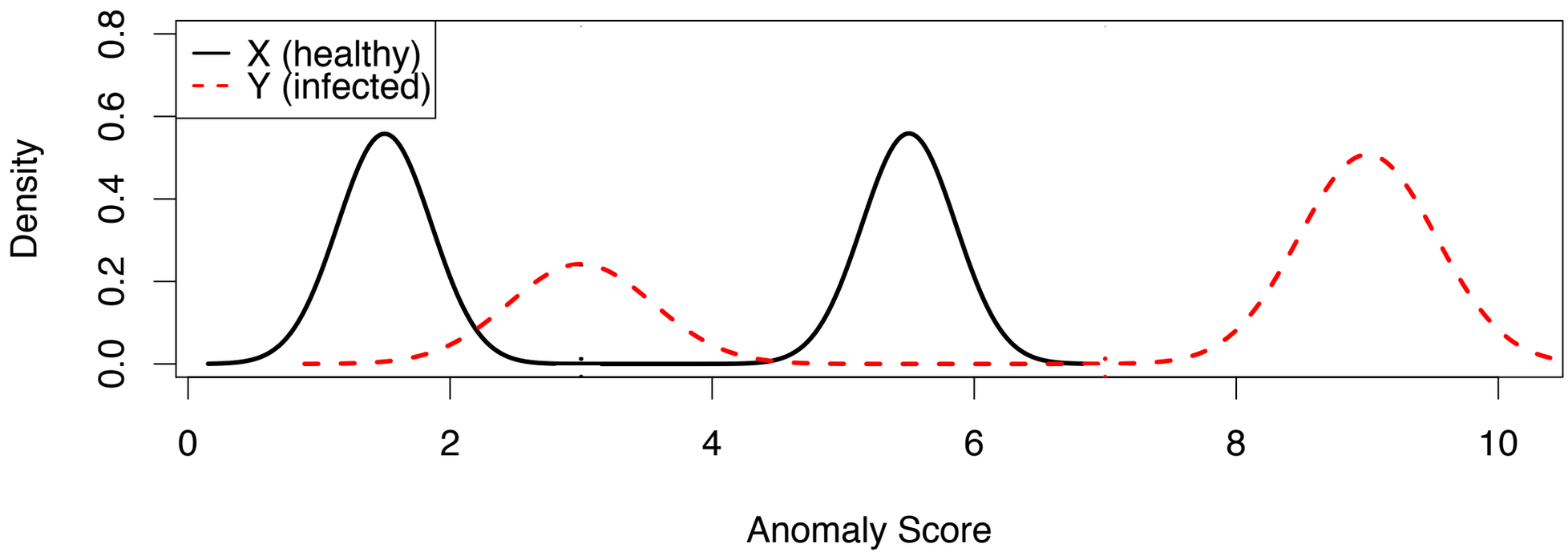
# Intrusion Detection

# Client Detection


- Model generates *anomaly scores*
- Generate an alarm (✘) when the score exceeds some threshold
- e.g., [Debar92][Eskin00][Feng03][Forrest96] [Gao04][Gao06][Giffin02][Hofmeyr98][Javitz91] [Malan05][Mutz06][Paxson99][Porras97][Sebring88] [Smaha88][Tan02][Vaccaro89][Xie04]

# Anomaly Scores

- Average infected score is higher
- There is no perfect threshold



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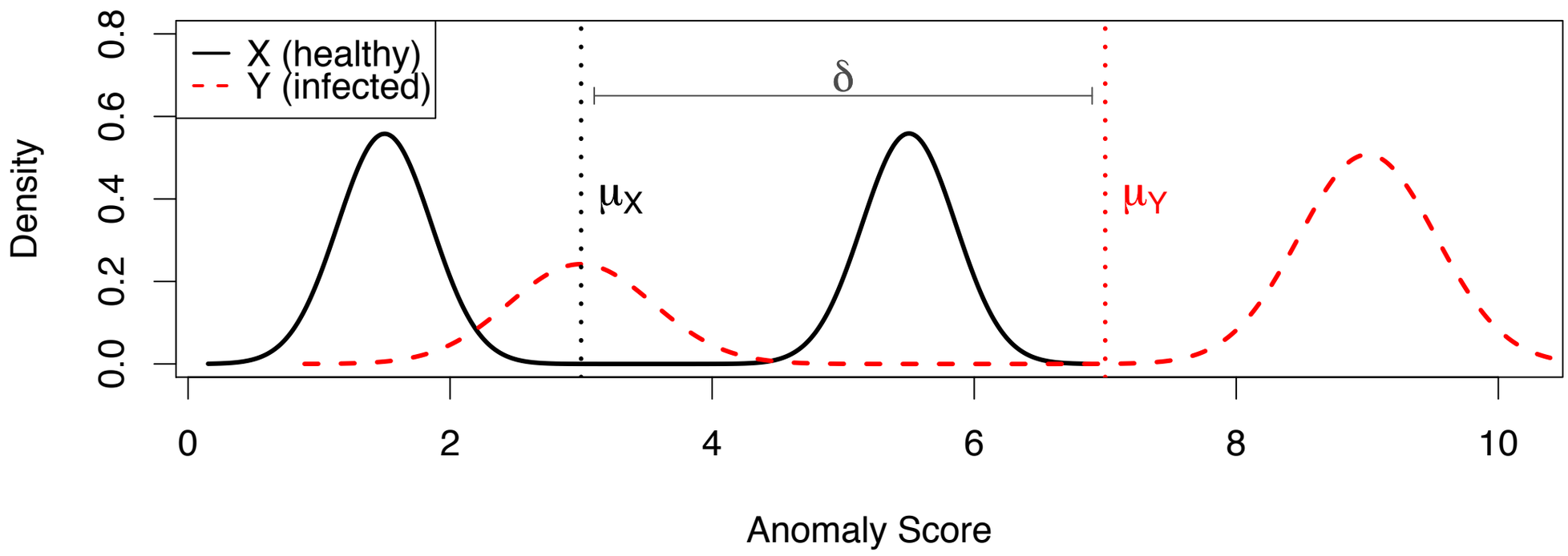

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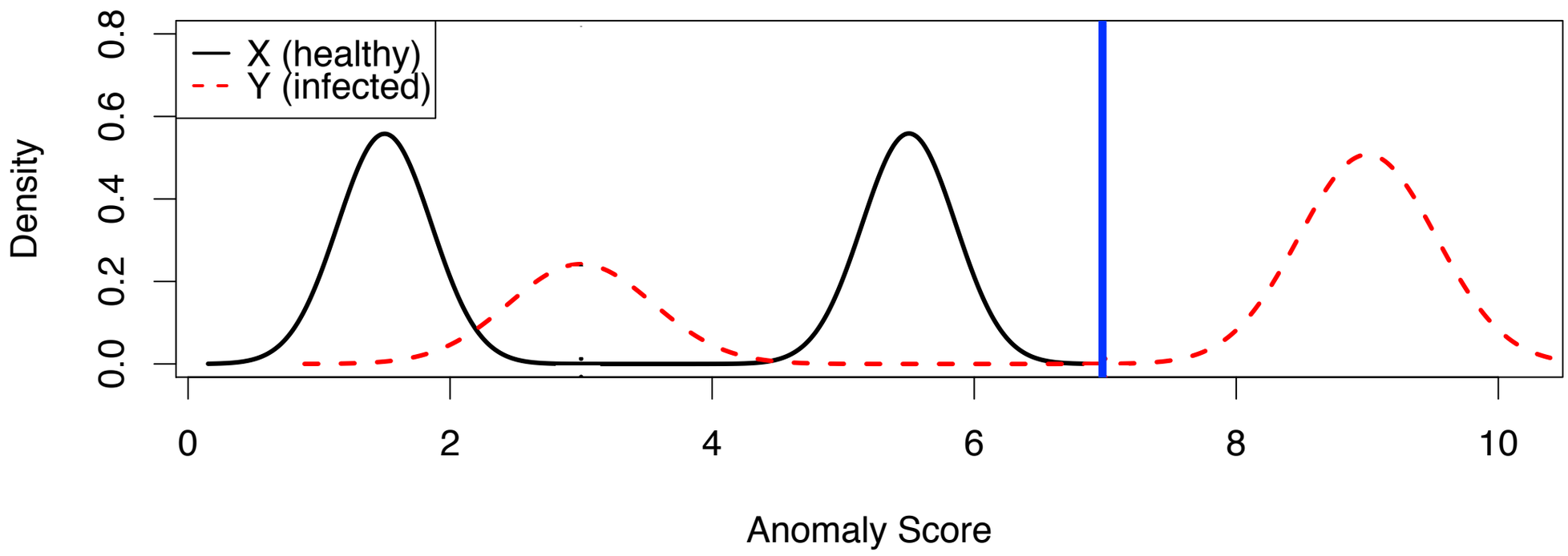

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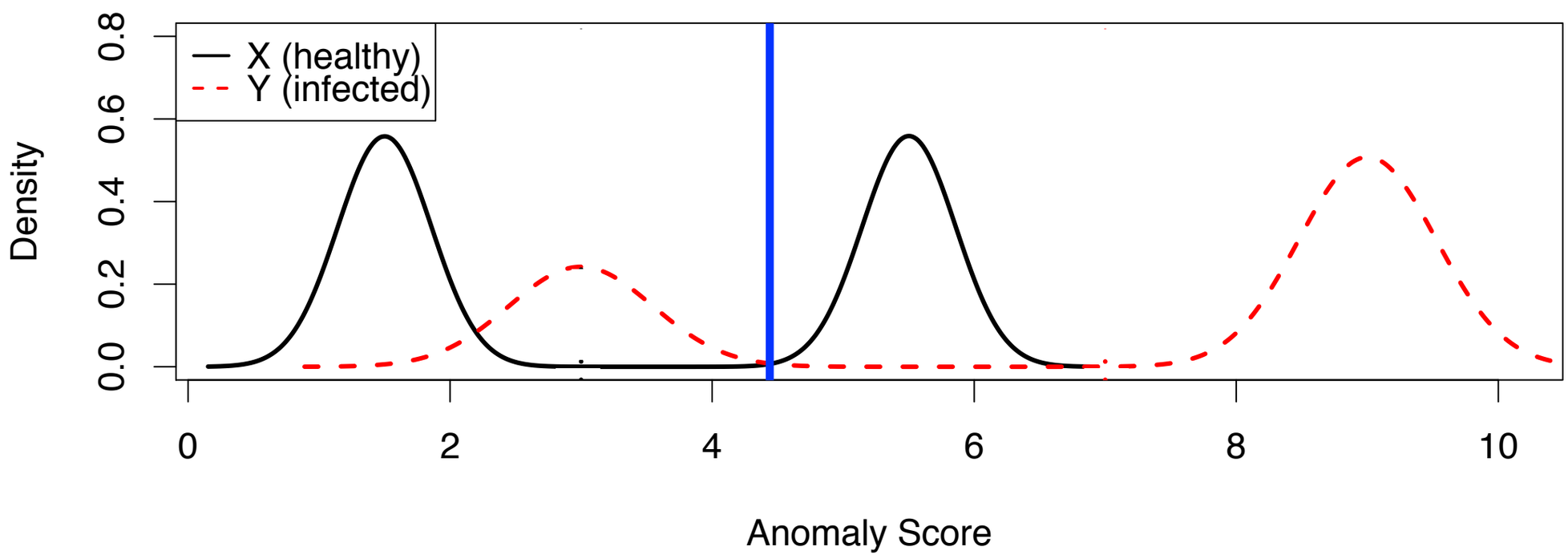
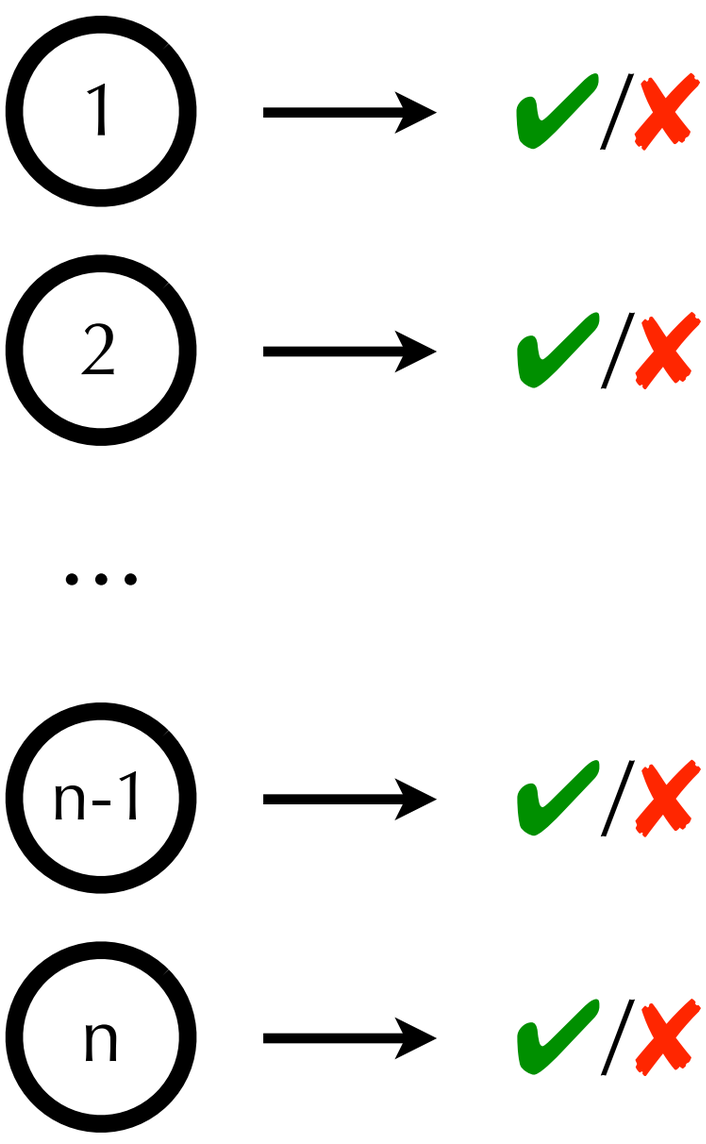


# Community

- Set of instances of an application
  - "all Firefox browsers in a company"
  - "all Apache servers in a cluster"
- Each client generates anomaly scores
- Are >0 infected? (*epidemic*)

# Previous Approaches



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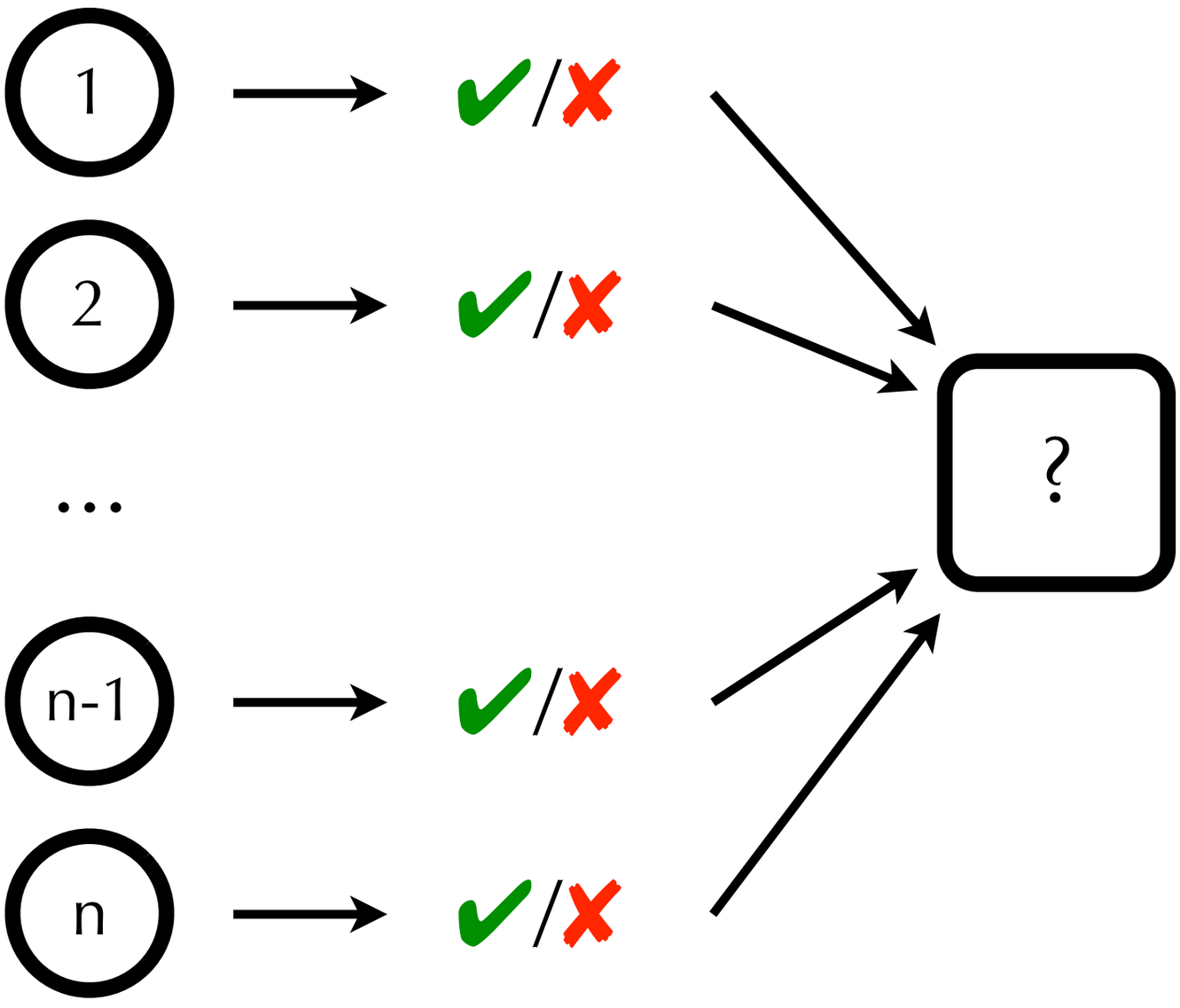


"alert fusion"
e.g., [Cuppens02]
[Gu08][Valdes01]

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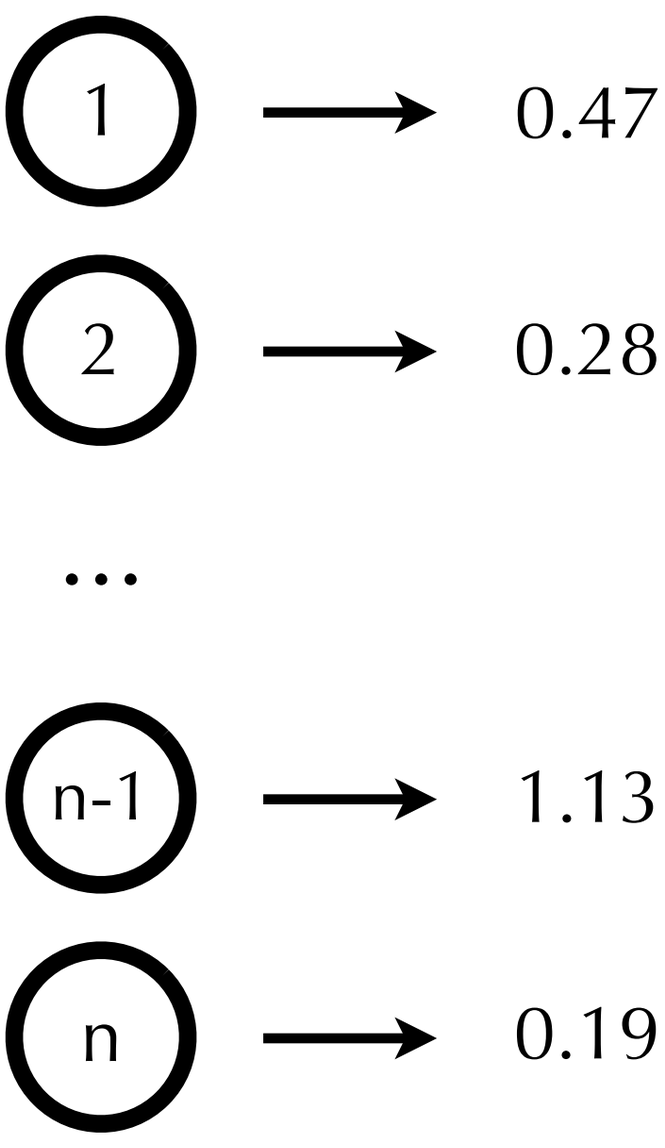
# Syzygy

# Syzygy



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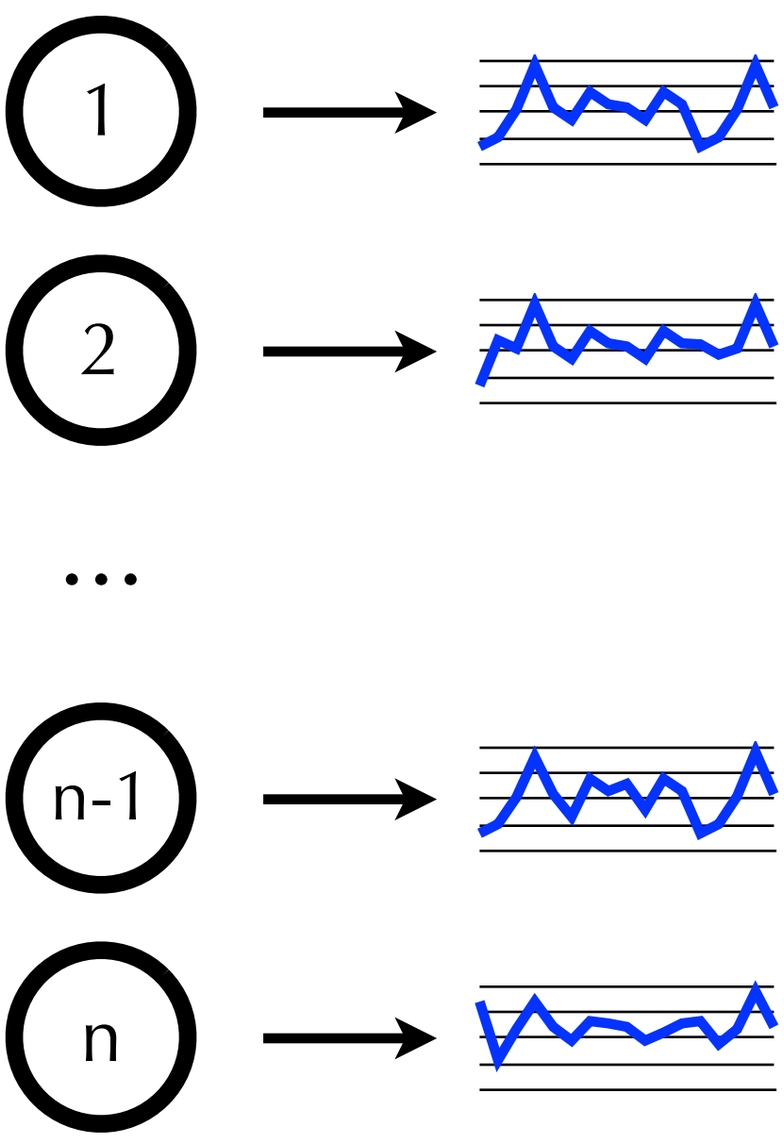

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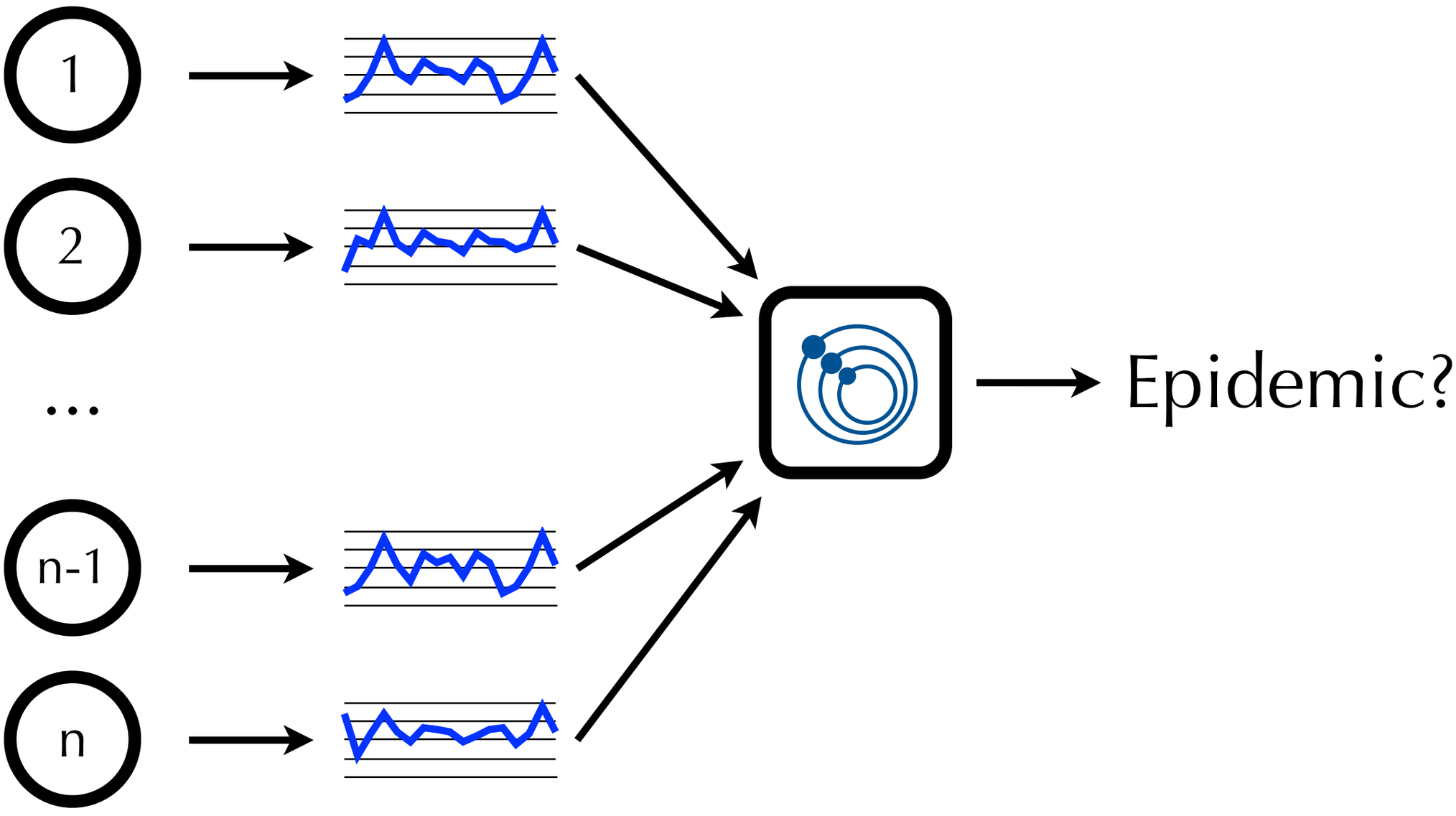

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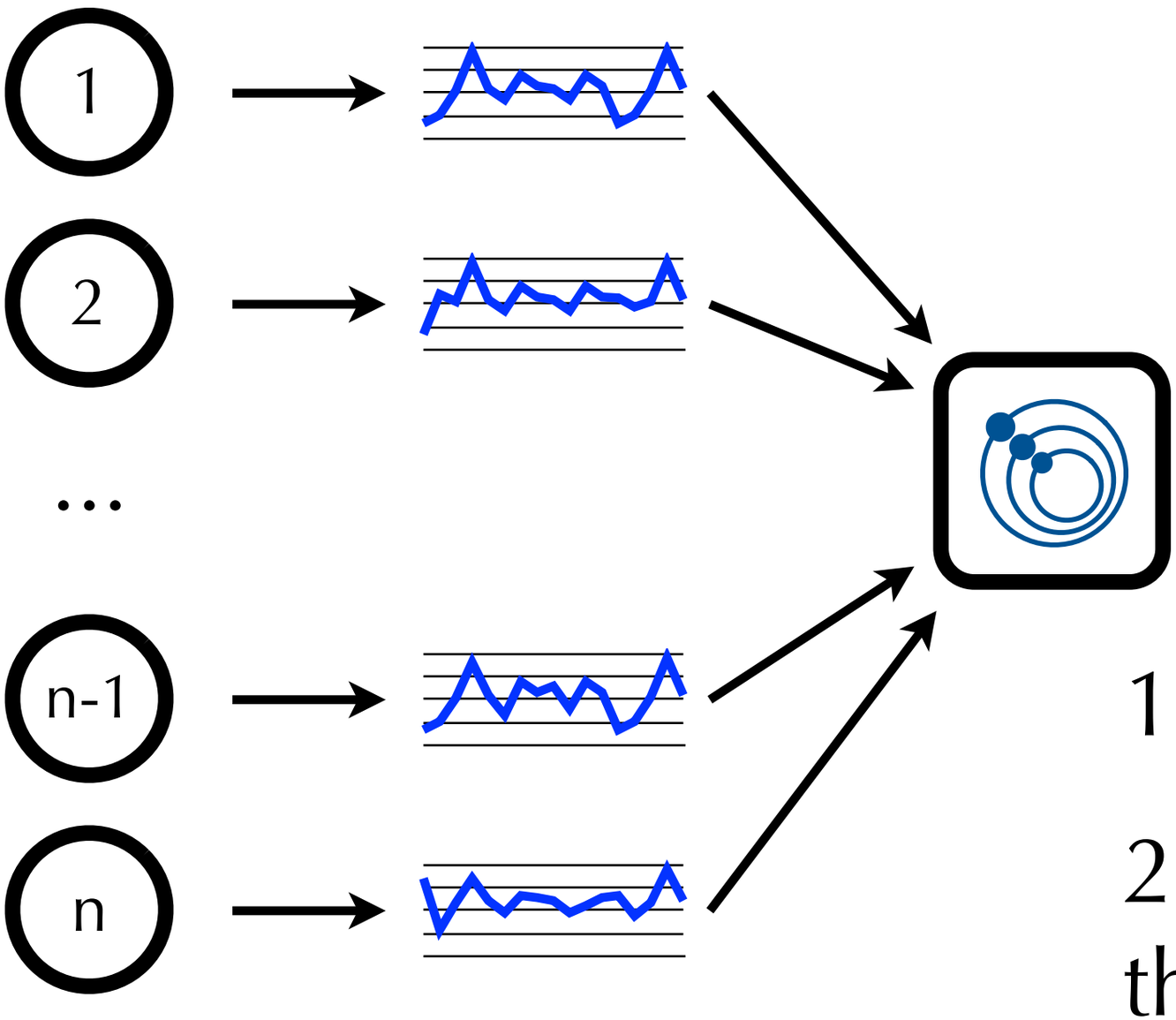
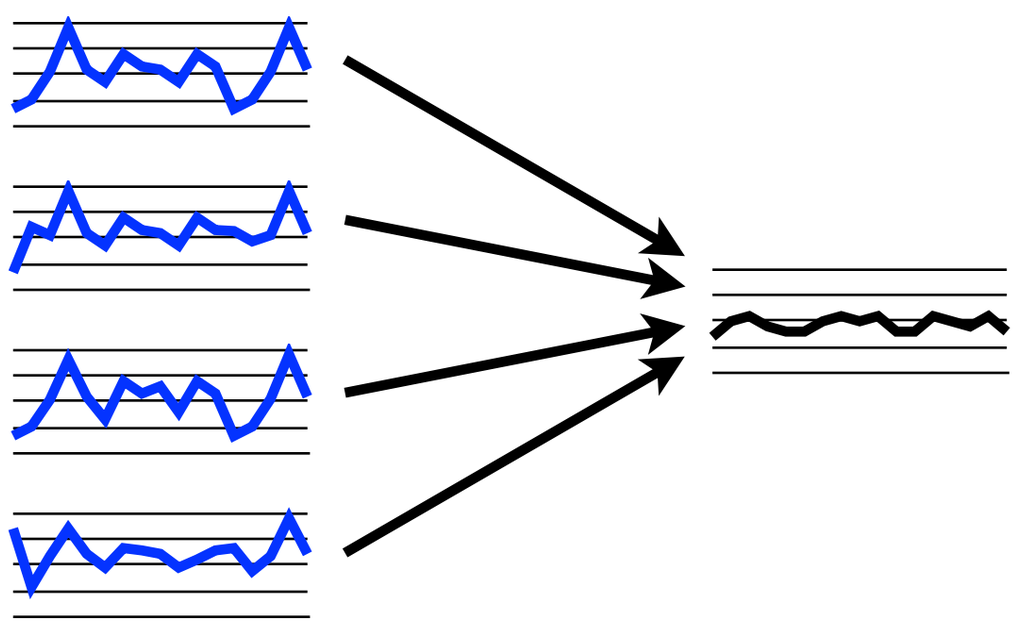



1. Compute average
2. Compare against threshold

# Community Score

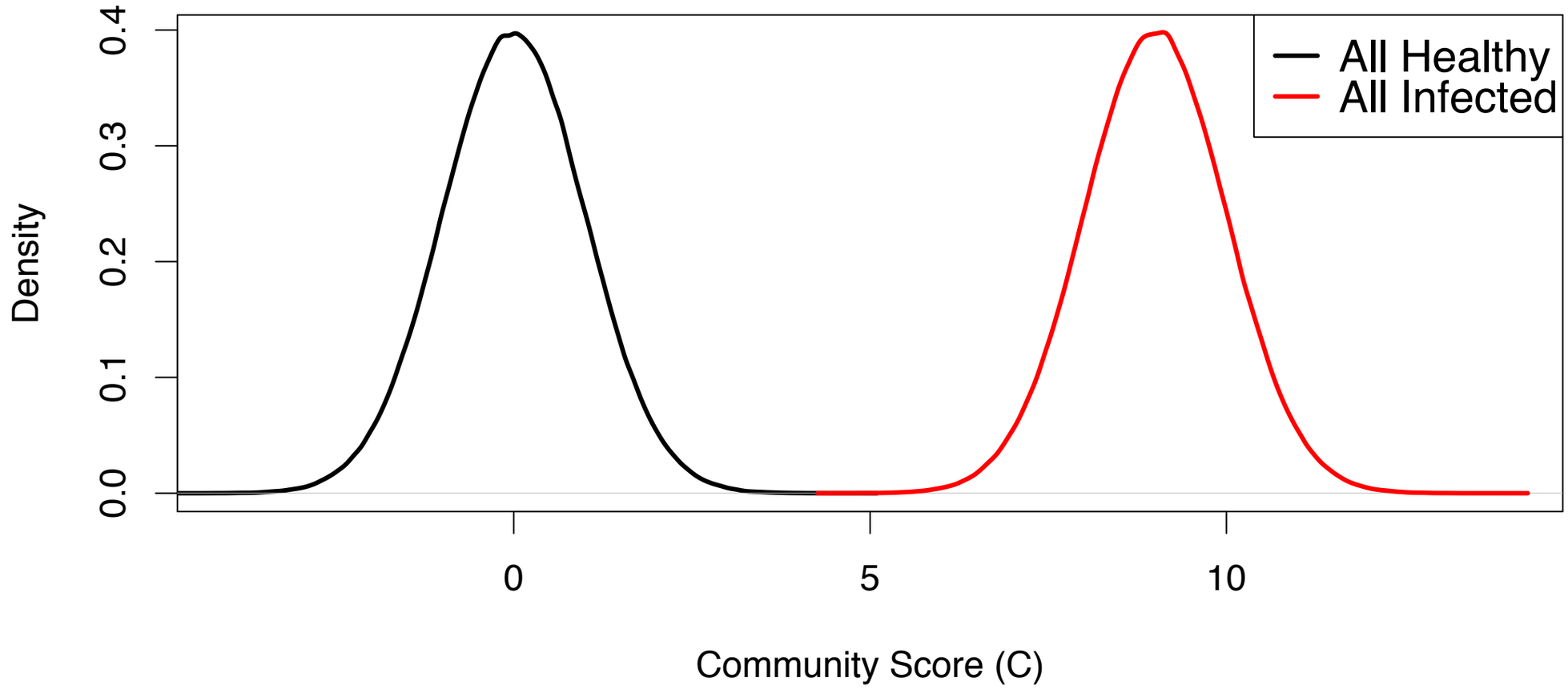
- Average of current anomaly scores
- **n** i.i.d. random variables



= normally distributed (from CLT)

# Community Score

- Clearer separation



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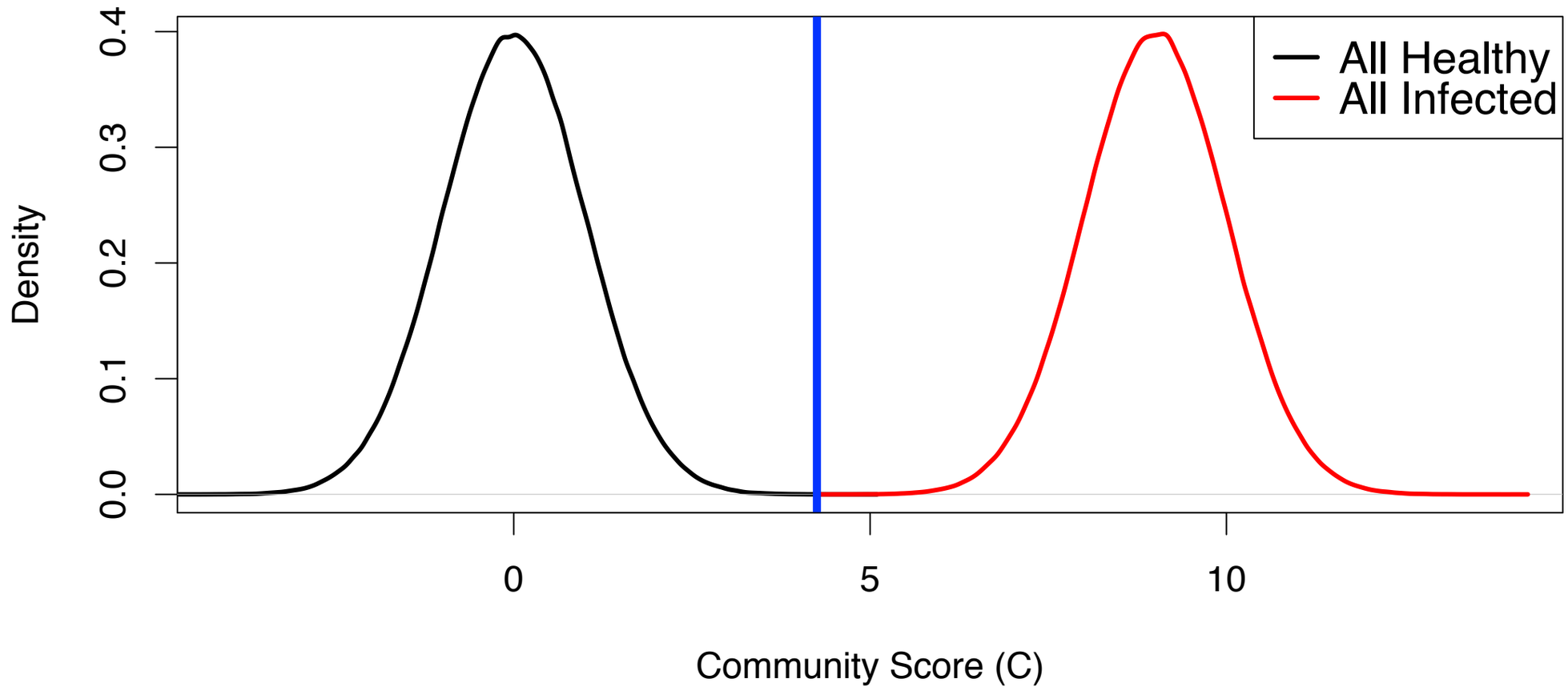

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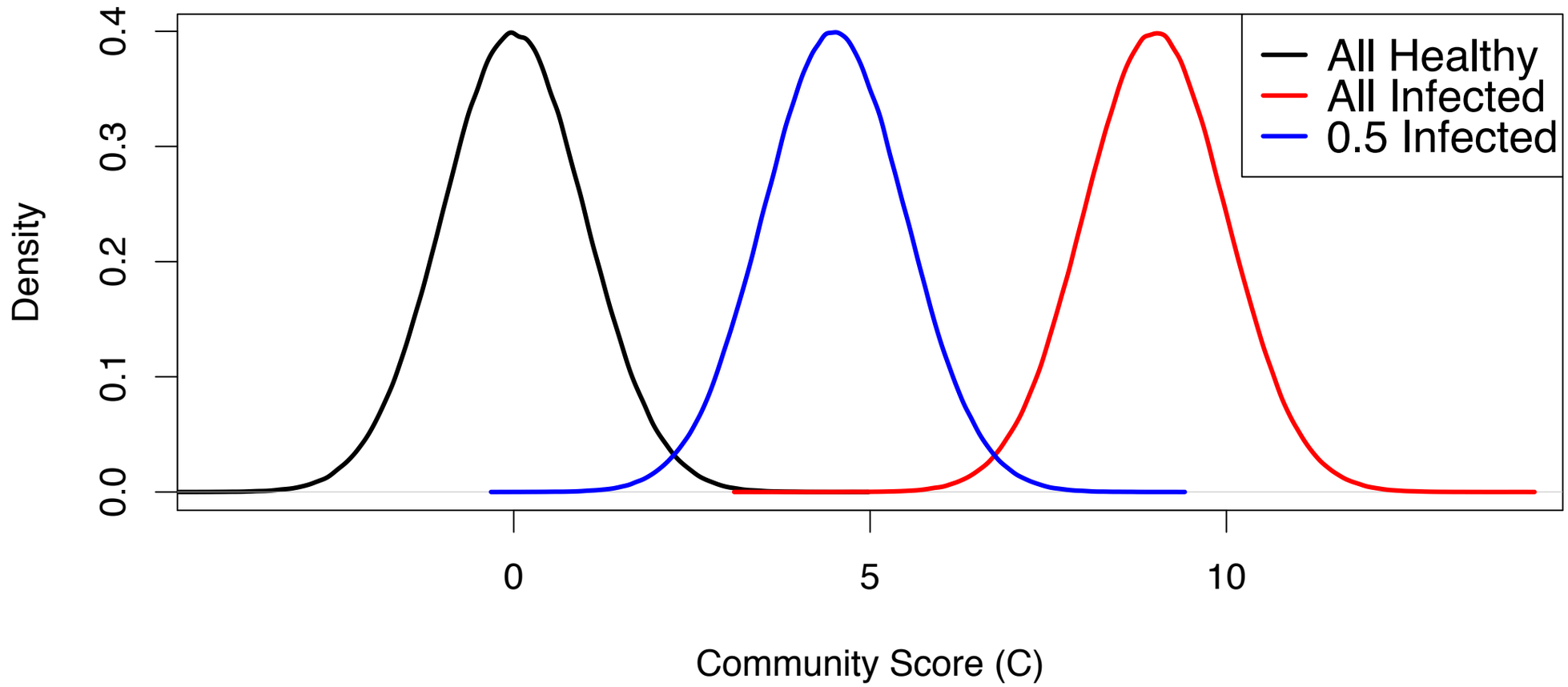

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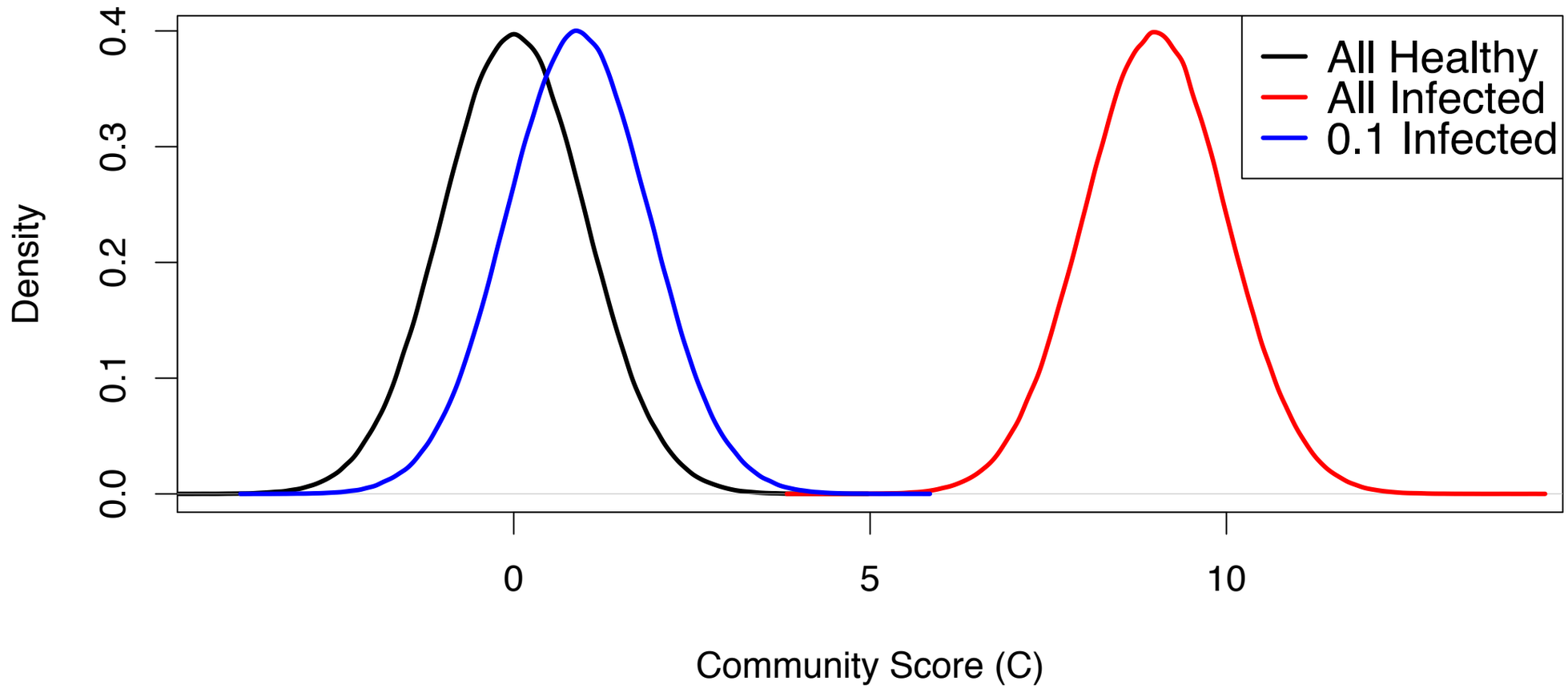

# Properties

- Weak requirements
  - Independence
  - Measurable effect
- Strong theoretical guarantees
  - Tunable false positive rate
  - Asymptotically perfect detection

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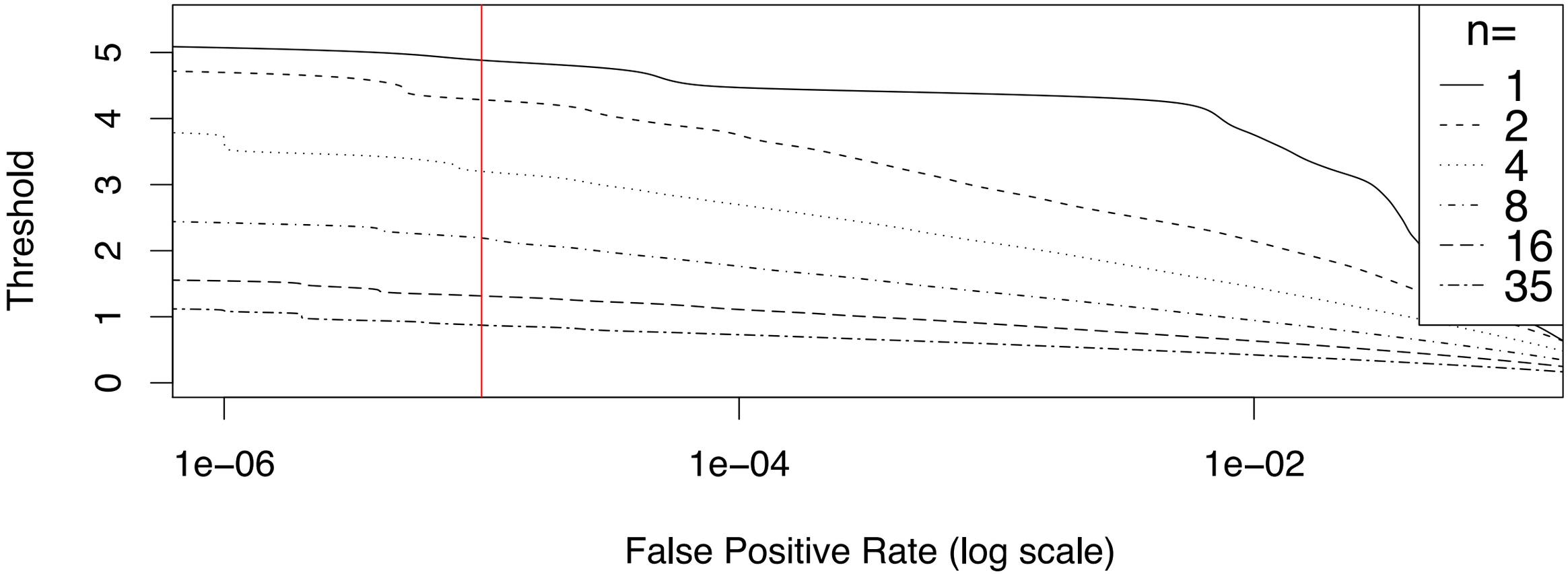
# Deployments

# Deployment #1

- Firefox in Stanford CS Building
- 35 clients over two weeks
- Model uses distributions of system call sequences
- > Ten billion anomaly scores
- No false positives

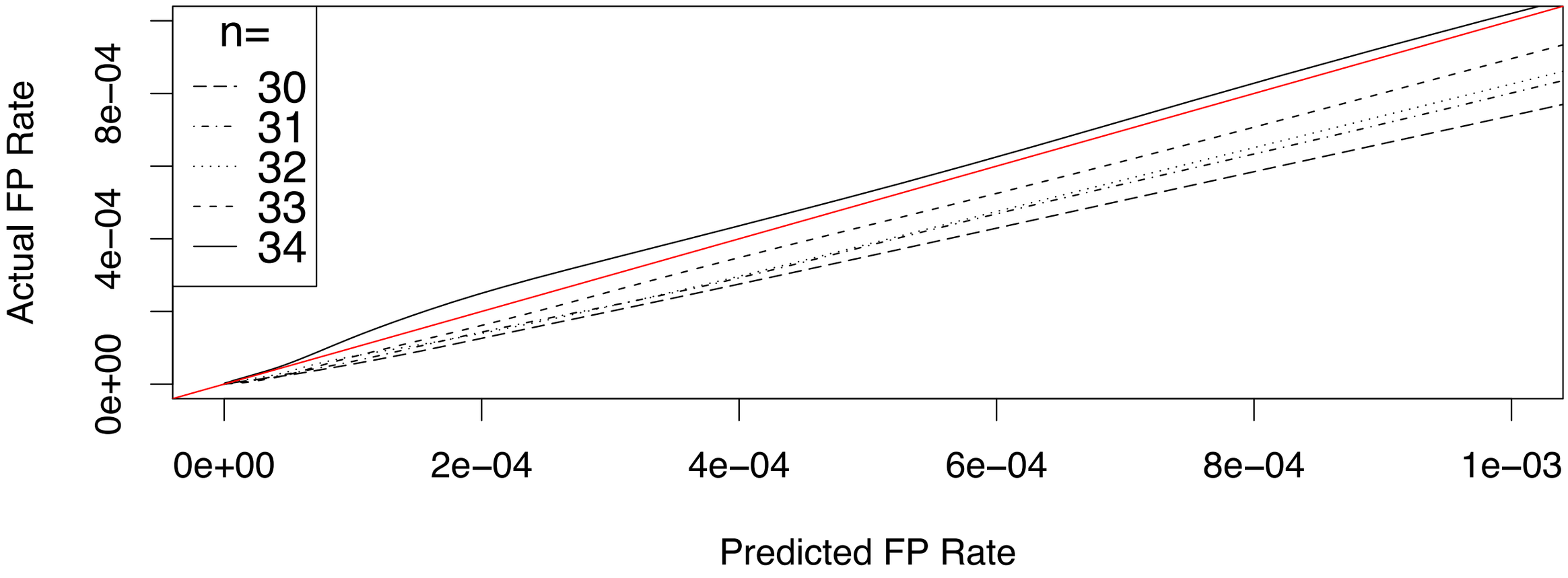
# Setting FP Rate

- Automatically sets the threshold



# Threshold Accuracy

- Can pick FP rate in a live deployment

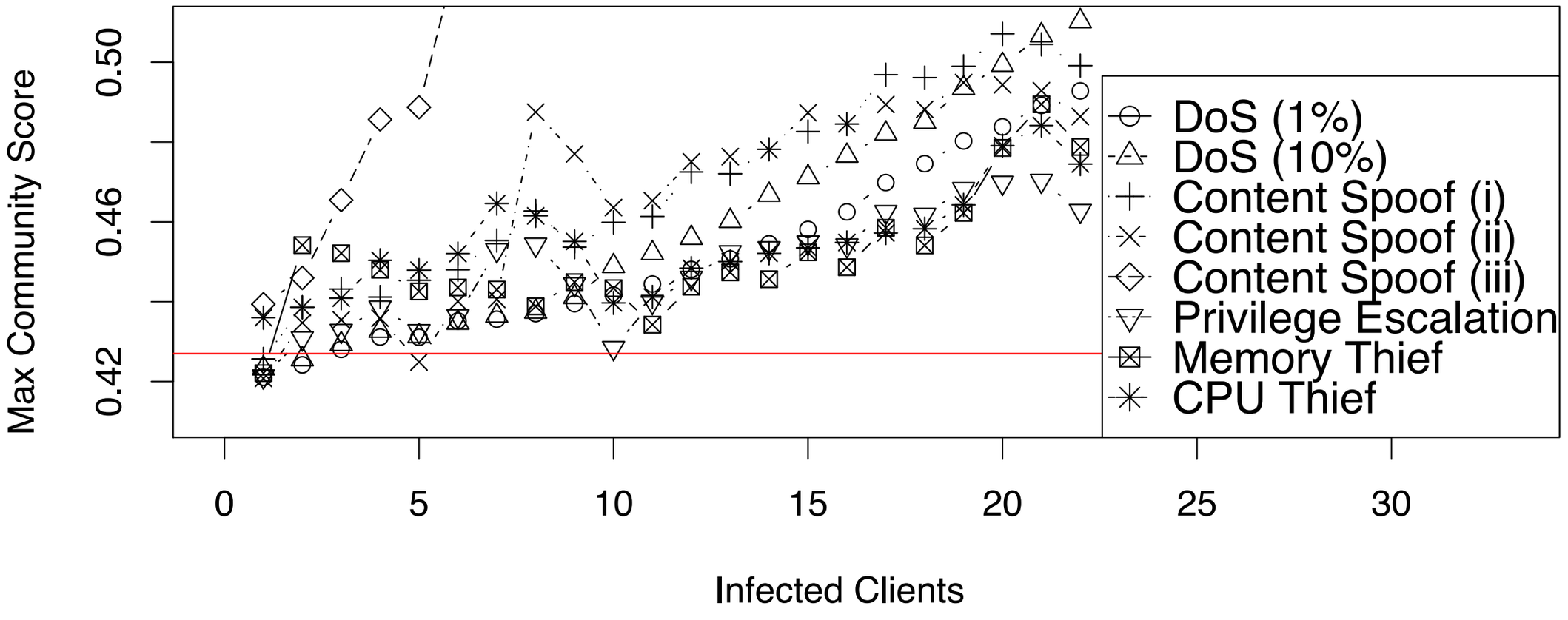


# Deployment #2

- Apache server cluster
- 22 clients driven by workload generator
- Model uses response time distributions
- Attacks: DoS, resource exhaustion, content spoofing, privilege escalation

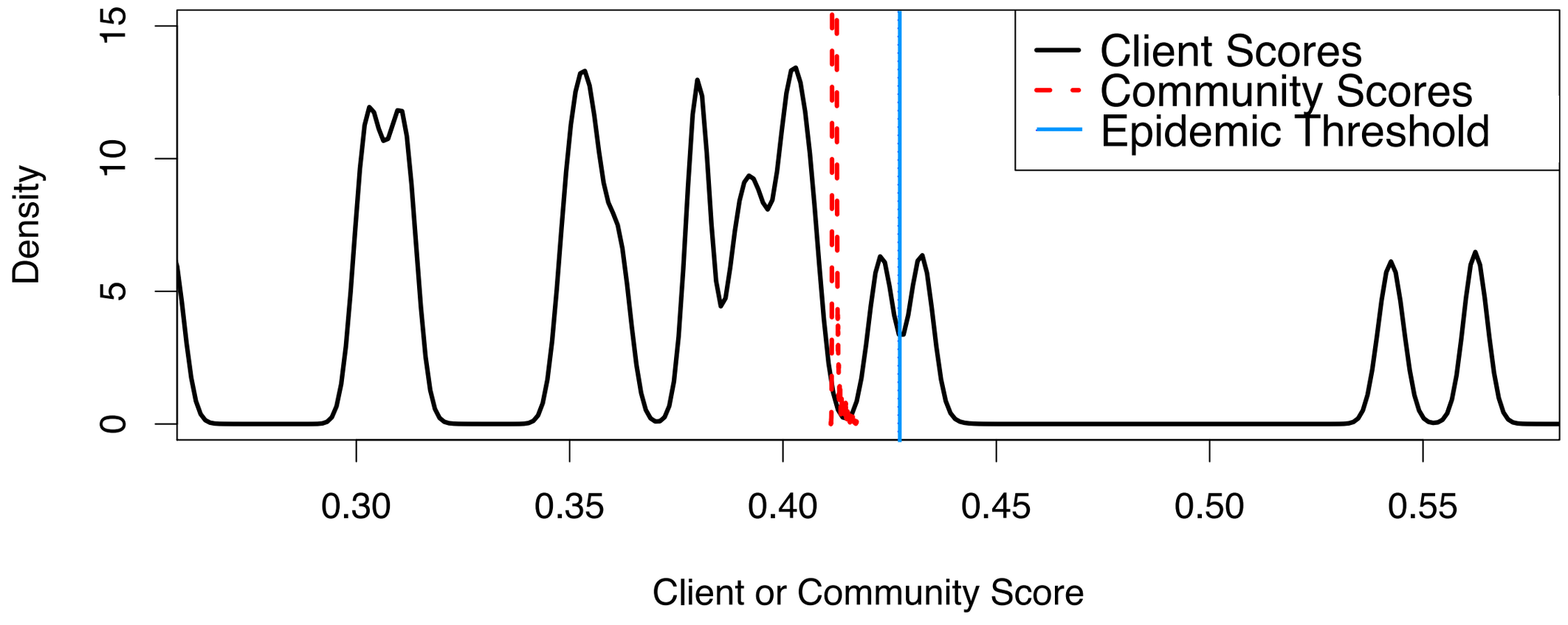
# Detection

- All attacks detected, no false positives



# Convergence

- Even at low **n** (22)



# Contributions

- Proposed Syzygy epidemic detector
- Proved strong guarantees
- Verified robustness claims
- Demonstrated practicality

# Fin

You have reached the end of the presentation. Please turn back.

# Data Sets

- Four desktop applications
- Four exploits
  - More powerful than those in the wild (in a technical sense, see paper)
- Model uses system call sequences



# Experiments

- Attack detection
- Tainted training data
- Mimicry
- Client variation
- Parameter sensitivity

# Simulation Summary

Syzygy is robust to noisy or incomplete client models, tainted training data, exploits that exhibit advanced behavior like mimicry, and a variety of other adverse conditions.