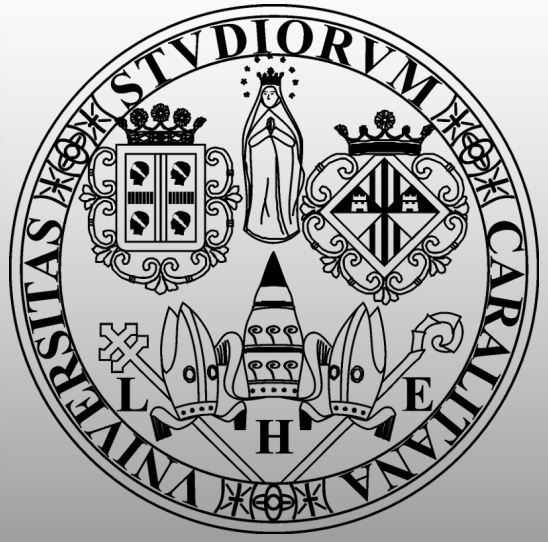

Decomposing Training Data to Improve Network Intrusion Detection Performance

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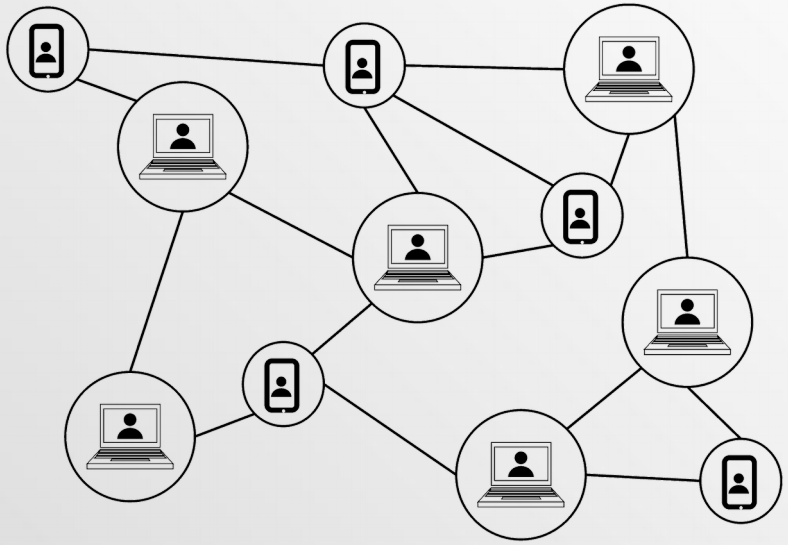
Outline

- Scenario
- Idea
- Formalization
- Conclusion

Scenario

The enormous exponential growth of **network-based services** has made the problem of their security a crucial aspect of the everyday life, public and private, since the high degree of **heterogeneity** that characterizes network events makes the detection of attacks an **hard task**



Scenario

The **Intrusion Detection Systems** (IDSs) have been designed to face such a problem, as their goal is to classify all the network events as **normal** or **intrusion**

But regardless of the adopted classification technique, their effectiveness is reduced by:

- A high level of **heterogeneity** and **dynamism** of the network events
- The fact that an attack **behavior** can be very similar to that of a **legitimate** network activity

Idea

- The idea behind the **proposed strategy** relies on the observation that the data used to train an evaluation model refers to **different periods**, as well as the features that characterize each event refer to **different aspects** of the involved scenario.
- We proposed to **divide** the training dataset into **several regions**, in order to characterize different scenarios in terms of **time** (*events*) and **characteristics** (*features*)
- The **event classification** will be performed on the basis of **all the models** we trained using these data regions

Formalization

- We **combine** different **evaluation models**, each of them trained on a different region of the training set **T**
- the regions are **bounded** in terms of *events* ***e*** and *features* ***f***, as in the following example, where a **2x2 region** has been highlighted

$$\mathbf{T} = \begin{array}{c} \longleftarrow \textit{behavior} \longrightarrow \\ \begin{array}{|cccc|c} e_1(f_1) & e_1(f_2) & e_1(f_{...}) & e_1(f_W) & \uparrow \\ e_2(f_1) & e_2(f_2) & e_2(f_{...}) & e_2(f_W) & \textit{time} \\ \vdots & \vdots & \ddots & \vdots & \downarrow \\ e_N(f_1) & e_N(f_2) & e_N(f_{...}) & e_N(f_W) & \end{array} \end{array}$$

Formalization

- An **intrusion detection algorithm** is applied to a **different part** of the training set
- The event classification depends on all single region **r** classification, as shown in the following equation, which refers to a training set with **4 events** and **4 features**, divided into **2x2 regions** that involve four $\mathbf{m_1}$, $\mathbf{m_2}$, $\mathbf{m_3}$, and $\mathbf{m_4}$ evaluation models

$$\left[\begin{array}{c|c} r_1 & r_2 \\ \hline r_3 & r_4 \end{array}\right] = \left[\begin{array}{cc|cc} f_{1,1} & f_{2,1} & f_{3,1} & f_{4,1} \\ f_{1,2} & f_{2,2} & f_{3,2} & f_{4,2} \\ \hline f_{1,3} & f_{2,3} & f_{3,3} & f_{4,3} \\ f_{1,4} & f_{2,4} & f_{3,4} & f_{4,4} \end{array}\right] \Rightarrow \left[\begin{array}{c|c} m_1 & m_2 \\ \hline m_3 & m_4 \end{array}\right]$$

Conclusions

- The proposed strategy is aimed to **improve** the performance of the IDSs
- It operates by **dividing** the training dataset into **several regions**, in order to better characterize the network events
- Each region is used to trains an **independent evaluation model**, and the event classification takes into account all the models, according to a majority voting criterion

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THANK YOU FOR YOUR ATTENTION

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