Attacking DBSCAN for Fun and Profit

(Proceedings of the SIAM International Conference on Data Mining, May 2015, Vancouver, CA)

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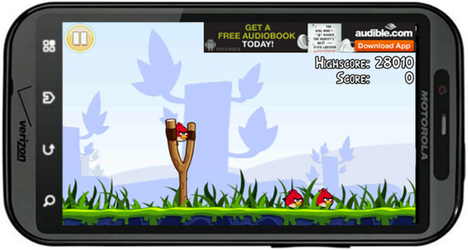
May 13th, 2015

[1] Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

App Plagiarism



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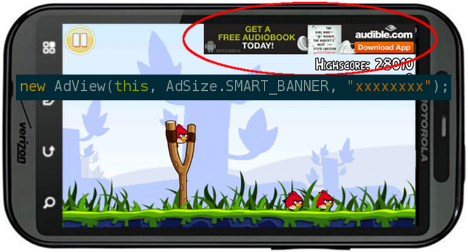

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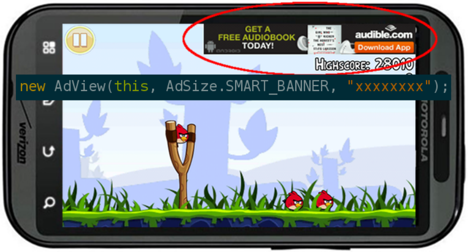

Miscreants copy apps to siphon ad revenue

- Gibler et al. (MobiSys'13) estimate losses of 14%

AnDarwin

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- One application: plagiarism detection
- Designed to be robust to attacks against data representation
- *Not* designed to be robust to attacks against data analysis

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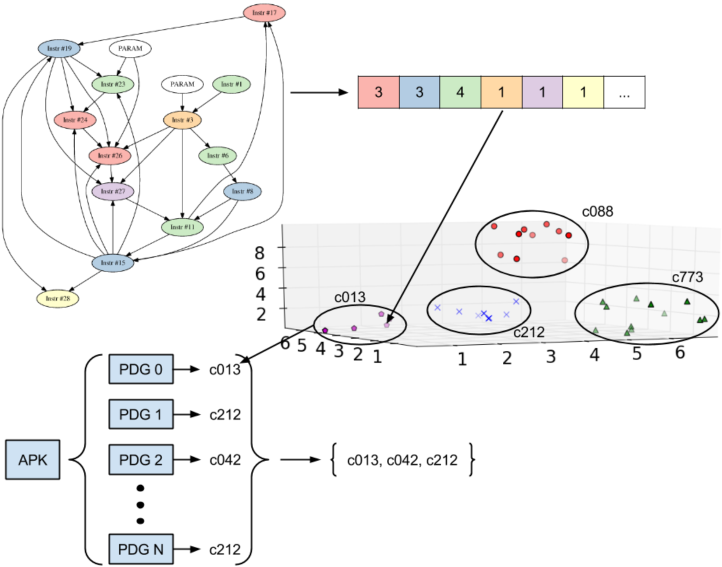

Instr #17
Instr #19
PARAM
Instr #23
PARAM
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c088
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c013
c212
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1 2 3 4 5 6
APK
PDG 0
c013
PDG 1
c212
PDG 2
c042
PDG N
c212
{ c013, c042, c212 }

Thinking like an Adversary

What goals might an adversary have?

- Avoid being clustered with similar apps
- Favorably alter clustering structure
- ...

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Confidence Attack

- Inject new points into dataset to poison the clustering

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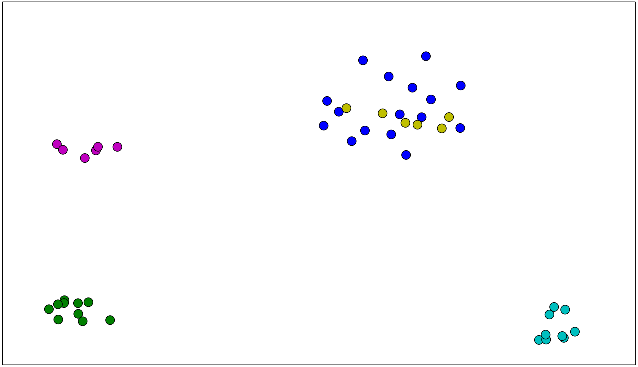

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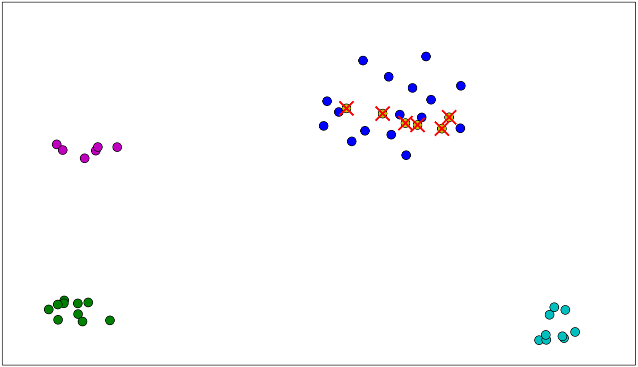

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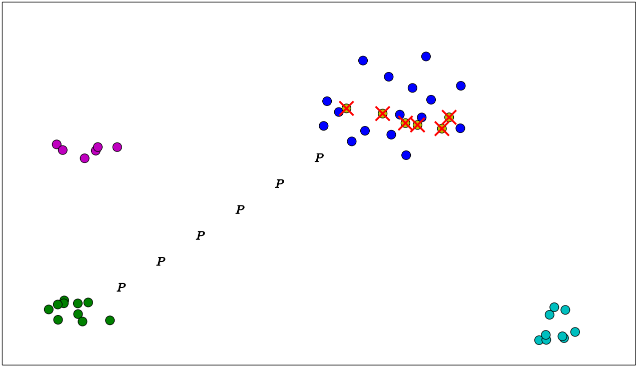

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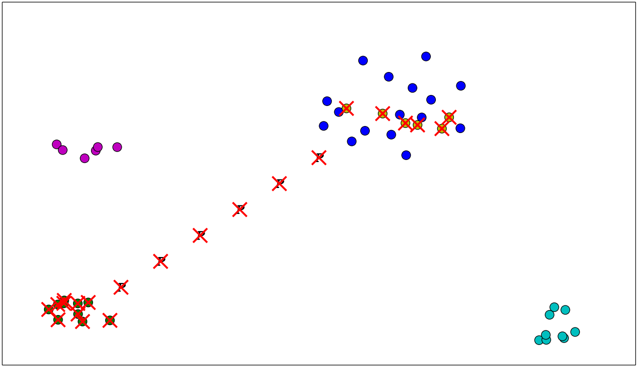

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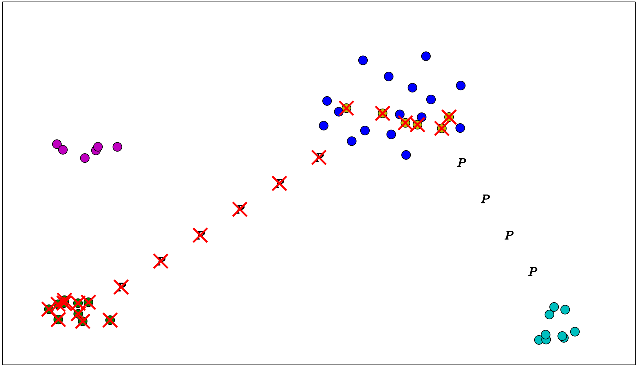

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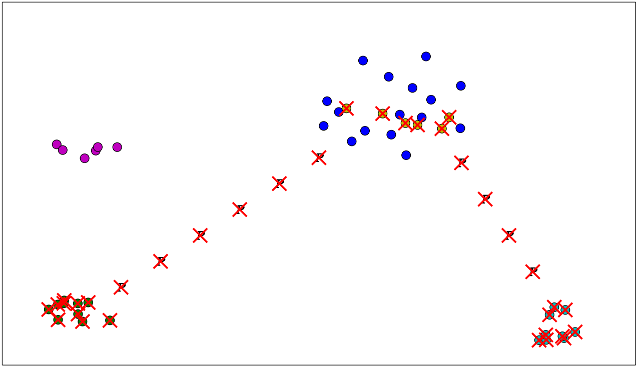

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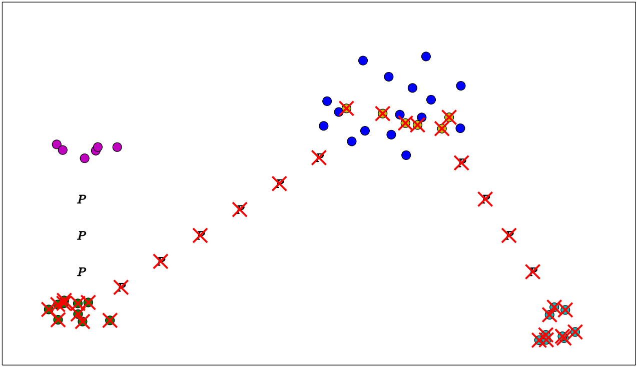

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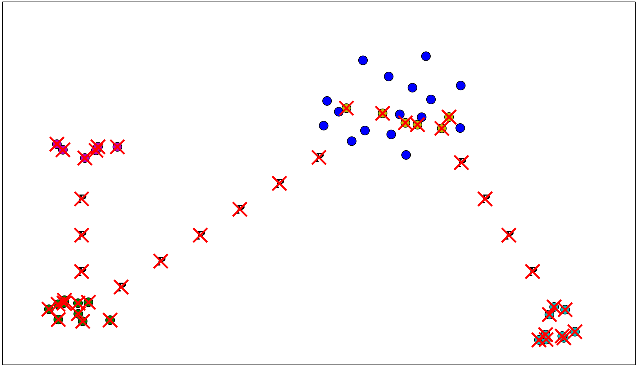

Is this Feasible?

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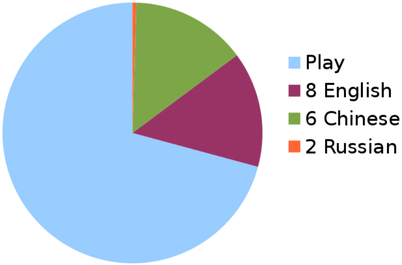

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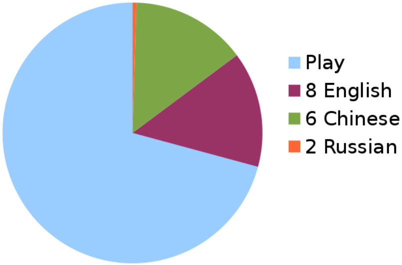

Semantic Gap (Jana and Shmatikov, IEEE S&P’12)

- Program analysis vs program execution

Attack Methodology

1. Pick two clusters to merge

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Generating Data Mines

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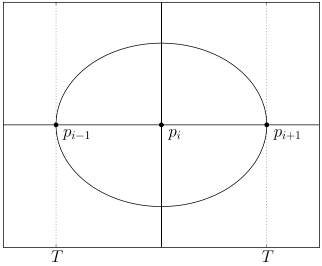
Generate points exactly T-width apart:



Generating Data Mines

DBSCAN (Ester et al., KDD'96):

- Core point has $>=$ *MinPts* neighbors in T-neighborhood
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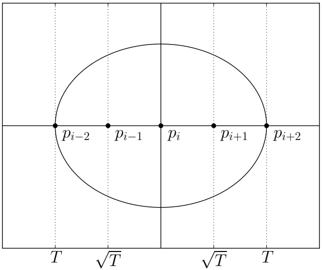
Generate points to match *MinPts*:



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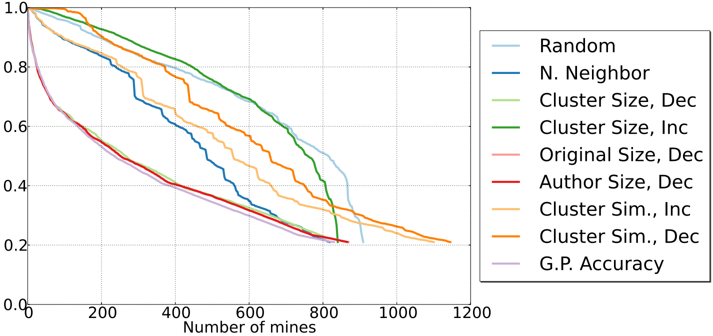

Dataset: 273 randomly selected clusters (1,394 apps total)

Defenses?

Increasing T and *MinPts* may cause us to miss plagiarizing apps

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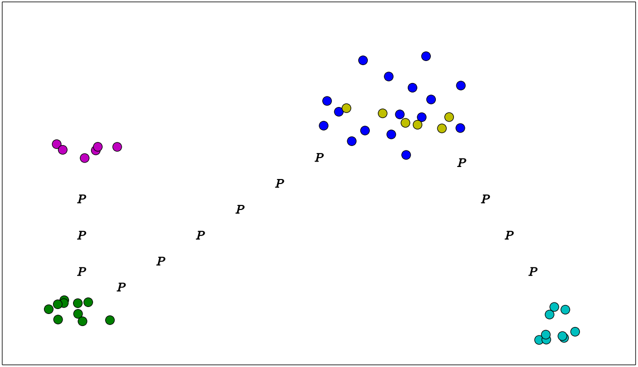

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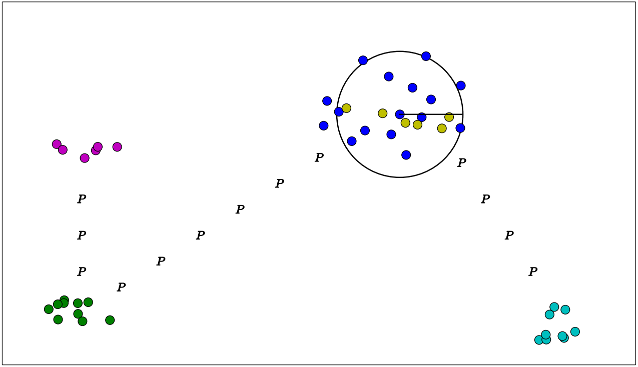

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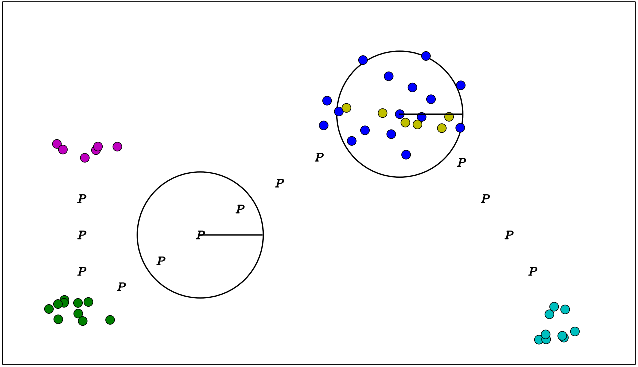
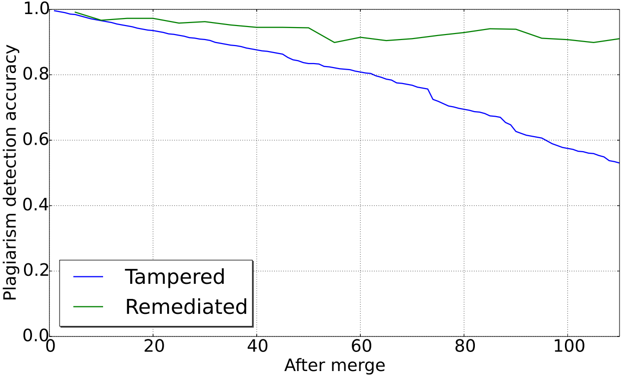


Remediation Results



Conclusion

Contributions:

- Methodology for selecting and then merging arbitrary clusters
- Evaluate effectiveness in a real-world scenario
- Show DBSCAN's vulnerability to the chaining phenomenon
- Propose and evaluate outlier-based remediation

Questions/Comments?

Presenter: Jonathan Crussell
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This work was supported by the CADA LDRD program at Sandia National Laboratories. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

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As a function of the T:

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As a function of T and $MinPts$:

$$UBAC(T, MinPts) = \frac{1 + \sqrt[\frac{MinPts-1}{2}]{T}}{1 - \sqrt[\frac{MinPts-1}{2}]{T}} - 1$$