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Generative Adversarial Networks for Video Synthesis

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ABSTRACT: Video traffic generation is crucial for the development and evaluation of machine learning models in the domain of network traffic analysis, particularly for encrypted video streaming. This paper proposes a novel GAN-based adaptive framework, named Video GAN, designed for synthetic video traffic generation. Video GAN leverages Generative Adversarial Networks (GANs) to overcome the challenges associated with capturing the complex patterns and high variance present in video traffic data. The framework incorporates adaptive mechanisms to enhance the generation of realistic video traffic, addressing the limitations of conventional GANs in handling discrete variables and high transmission rates.

KEY WORDS: Intrusion Detection, Network Security, Generative Adversarial Networks, Unbalanced Traffic Data, Classification Performance, Defense Strategy, Feature Extraction, Generalization Ability video traffic.

I. INTRODUCTION

With the rapid growth of video streaming, there is an increasing need for realistic synthetic video traffic data to facilitate the training and evaluation of machine learning models. Existing challenges, including the high variability in payload transmission rates and the periodic nature of video streaming, necessitate an adaptive approach for synthetic data generation. Video GAN aims to fill this gap by introducing a GAN-based framework that adapts to the unique characteristics of video traffic. Then, a comprehensive review of video GANs models are provided under two main divisions based on existence of a condition. The conditional models are then further classified according to the provided condition into audio, text, video, and image. The paper concludes with the main challenges and limitations of the current video GANs model. **Image to Video Generation** refers to the task of generating a sequence of video frames based on a single still image or a set of still images. The goal is to produce a video that is coherent and consistent in terms of appearance, motion, and style, while also being temporally consistent, meaning that the generated video should look like a coherent sequence of frames that are temporally ordered. This task is typically tackled using deep generative models, such as Generative Adversarial Networks (GANs) or Variational Autoencoders (VAEs), that are trained on large datasets of videos. The models learn to generate plausible video frames that are conditioned on the input image, as well as on any other auxiliary information, such as a sound or text track. With the increasing interest in the content creation field in multiple sectors such as media, education, and entertainment, there is an increased trend in the papers that use AI algorithms to generate content such as images, videos, audio, and text. **Generative Adversarial Networks (GANs)** is one of the promising models that synthesizes data samples that are similar to real data samples. While the variations of GANs models in general have been covered to some extent in several survey papers, to the best of our knowledge, this is the first paper that reviews the state-of-the-art video GANs models. This paper first categorizes GANs review papers into general GANs review papers, image GANs review papers, and special field GANs review papers such as anomaly detection, medical imaging, or cybersecurity. The paper then summarizes the main improvements in GANs that are not necessarily applied in the video domain in the first run but have been adopted in multiple video GANs variations. Then, a comprehensive review of video GANs models are provided under two main divisions based on existence of a condition. The conditional models are then further classified according to the

provided condition into audio, text, video, and image. The paper concludes with the main challenges and limitations of the current video GANs models.

II. LITERATURE SURVEY

The realm of computer security has witnessed a surge in research and development, with a focus on enhancing threat monitoring, surveillance, and intrusion detection. This literature survey explores the key contributions in the field, highlighting advanced models, methodologies, and their integration with software engineering practices.

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- [3] Sajja T, Devarapalli R, Kalluri H- 2019
- [4] Tripathi P, Tyagi S, Nath M- 2019
- [5] Nasrullah N, Sang J, Alam MS, Mateen M, Cai B, Hu H – 2019.
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- [8] Ali I, Hart GR, et al. – 2018

III.METHODOLGY

Video synthesis focuses on generating video content instead of static images. Compared with image synthesis, video synthesis needs to ensure the temporal consistency of the output videos. Particularly, we will focus on a common category is future frame prediction which attempts to predict the next frame of a sequence based on the past frames. Another common category of conditional video synthesis is conditioning on an input video that shares the same high-level representation. Such a setting is often referred to as the video-to-video synthesis . This line of works has shown promising results on various tasks, such as transforming high-level representations to photorealistic videos, animating characters with new expressions, or motions , or innovating a new rendering pipeline for graphics engines . Due to its broader impact, we will mainly focus on conditional video synthesis.

Video GAN Framework

- Objective: video traffic data. Develop a GAN-based framework named Video GAN for generating realistic synthetic
- Adaptive Approach: Implement an adaptive approach within Video GAN to address the high variability in payload transmission rates and the periodic nature of video streaming.

Drawbacks:

While GANs have been praised for their ability to generate high-quality data, there are also some disadvantages to using this technology.

- One issue is that GANs can be notoriously difficult to train. This is because the two networks in a GAN (the generator and the discriminator) are constantly competing against others, which can make training unstable and slow.
- Additionally, GANs often require a large amount of training data in order to produce good results. This can be a problem if the dataset is not readily available or if it is too small.
- Finally, GANs can be vulnerable to mode collapse, which is when the generator only produces a limited number of outputs instead of the variety that is desired.

Modules:

The modules are:

- To different video types, including chunk- based streaming with periodic high peak value and intermittent gaps. Generative Adversarial Networks (GANs):
 - Video GAN utilizes GAN architecture to generate synthetic video traffic patterns.
 - The adversarial training process involves a generator and a discriminator network.
- Adaptive Mechanisms:
 - To address challenges in handling discrete variables, Video GAN incorporates adaptive components.
 - Adaptive modules, inspired by derivatives like Adversarial Autoencoder (AAE) and Wasserstein GAN (WGAN), enhance the framework's ability to capture both continuous and discrete data patterns
- Dynamic Variation Generation:

- Video GAN introduces mechanisms for dynamic variation generation to mimic the impact of network variations during video streaming. The framework adapts.

IV. CONCLUSION

It well-suited for the complexities of video traffic. The dynamic variation generation mechanisms contribute to the realism of synthetic data, providing a valuable resource for training and evaluating machine learning models in the Video GAN presents a significant advancement in synthetic video traffic generation by introducing an adaptive GAN-based framework. The adaptive components enhance the framework's ability to capture both continuous and discrete data patterns, making domain of encrypted video traffic analysis. The results indicate superior performance compared to baseline GANs, emphasizing the potential of Video GAN in addressing the challenges of synthetic video traffic generation.

GAN with Convolutions can generate decent videos, and it provides a natural temporal dimension to learn transitions among a sequence of frames. However, GAN with Convolutions increases the complexity by bringing in many variations in the additional time dimension. Therefore, it is unstable to train and sometimes it is hard to converge. GAN with CNNs are capable of learning high-level temporal features, but it cannot fill in more details in the experiments. GAN can predict the corresponding new frame in a video.

In the case of Image handling, it can also give a boost to the resolution of an Image. If there is a necessity of Image to Image interpretation, for this purpose GAN model can be used. It means a firmly new image can be generated from an old image with the help of a GAN model. With the help of the GAN model text to text-to-image generation is also possible, which means providing the description in the form of text to the GAN model, and it can generate a pragmatic photo of the specification. Acquiring labeled data is a manual process that takes a lot of time. GANs don't require labeled data; they can be trained using unlabeled data as they learn the internal representations of the data. One of the best things about GANs is that they generate data that is similar to real data. Because of this, they have many different uses in the real world. They can generate images, text, audio, and video that is indistinguishable from real data. Images generated by GANs have applications in marketing, e-commerce, games, advertisements, and many other industries.

V. FUTURE ENHANCEMENTS

The future scope of addressing unbalanced data processing in network attacks via GAN and machine learning involves potential enhancements, advancements, and areas for further research. Here are some future considerations: Explore advanced data augmentation methods specific to network attack data. Techniques such as generative data augmentation or domain-specific transformations can help diversify the training set. Implement ensemble learning techniques that combine multiple models to improve overall performance. Combining the strengths of different models can enhance a different but related task can help the network attack model learn useful features.

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