Synthetic Couture: Generative Models for Fashion Design and Innovation

1 Project Description

1.1 Project Overview

We aim to develop a generative AI tool specifically designed for fashion design. Leveraging advanced generative models such as Generative Adversarial Networks (GANs), our tool will automate and enhance the fashion design process. It will generate innovative and unique clothing designs that reflect current trends and user preferences. In the context of fashion design, GANs can be trained on extensive datasets comprising a vast array of fashion images, encompassing everything from haute couture to streetwear, enabling the model to learn and assimilate the intricate patterns, textures, and styles that define contemporary fashion.

1.2 Problem Description and Significance

- The traditional fashion design process is time-consuming, involving multiple stages of sketching, prototyping, and iteration, limiting the speed of bringing new designs to market.
- By employing generative AI models, we aim to automate the initial design phase, allowing designers to focus on refining concepts.
- These models can enhance creativity by suggesting novel designs, reflecting current trends and user preferences through training on diverse datasets.
- Studying this problem is worthwhile as it has the potential to revolutionize the fashion industry.
- It will make the design process more efficient and creative, opening possibilities for customization and personalization catering to niche markets and individual preferences.

2 Literature Survey

2.1 Experimentation

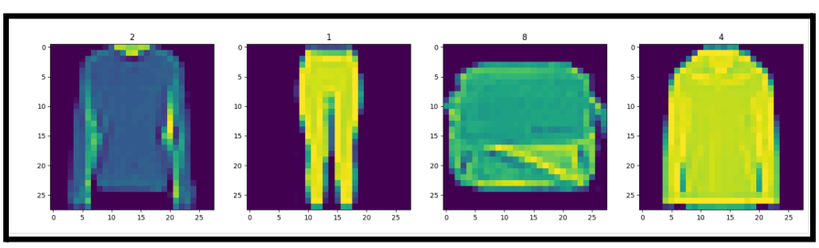
For preliminary research, we're training a Generative Adversarial Network (GAN) on the Fashion MNIST dataset [5] , containing 28x28 grayscale images of 10 classes of fashion items.

Key GAN components:

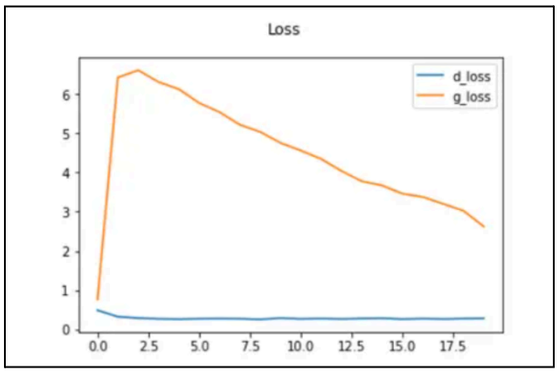
- Generator: Neural network generating new data samples
- Discriminator: Neural network classifying data as real or fake
- Latent space: Random vector input for generator
- Training loop: Iterative process training generator and discriminator

Data preprocessing:

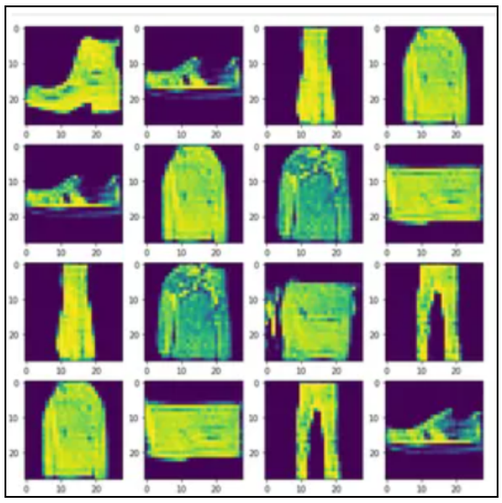
- Scale pixel values 0-1
- Batch images into groups of 128



Loss:



We generate new fashion images by passing random latent vectors to the generator. The generator interprets these random vectors and generates corresponding images.



We further will explore complex GANs and Variational Autoencoder algorithms to work on RGB images as follows:

We will be utilizing the SHHQ dataset for training our model.

2.2 Related work discussion

We have explored StyleGAN [1], Introspective Variational Autoencoders for Photographic Image Synthesis [2], DeepFashion [3] and Fashion Apparel Generation [4] which account for our literature survey.

Further, we propose to design a framework which will involve complementary strengths of VAEs and GANs. VAE-GANs can produce high-quality samples with better control over the latent space distribution, leading to more diverse and realistic outputs in fashion design generation.

3 Challenges and improvement

- Data Representation: Representing the high-dimensional, complex nature of fashion data without losing important details.
- Model Complexity: Designing models with enough capacity to capture intricate fashion structures and details without overfitting.
- Style Consistency: Ensuring generated designs adhere to stylistic themes and trends while still being novel.
- Variability and Diversity: Producing a wide variety of designs appealing to different tastes as fashion trends evolve.
- Semantic Understanding: Integrating understanding of garment types, shapes, and functionalities for coherent designs.
- Evaluation Metrics: Developing reliable metrics to assess creativity, novelty, realism, and adherence to style constraints.
- Scalability and Efficiency: Handling large fashion datasets efficiently during training.

4 An experimental evaluation protocol.

To evaluate the success of our Generative Adversarial Network (GAN) model trained on the Fashion MNIST dataset and later on the SHHQ dataset, we will use a combination of quantitative and qualitative metrics. These metrics will help us assess various aspects of the model's performance, including image quality, diversity, style consistency, and training efficiency. Here are the evaluation metrics:

- **Inception Score (IS):** Measures quality and diversity of generated images.
- **Frechet Inception Distance (FID):** Evaluates distance between real and generated image distributions.
- **Precision and Recall for Generative Models:** Measures coverage (recall) and fidelity (precision) of generated samples.
- **Visual Inspection:** Manual assessment of visual quality, coherence, and diversity.
- **User Study:** Collects subjective feedback on quality, realism, and creativity of images.
- **Style Classification Accuracy:** Checks consistency of styles in generated images.
- **Latent Space Interpolation:** Assesses smoothness and coherence of transitions between generated images.
- **Attribute Consistency:** Evaluates consistency of semantic attributes in generated images.
- **Training Time and Resource Utilization:** Measures time and computational resources used for training.
- **Model Convergence:** Evaluates speed and effectiveness of model convergence.
- **Baseline Performance Comparison:** Compares performance with baseline models on the same datasets.

References

[1] I. Choi, S. Park and J. Park, "Generating and Modifying High Resolution Fashion Model Image using StyleGAN," 2022 13th International Conference on Information and Communication Technology Convergence (ICTC), Jeju Island, Korea, Republic of, 2022, pp. 1536-1538, doi: 10.1109/ICTC55196.2022.9952574.

[2] Huang, H., Li, Z., He, R., Sun, Z., & Tan, T. (2018). IntroVAE: Introspective Variational Autoencoders for Photographic Image Synthesis. CoRR, abs/1807.06358. Retrieved from http://arxiv.org/abs/1807.06358

[3] Liu, Z., Luo, P., Qiu, S., Wang, X., & Tang, X. (2016). DeepFashion: Powering Robust Clothes Recognition and Retrieval with Rich Annotations. In Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

[4] Project Report.pdf

[5] https://github.com/zalandoresearch/fashion-mnist