# SimVP: Simpler yet Better Video Prediction

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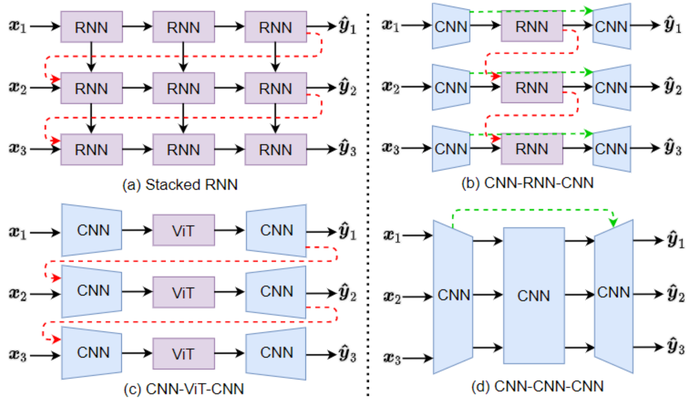
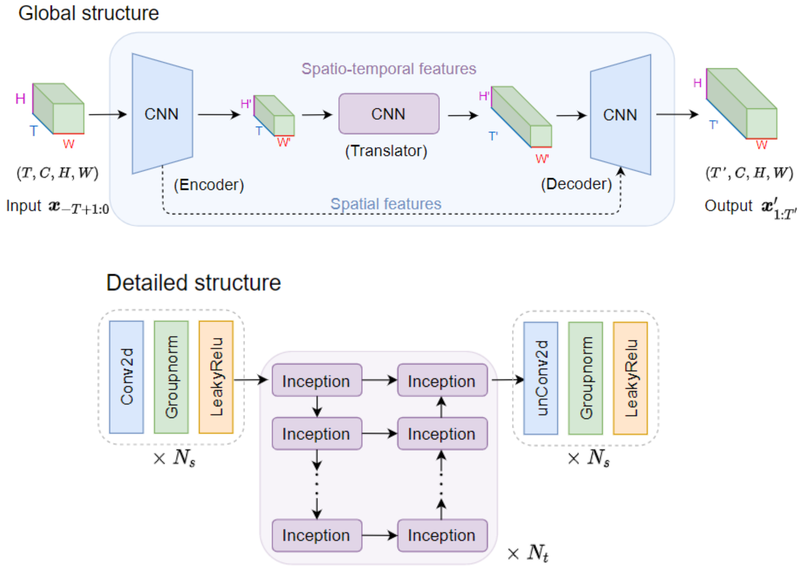
## Section 1 Previous methods




- We have witnessed many terrific methods that have achieved outstanding performance.
- However, as the models become more complex, understanding their performance gain is an inevitable challenge, and scaling them into large datasets is intractable.
- Can we develop a simpler model to provide better understanding and performance?

## Section 2 SimVP

- SimVP consists of an encoder, a translator and a decoder built on CNN.
- SimVP can achieve state-of-the-art results without introducing any complex modules, strategies and tricks.
- SimVP has better computational time efficiency than baselines.




The **encoder** and **decoder** stack $N_s$ ConvNormReLU blocks to extract spatial features, i.e., convoluting $C$ channels on $(H, W)$. The hidden feature is:

$$z_i = \sigma\left(\mathrm{LayerNorm}\left(\mathrm{Conv2d}(z_{i-1})\right)\right), 1 \leq i \leq N_s$$

The **translator** employs $N_t$ Inception modules to learn temporal evolution, i.e., convoluting $T{\times}C$ channels on $(H, W)$. The Inception module consists of a bottleneck Conv2d with $1{\times}1$ kernel followed by parallel GroupConv2d operators. The hidden feature is:

$$z_j = \mathrm{Inception}\left(z_{j-1}\right), N_s \leq j \leq N_s + N_t$$

## Section 3 Experimental results

- SimVP achieves state-of-the-art MSE and SSIM on Moving MNIST, TrafficBJ, Human3.6, Caltech Pedestrian, and KTH.
- The simplicity leads to good computational efficiency..
- SimVP extends well to the case of flexible predictive length.

| | | Moving MNIST | | | TrafficBJ | | | Human3.6 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MSE↓ | MAE↓ | SSIM↑ | MSE × 100 ↓ | MAE↓ | SSIM↑ | MSE / 10 ↓ | MAE / 100 ↓ | SSIM↑ |
| | ConvLSTM | 103.3 | 182.9 | 0.707 | 48.5 | 17.7 | 0.978 | 50.4 | 18.9 | 0.776 |
| | PredRNN | 56.8 | 126.1 | 0.867 | 46.4 | 17.1 | 0.971 | 48.4 | 18.9 | 0.781 |
| | CausalLSTM | 46.5 | 106.8 | 0.898 | 44.8 | 16.9 | 0.977 | 45.8 | 17.2 | 0.851 |
| | MIM | 44.2 | 101.1 | 0.910 | 42.9 | 16.6 | 0.971 | 42.9 | 17.8 | 0.790 |
| | E3D-LSTM | 41.3 | 86.4 | 0.910 | 43.2 | 16.9 | 0.979 | 46.4 | 16.6 | 0.869 |
| Train for 10 day | PhyDNet | 24.4 | 70.3 | 0.947 | 41.9 | **16.2** | **0.982** | 36.9 | 16.2 | 0.901 |
| Train for 2 day | SimVP | **23.8** | **68.9** | **0.948** | **41.4** | **16.2** | **0.982** | **31.6** | **15.1** | **0.904** |

| Method | Caltech Pedestrian (10 → 1) | | |
|---|---|---|---|
| | MSE↓ | SSIM↑ | PSNR↑ |
| BeyondMSE [40] | 3.42 | 0.847 | - |
| MCnet [62] | 2.50 | 0.879 | - |
| DVF [35] | - | 0.897 | 26.2 |
| Dual-GAN [32] | 2.41 | 0.899 | - |
| CtrlGen [19] | - | 0.900 | 26.5 |
| PredNet [37] | 2.42 | 0.905 | 27.6 |
| ContextVP [5] | 1.94 | 0.921 | 28.7 |
| GAN-VGG [54] | - | 0.916 | - |
| G-VGG [54] | - | 0.917 | - |
| SDC-Net [50] | 1.62 | 0.918 | - |
| rCycleGan [29] | 1.61 | 0.919 | 29.2 |
| DPG [16] | - | 0.923 | 28.2 |
| G-MAE [54] | - | 0.923 | - |
| GAN-MAE [54] | - | 0.923 | - |
| CrevNet [73] | - | 0.925 | 29.3 |
| STMFANet [26] | - | 0.927 | 29.1 |
| SimVP (ours) | **1.56** | **0.940** | **33.1** |

| Method | KTH (10 → 20) | | KTH (10 → 40) | |
|---|---|---|---|---|
| | SSIM↑ | PSNR↑ | SSIM↑ | PSNR↑ |
| MCnet [62] | 0.804 | 25.95 | 0.73 | 23.89 |
| ConvLSTM [71] | 0.712 | 23.58 | 0.639 | 22.85 |
| SAVP [30] | 0.746 | 25.38 | 0.701 | 23.97 |
| VPN [28] | 0.746 | 23.76 | – | – |
| DFN [25] | 0.794 | 27.26 | 0.652 | 23.01 |
| fRNN [43] | 0.771 | 26.12 | 0.678 | 23.77 |
| Znet [74] | 0.817 | 27.58 | – | – |
| SV2Pi [3] | 0.826 | 27.56 | 0.778 | 25.92 |
| SV2Pv [3] | 0.838 | 27.79 | 0.789 | 26.12 |
| PredRNN [67] | 0.839 | 27.55 | 0.703 | 24.16 |
| VarNet [27] | 0.843 | 28.48 | 0.739 | 25.37 |
| SVAP-VAE [30] | 0.852 | 27.77 | 0.811 | 26.18 |
| PredRNN++ [65] | 0.865 | 28.47 | 0.741 | 25.21 |
| MSNET [31] | 0.876 | 27.08 | – | – |
| E3d-LSTM [66] | 0.879 | 29.31 | 0.810 | 27.24 |
| STMFANet [26] | 0.893 | 29.85 | 0.851 | 27.56 |
| SimVP (ours) | **0.905** | **33.72** | **0.886** | **32.93** |

- More experiments can be found in our paper.

## Summary

- We propose SimVP, a simpler yet effective CNN model for video prediction.
- SimVP can achieve state-of-the-art results with better computational time efficiency.
- We believe simpler is better, and SimVP may serve as a strong baseline and provide inspiration for future researches.