**PROBLEM STATEMENT**

Develop general framework for one-to-many conditional image synthesis problems which produces *diverse* and *realistic* outputs.

**Our contributions**

1) Detailed comparison of generative methods in conditional setting across a variety of datasets
2) Propose BicycleGAN, which encourages bijection between latent and output in multiple ways
3) Assess tradeoffs in latent space size and architectures

**EXAMPLE QUALITATIVE RESULTS**

**METHODS**

- **cLR-GAN** ($z \rightarrow \tilde{B} \rightarrow \tilde{z}$)
- **cVAE-GAN** ($B \rightarrow z \rightarrow \tilde{B}$)

BicycleGAN (our full method)

Other variants:
- **cAE-GAN** (cVAE-GAN without KL divergence on latent space)
- **cVAE-GAN++** (cVAE-GAN + check randomly drawn $z$ for realism)

**REALISM VS DIVERSITY**

**Assessment Metrics**

- **Realism**: Real vs. Fake at Amazon Mechanical Turk
- **Diversity**: average feature distance between randomly drawn samples

**Conclusions**

- pix2pix+noise baseline produces realistic results but little variation
- with no regularity in the latent space, cAE-GAN does not produce realistic samples

- checking randomly drawn samples helps (cVAE-GAN++ vs cVAE-GAN)
- combining cLR and cVAE-GAN into BicycleGAN helps realism and diversity

**LATENT EXPLORATION**

- Walking through the latent space
- Applying the same $z$ across instances

**QUALITATIVE COMPARISON**

**LATENT SPACE SIZE**

larger $|z|$ more expressive but difficult to densely fill

$|z| = 2$  $|z| = 8$  $|z| = 256$

**ENCODER ARCH, METHOD FOR INJECTING Z**

Architecture

ResNet (E_ResNet) vs VGG-style Encoder (E_CNN)

**Injecting z**

input layer only vs every layer in the 1st half

<table>
<thead>
<tr>
<th>Encoder</th>
<th>E_ResNet</th>
<th>E_CNN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injecting $z$</td>
<td>add_to_all</td>
<td>add_to_all</td>
</tr>
<tr>
<td>label→photo</td>
<td>0.256 ± 0.064</td>
<td>0.256 ± 0.064</td>
</tr>
<tr>
<td>map→satellite</td>
<td>0.256 ± 0.064</td>
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</tr>
</tbody>
</table>

Assess L1 reconstruction error