


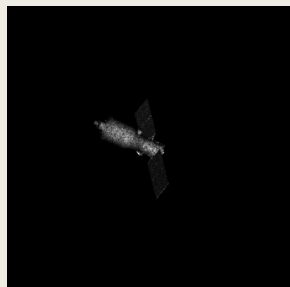


10.14

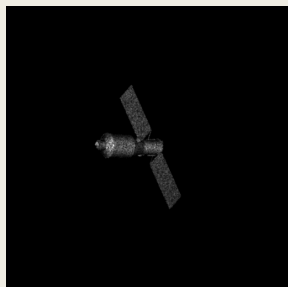
L1w31f3ng



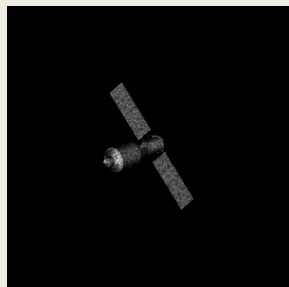
时空预测模型是什么？



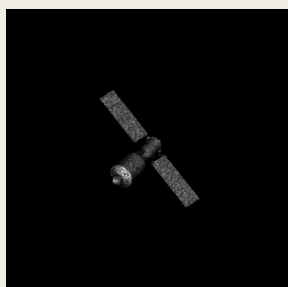
T0



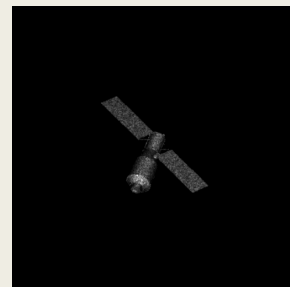
T1



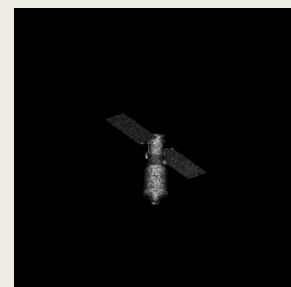
T2



T3



T4



T5

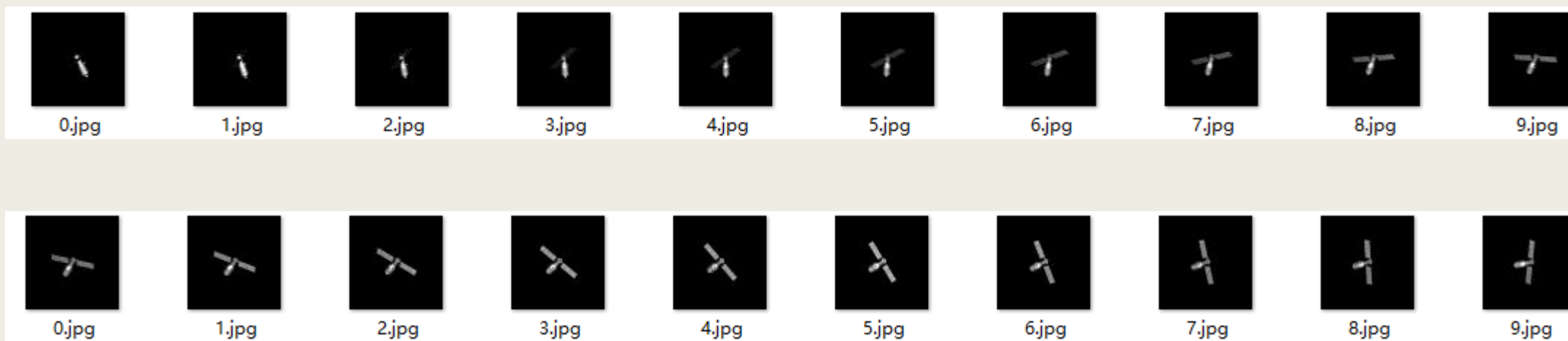


T6

- 一种基于某一序列的时间变化，预测该序列空间变化的模型
- 结构一般为CNN+RNN，VAE，GAN等

目的

- 仅通过部分输入的卫星序列图像，预测未来几帧的卫星序列图像。
- 评价指标：目前是PSNR、SSIM、MSE、AE



ConvLSTM

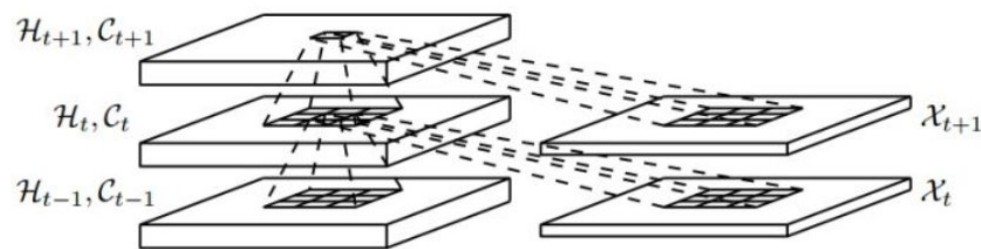
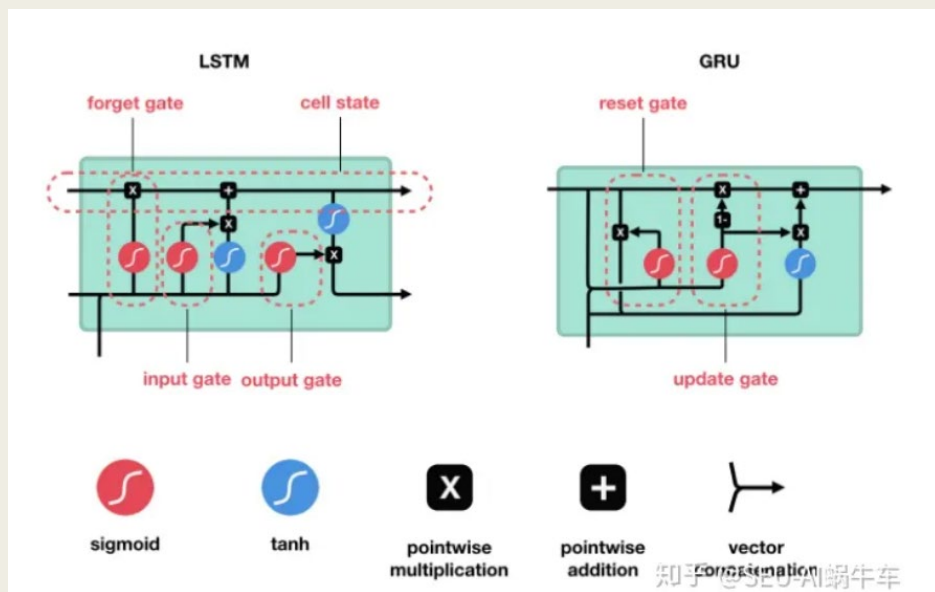


Figure 2: Inner structure of ConvLSTM

$$\begin{aligned} i_t &= \sigma(W_{xi} * \mathcal{X}_t + W_{hi} * \mathcal{H}_{t-1} + W_{ci} \circ \mathcal{C}_{t-1} + b_i) \\ f_t &= \sigma(W_{xf} * \mathcal{X}_t + W_{hf} * \mathcal{H}_{t-1} + W_{cf} \circ \mathcal{C}_{t-1} + b_f) \\ \mathcal{C}_t &= f_t \circ \mathcal{C}_{t-1} + i_t \circ \tanh(W_{xc} * \mathcal{X}_t + W_{hc} * \mathcal{H}_{t-1} + b_c) \\ o_t &= \sigma(W_{xo} * \mathcal{X}_t + W_{ho} * \mathcal{H}_{t-1} + W_{co} \circ \mathcal{C}_t + b_o) \\ \mathcal{H}_t &= o_t \circ \tanh(\mathcal{C}_t) \end{aligned}$$

- 可以简单理解为LSTM原来部分全连接层（点乘运算）变成了卷积层（卷积运算）。

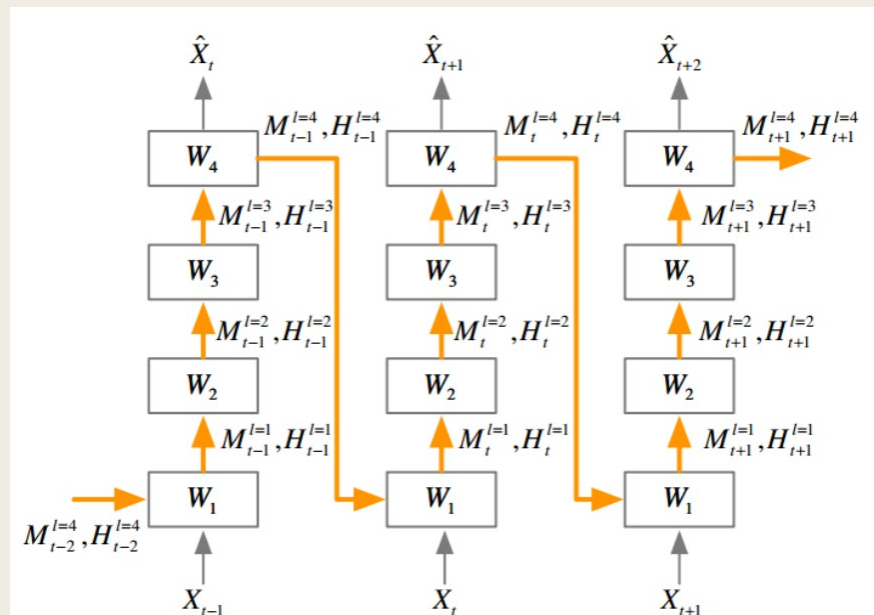
ConvGRU



$$\begin{aligned}Z_t &= \sigma(\mathcal{W}_{xz} * \mathcal{X}_t + \mathcal{W}_{hz} * \mathcal{H}_{t-1}) \\ \mathcal{R}_t &= \sigma(\mathcal{W}_{xr} * \mathcal{X}_t + \mathcal{W}_{hr} * \mathcal{H}_{t-1}) \\ \mathcal{H}'_t &= f(\mathcal{W}_{xh} * \mathcal{X}_t + \mathcal{R}_t \circ (\mathcal{W}_{hh} * \mathcal{H}_{t-1})) \\ \mathcal{H}_t &= (1 - Z_t) \circ \mathcal{H}'_t + Z_t \circ \mathcal{H}_{t-1}\end{aligned}$$

- GRU的结构和LSTM类似。ConvGRU也是把全连接层（点乘运算）变为卷积层（卷积运算）

PredRNN



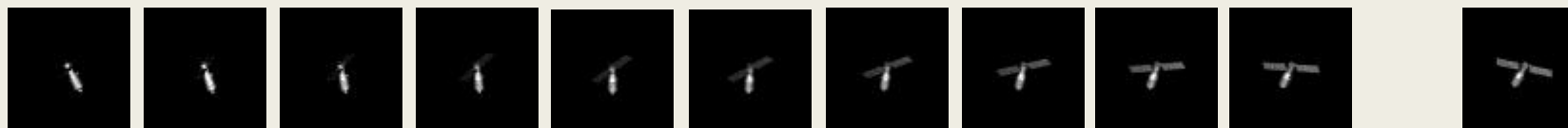
$$\begin{aligned}
 g_t &= \tanh(\mathcal{W}_{xg} * \mathcal{X}_t \mathbb{1}_{\{l=1\}} + \mathcal{W}_{hg} * \mathcal{H}_t^{l-1} + b_g) \\
 i_t &= \sigma(\mathcal{W}_{xi} * \mathcal{X}_t \mathbb{1}_{\{l=1\}} + \mathcal{W}_{hi} * \mathcal{H}_t^{l-1} + \mathcal{W}_{mi} \odot \mathcal{M}_t^{l-1} + b_i) \\
 f_t &= \sigma(\mathcal{W}_{xf} * \mathcal{X}_t \mathbb{1}_{\{l=1\}} + \mathcal{W}_{hf} * \mathcal{H}_t^{l-1} + \mathcal{W}_{mf} \odot \mathcal{M}_t^{l-1} + b_f) \\
 \mathcal{M}_t^l &= f_t \odot \mathcal{M}_t^{l-1} + i_t \odot g_t \\
 o_t &= \sigma(\mathcal{W}_{xo} * \mathcal{X}_t \mathbb{1}_{\{l=1\}} + \mathcal{W}_{ho} * \mathcal{H}_t^{l-1} + \mathcal{W}_{mo} \odot \mathcal{M}_t^l + b_o) \\
 \mathcal{H}_t^l &= o_t \odot \tanh(\mathcal{M}_t^l).
 \end{aligned}$$

<https://chehongshu.blog.csdn.net>

- 复杂化了ConvLSTM的结构，一个PredRNN模块由4个ConvLSTM神经元构成，输入的隐藏状态来自上一个模块的3号神经元的输出

TS-DM

■ for(int i=10;i<20;i++){ //i=10



进行正向扩散(forward diffuse) 获得 $q(X_i)$

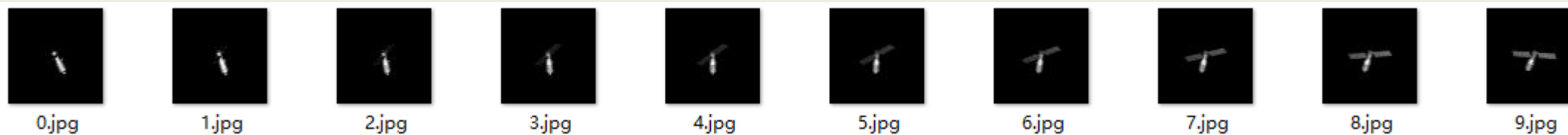
然后依靠 $q(X_i)$ 进行逆向采样,依次获得 $x_i, x_{i-1}, x_{i-2} \dots x_0$ 。

}

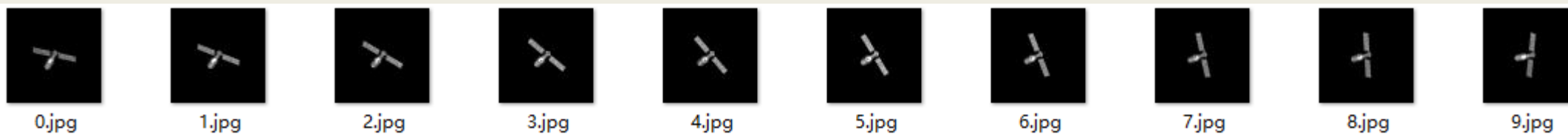
计算损失函数, 定义与普通的扩散模型相同

$$L(\theta) = \mathbb{E}_{\mathbf{x}_0, n, \epsilon} \|\epsilon - f_{\theta}(\mathbf{x}_n, n)\|^2, \quad \text{where } \mathbf{x}_n = \sqrt{\bar{\alpha}_n} \mathbf{x}_0 + \sqrt{1 - \bar{\alpha}_n} \epsilon. \quad (3)$$

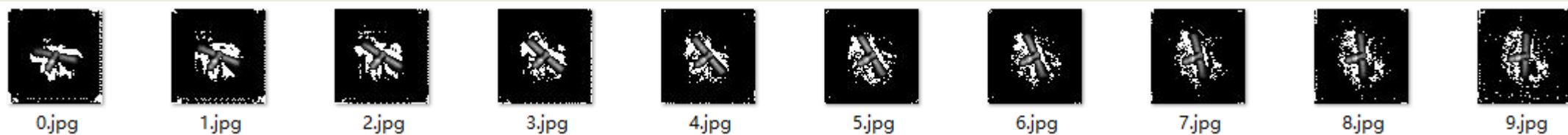
Input



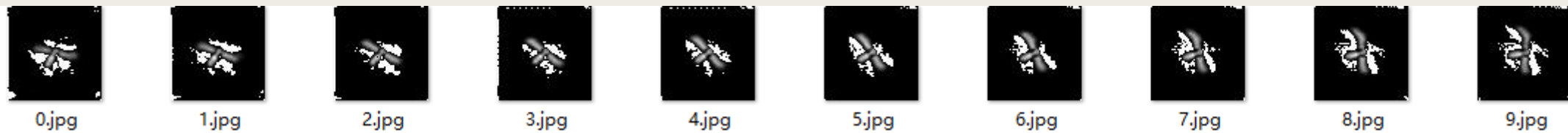
GT



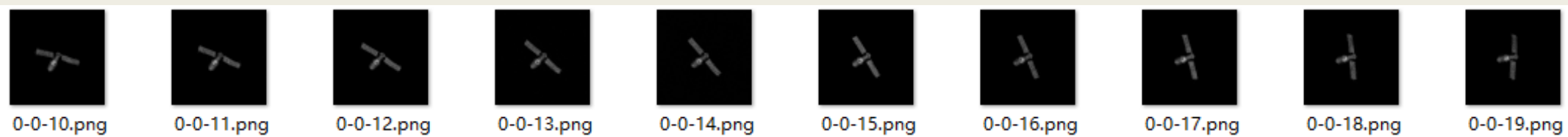
CGRU



CLSTM

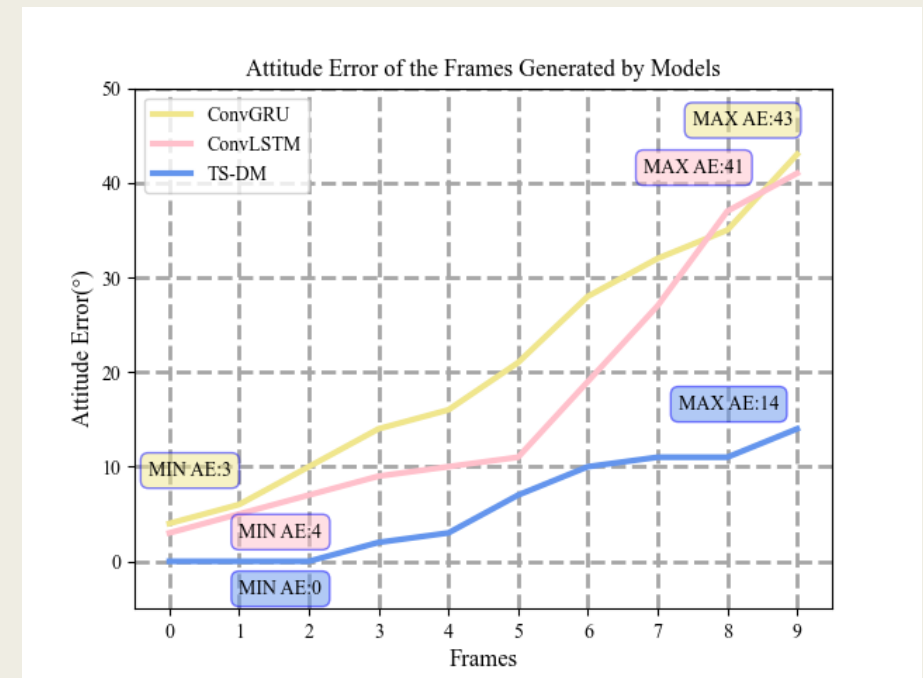
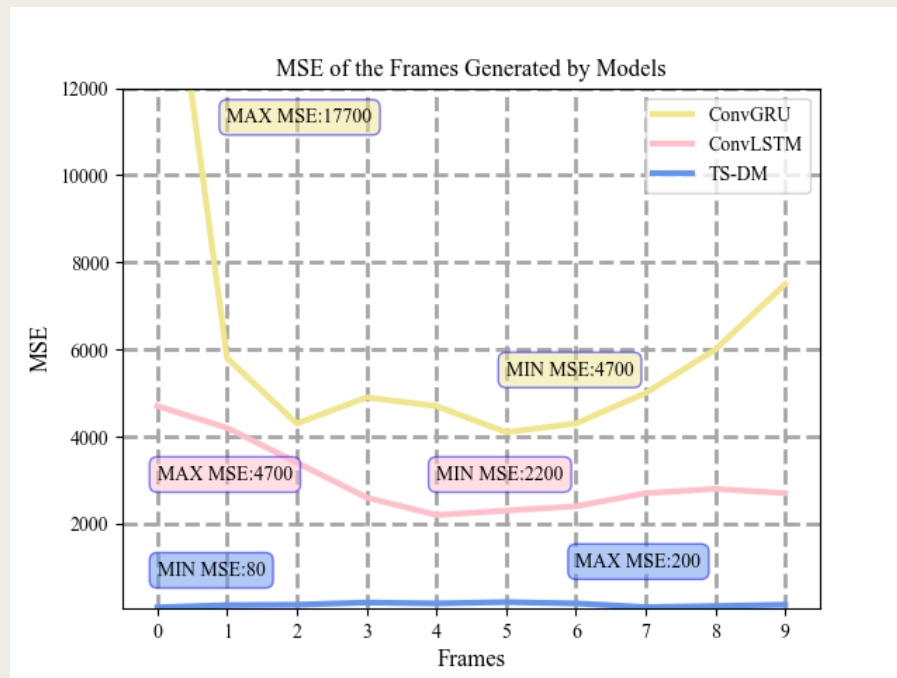
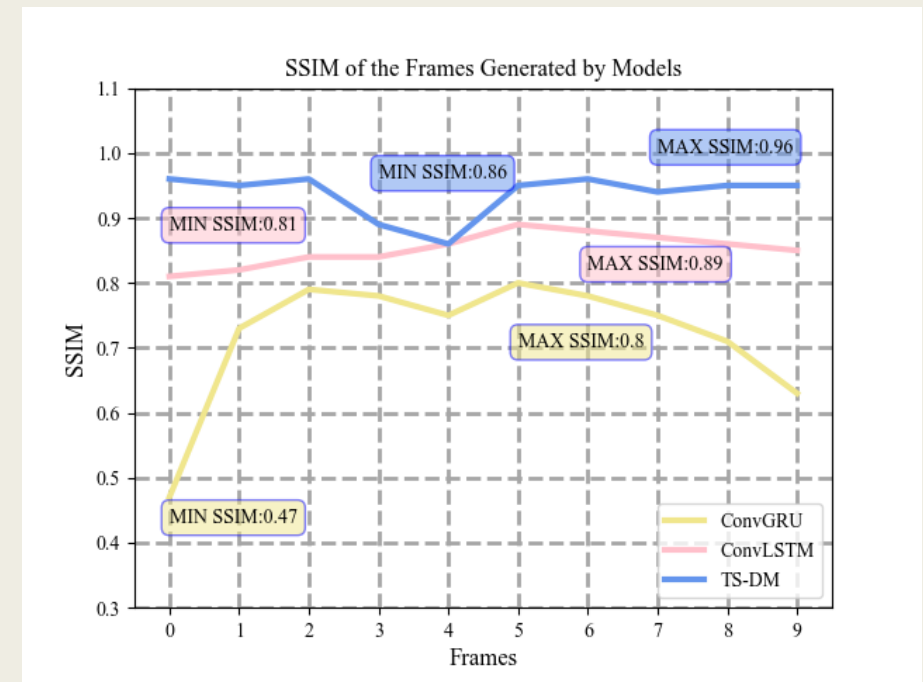
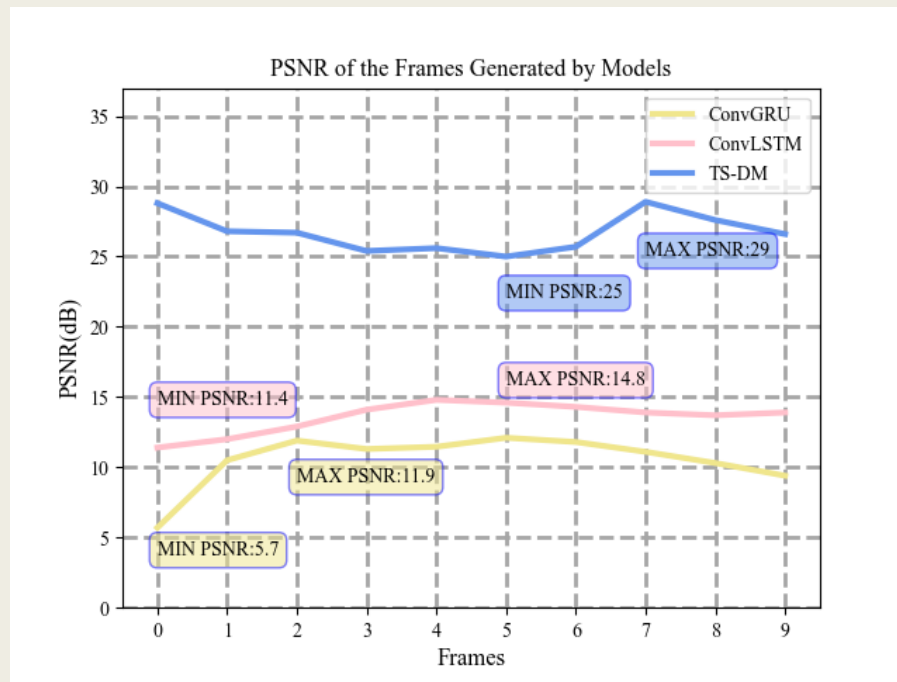


TS-DM





CGRU	0	1	2	3	4	5	6	7	8	9	越大越好 越接近1越好 越小越好 越小越好
psnr	5.7	10.5	11.9	11.3	11.46	12.1	11.8	11.1	10.3	9.4	
ssim	0.47	0.73	0.79	0.78	0.75	0.80	0.78	0.75	0.71	0.63	
mse	17.7k	5.8k	4.3k	4.9k	4.7k	4.1k	4.3k	5.0k	6.0k	7.5k	
AE	(1,1,2)	(1,2,3)	(2,4,4)	(3,6,5)	(4,7,5)	(5,9,7)	(7,12,9)	(9,13,10)	(11,15,9)	(14,18,13)	
CLSTM	0	1	2	3	4	5	6	7	8	9	
psnr	11.4	12.0	12.9	14.1	14.8	14.6	14.3	13.9	13.7	13.9	
ssim	0.81	0.82	0,84	0.84	0.86	0.89	0.88	0.87	0.86	0.85	
mse	4.7k	4.2k	3.4k	2.6k	2.2k	2.3k	2.4k	2.7k	2.8k	2.7k	
AE	(1,1,1)	(1,2,2)	(2,3,2)	(2,4,3)	(2,4,4)	(1,5,6)	(4,7,8)	(8,9,10)	(10,14,13)	(11,15,15)	
PRNN-V2	0	1	2	3	4	5	6	7	8	9	
psnr	18.4	25.2	18.0	24.0	17.2	23.9	17.5	24.1	17.2	21.7	
ssim	0.89	0.89	0.87	0.88	0.86	0.88	0.86	0.88	0.85	0.88	
mse	1.9k	0.4k	2.1k	0.53k	2.5k	0.58k	2.38k	0.57k	2.86k	0.99k	
TS-DM	0	1	2	3	4	5	6	7	8	9	
psnr	28.8	26.8	26.7	25.4	25.6	25.0	25.7	28.9	27.6	26.6	
ssim	0.96	0.95	0,96	0.89	0.86	0.95	0.96	0.94	0.95	0.95	
mse	0.08k	0.13k	0.14k	0.19k	0.17k	0.20k	0.17k	0.08k	0.11k	0.14k	
AE	(0,0,0)	(0,0,0)	(0,0,0)	(1,1,0)	(1,1,1)	(2,3,2)	(3,4,3)	(3,4,3)	(4,4,3)	(4,6,4)	





FIN

L1w31f3ng