# LANDSCAPE GENERATION IN PROLOGUE WITH PYSHEDS AND ML

PLAYERUNKNOWN Productions

Joey Faulkner

# PROLOGUE:
# GO WAYBACK!

Image credit: playtesters GLORIOUSPURPOSE & Nerdvous

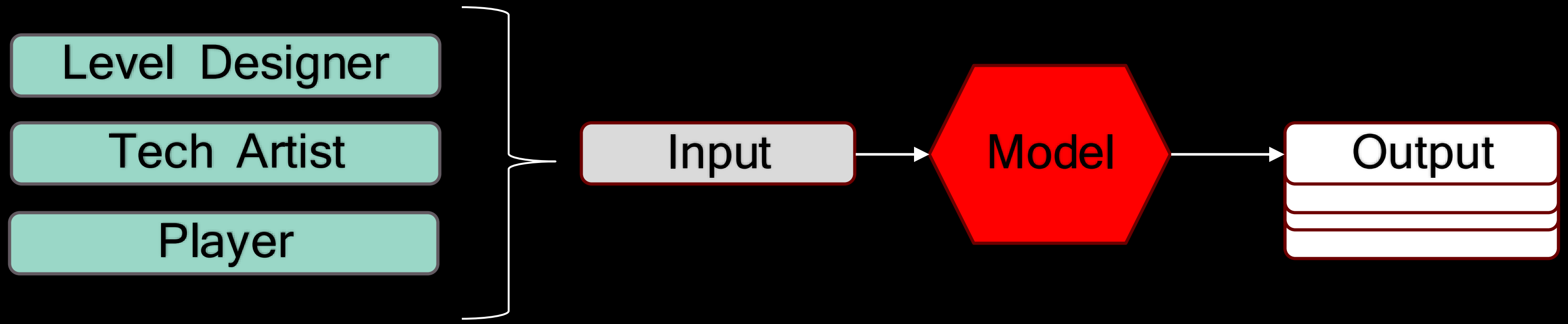

- Go Wayback! Is our survival game, releasing in summer 2025
- Realistic depiction of landscape inspired by Saxon Switzerland (real world data, augmented by our tech art team)
- Punishing, deadly environment
- Each run has a fresh 64km$^2$ chunk of land
- Land must be generated on a players' GPU in seconds


# GENERATIVE MACHINE LEARNING: 10,000 BOWLS OF SLOP

- **ML models are capable**
- **However:**
  - They are not creative
  - They don’t want to explore
  - They are black boxes without levers

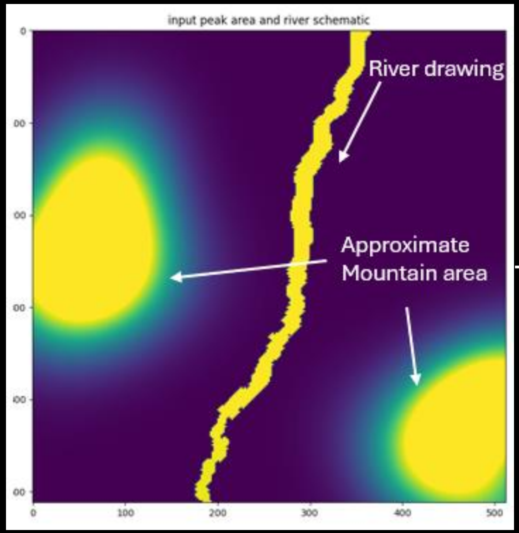
# GUIDED GENERATION

- **The guided generation principle:**
  - People are creative
  - ML is scalable
- **Design ML models to work with creative people**
- **Each interesting idea leads to many interesting outputs**

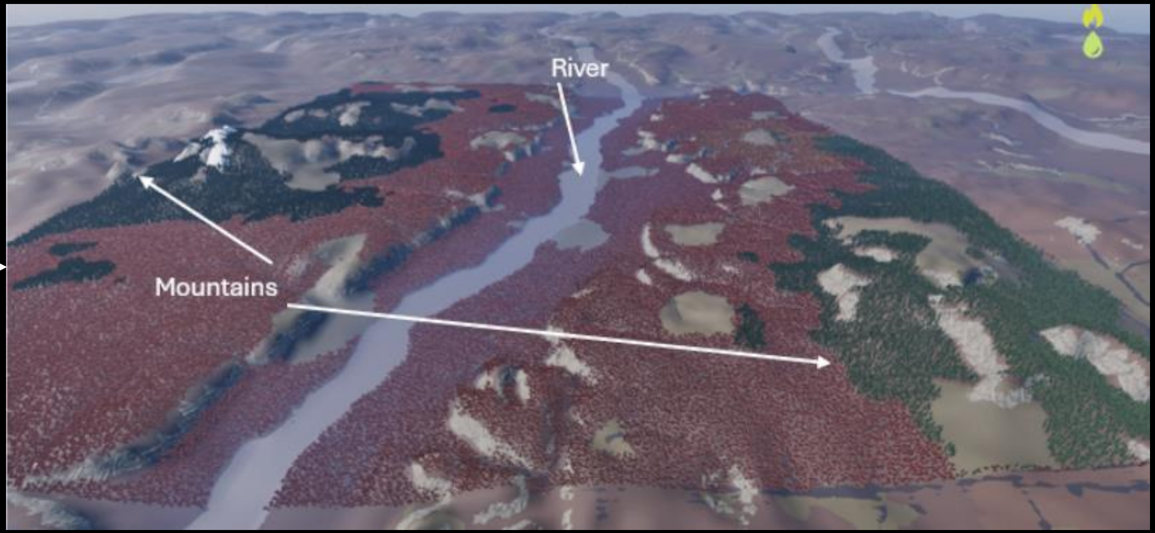


# PROLOGUE:
# GUIDED GENERATION

- Elevation and water are important gameplay features
- Artists draws a river and mountain area sketch
- ML generates heightmaps from these sketches
- ML provides 4m per pixel heightmap




Model



# PYSHEDS: FINDING RIVERS IN HEIGHTMAPS

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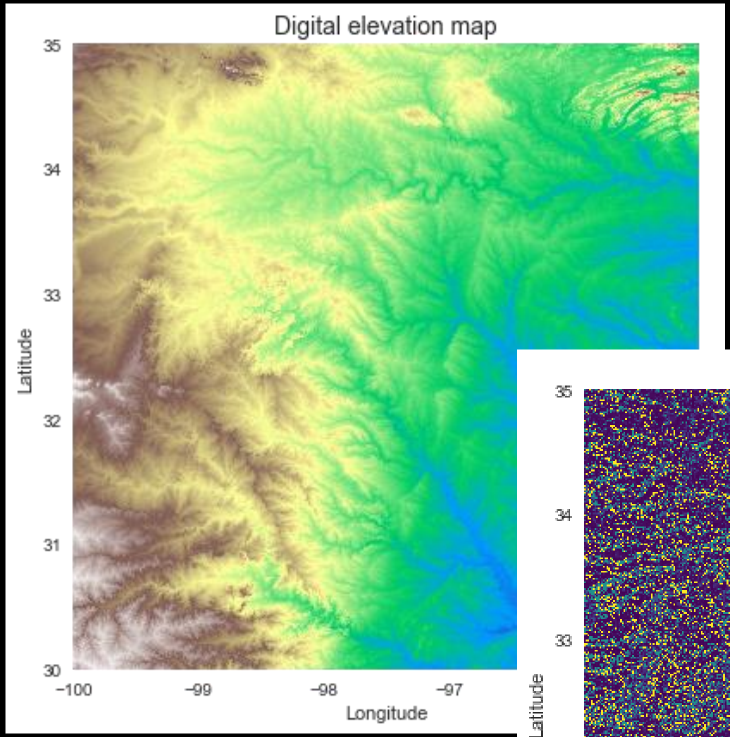
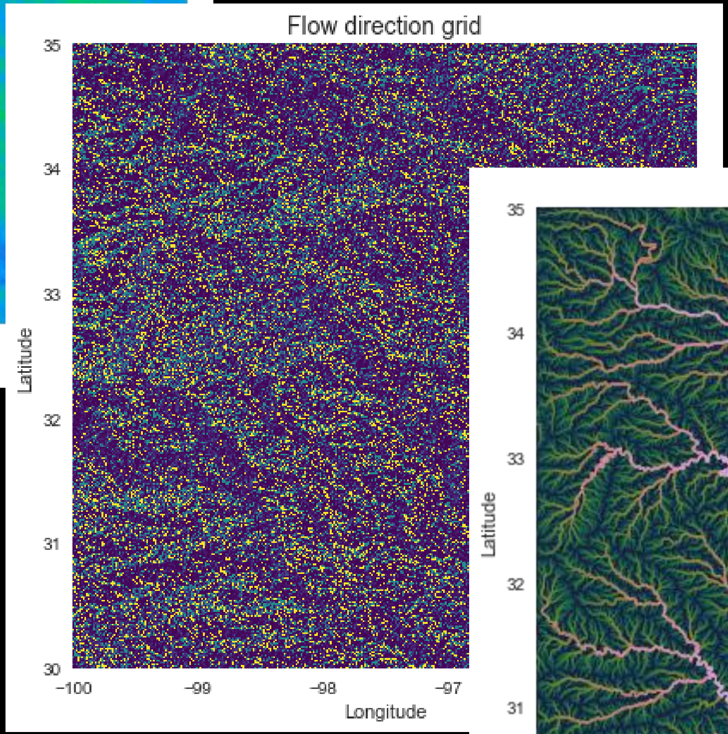
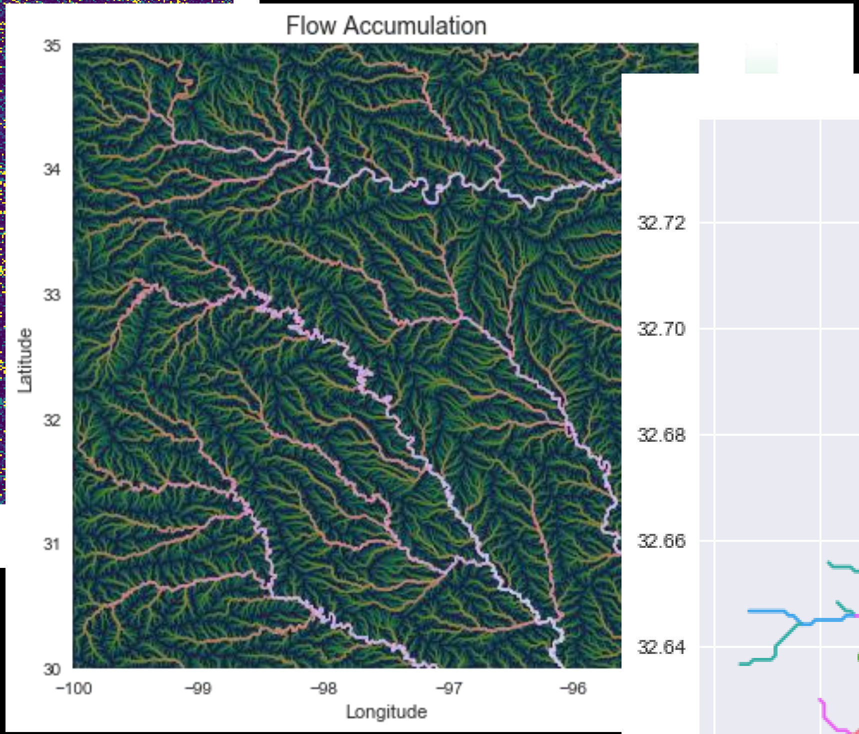
Image credit: Pysheds documentation

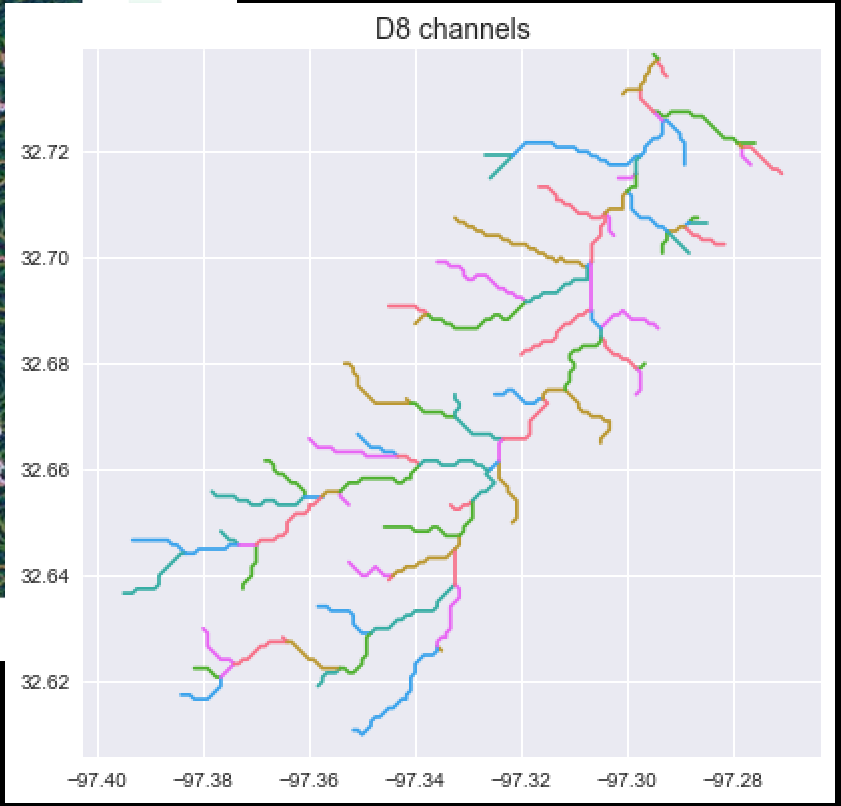
# PYSHEDS

```
grid = Grid.from_raster('elevation.tiff’)
fdir = grid.flowdir(dem)
acc = grid.accumulation(fdir)
branches = grid.extract_river_network(acc)
```



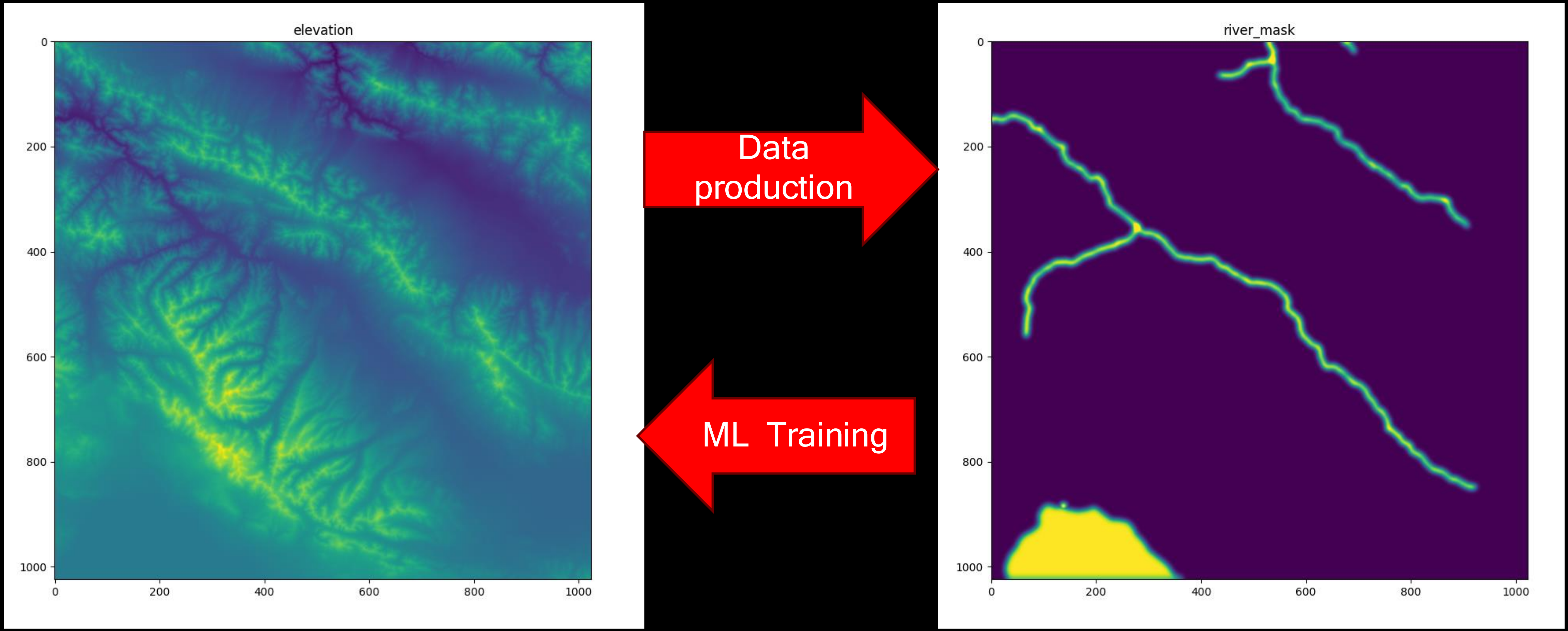



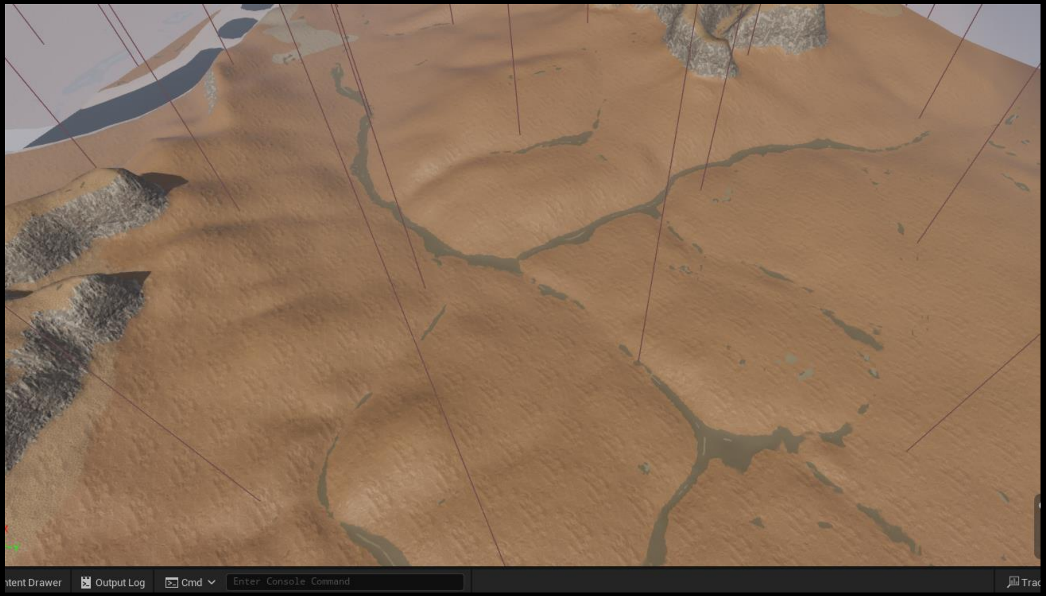

Relevant modules: pysheds.grid

# PYSHEDS




Relevant modules: internal (but lots of numpy, pysheds and a bit of skimage)


UE5-CL-14598
MLSeed : 163,320,704
N
MAP


Output Log
Cmd
Enter Console Command

# TORCH/DIFFUSERS: MAKING A LATENT SPACE OF LANDSCAPES

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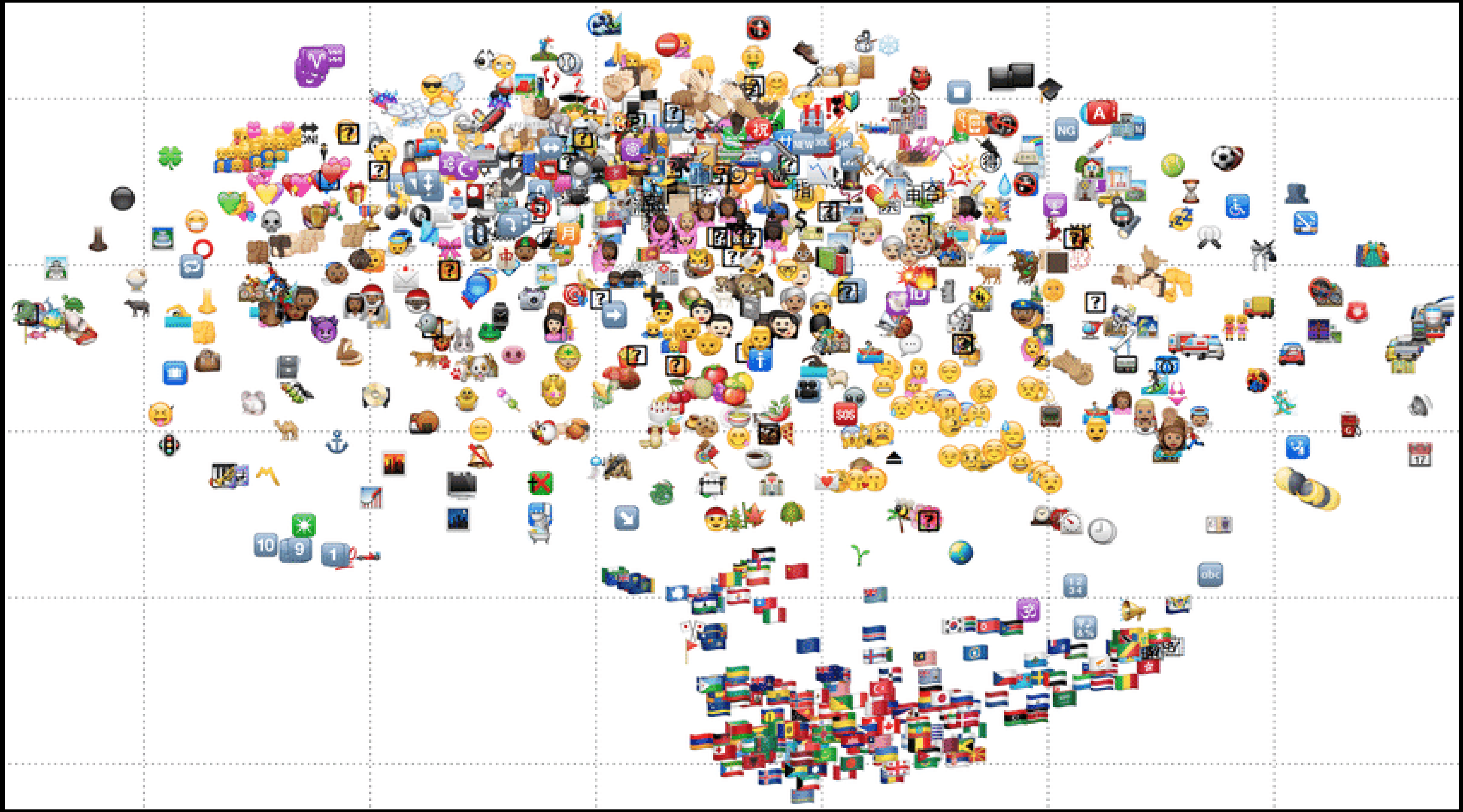
# LATENT SPACE

- **Latent space:**
  - ML trained
  - Compressed
  - Semantic “instructions”

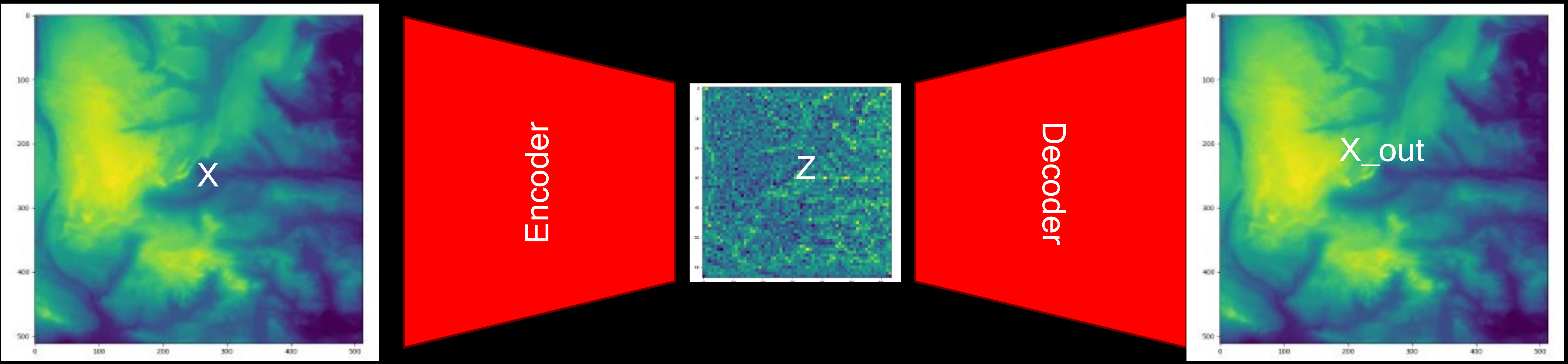


Relevant modules: spacy.Tok2Vec

# LANDSCAPE LATENT SPACE

```
#training
vae = AutoencoderKL()
Z = vae.encode(X)
X_out = vae.decode(Z)
Optimize(loss(X_out, X))
```

- **Variational Autoencoder**
- **512*512 -> 4*64*64 = 16x compressed**
- **Y,Z dims: ~spatial, X dim: ~instruction**

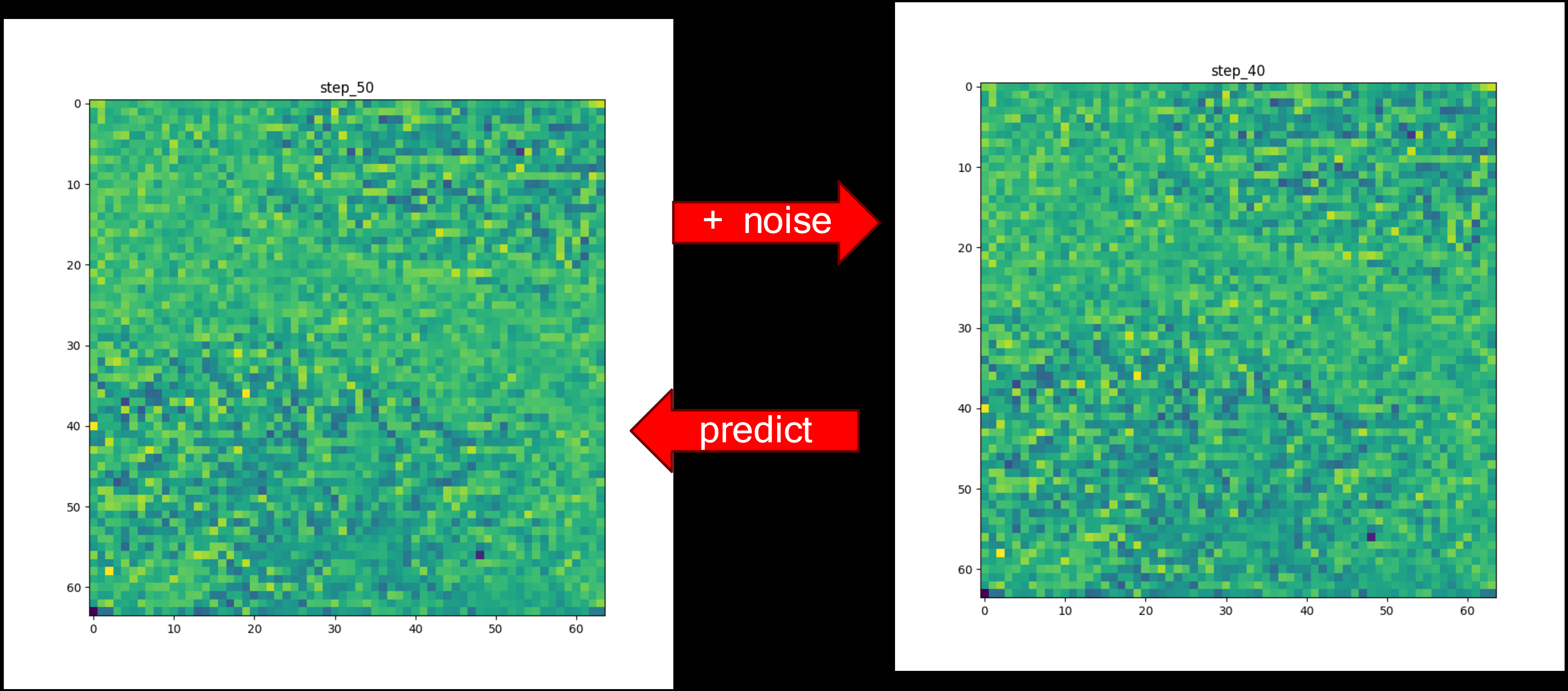



Relevant modules: diffusers.AutoencoderKL, torch

Relevant modules: diffusers.DDPM

```
# data production
X_i+1 = X_i + noise_i+1 * np.random.randn(X_i.shape)
# model training/inference
X_i = model(X_i+1, step=i+1)
```

# LATENT DIFFUSION



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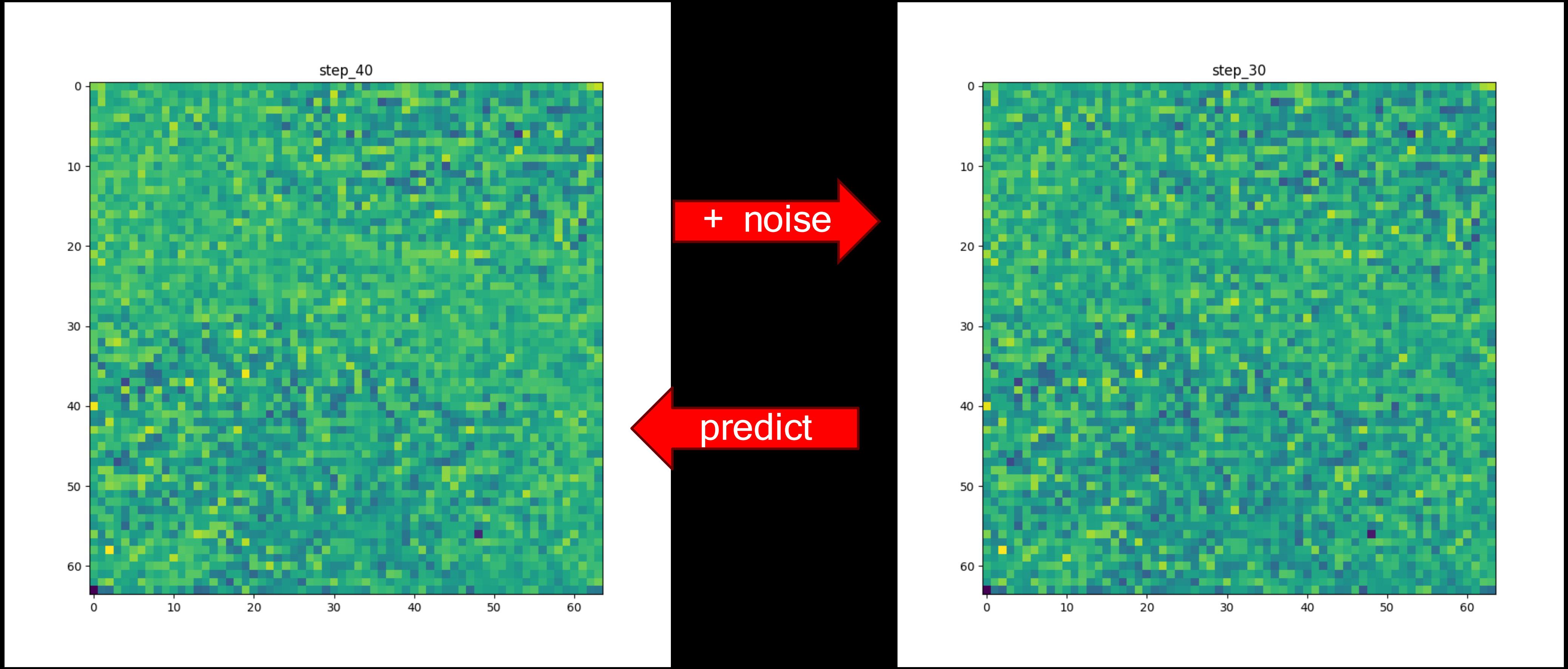

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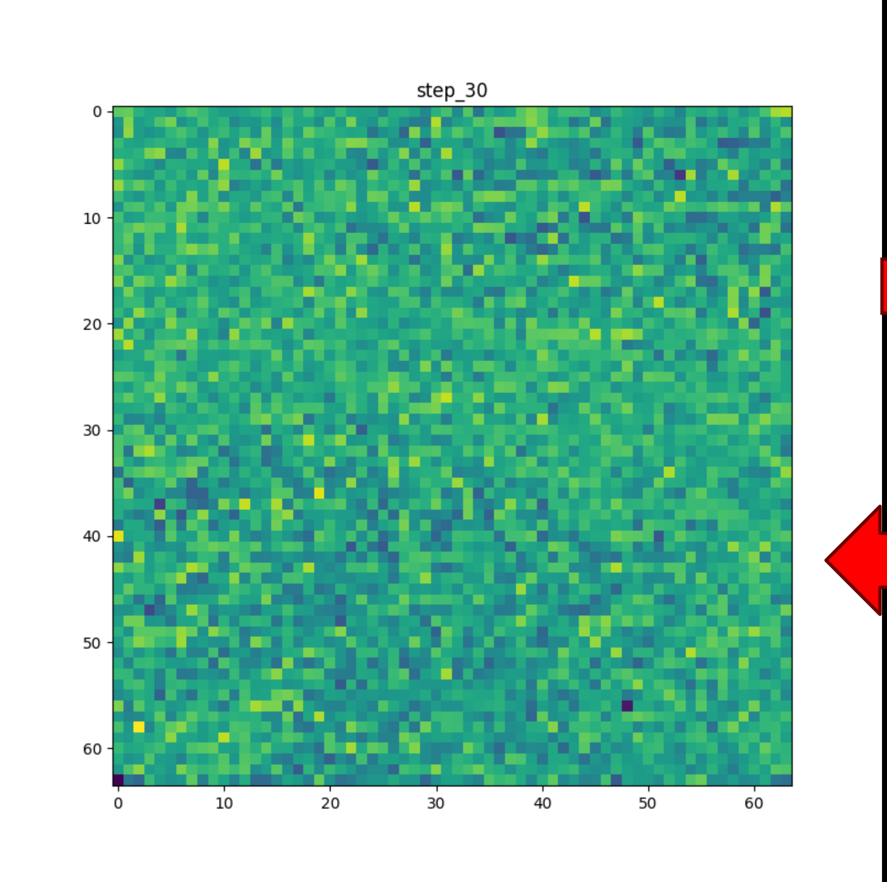
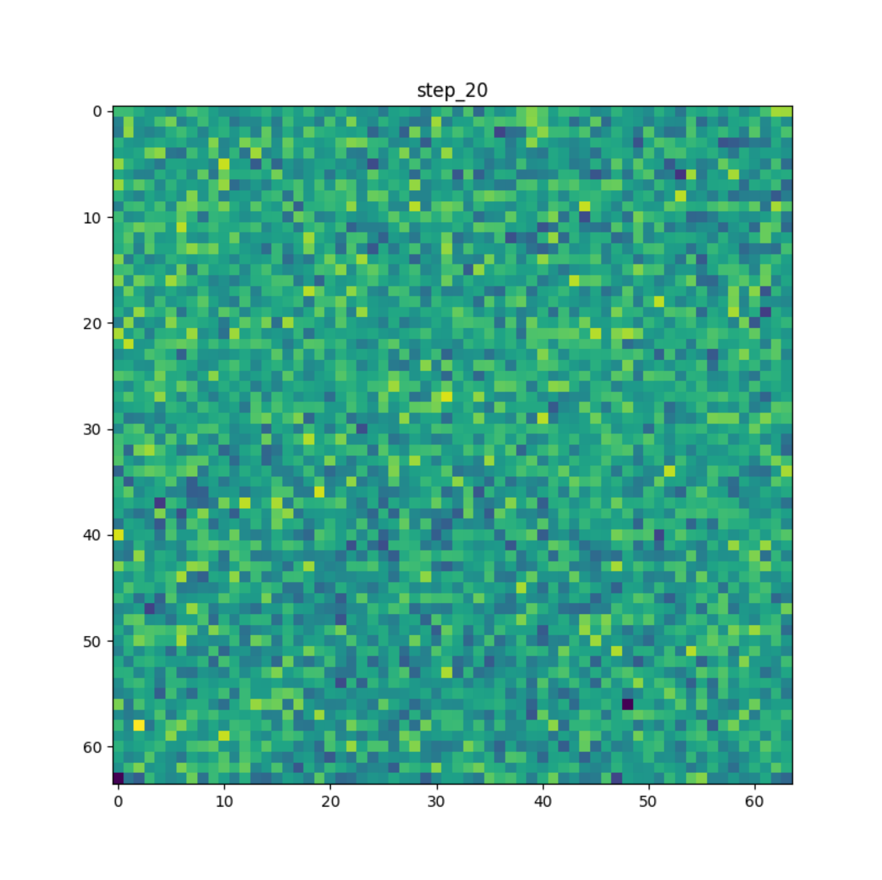



+ noise

predict



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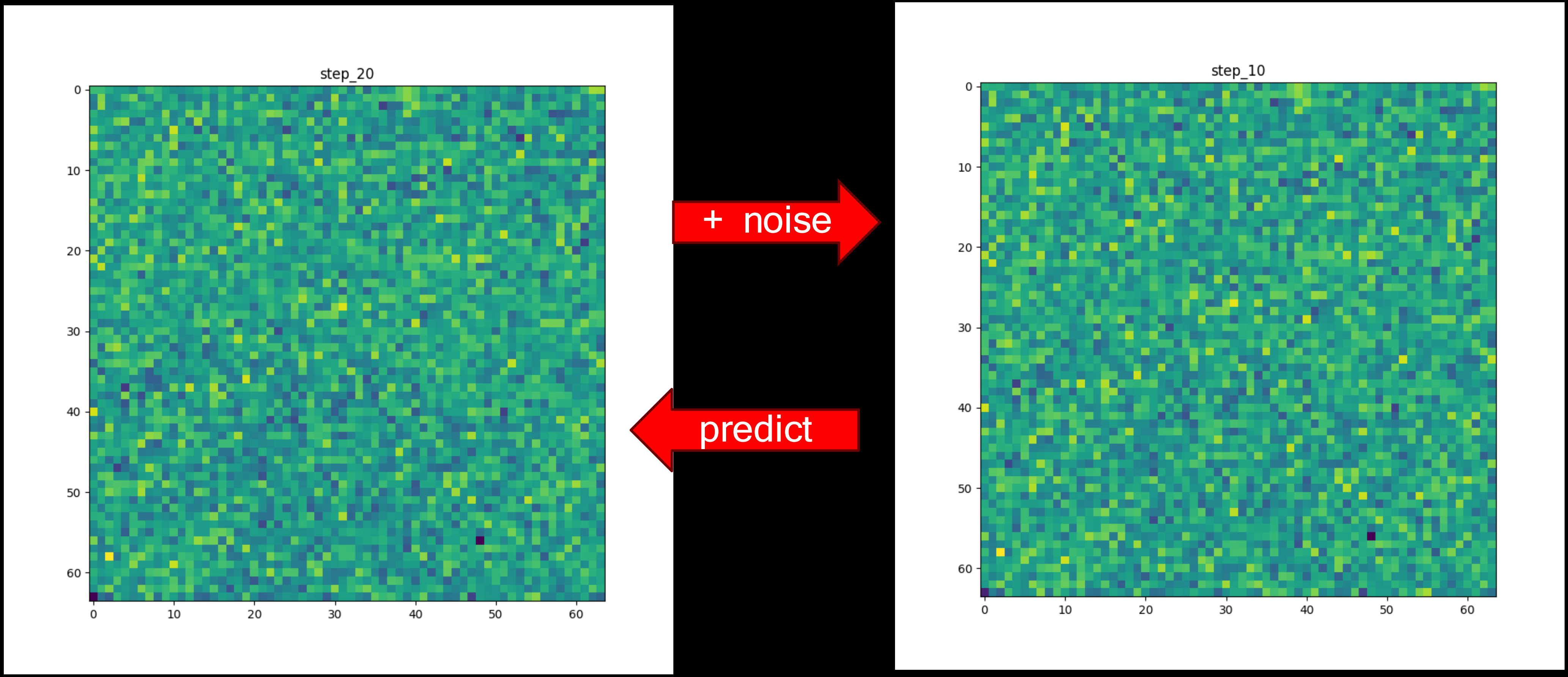

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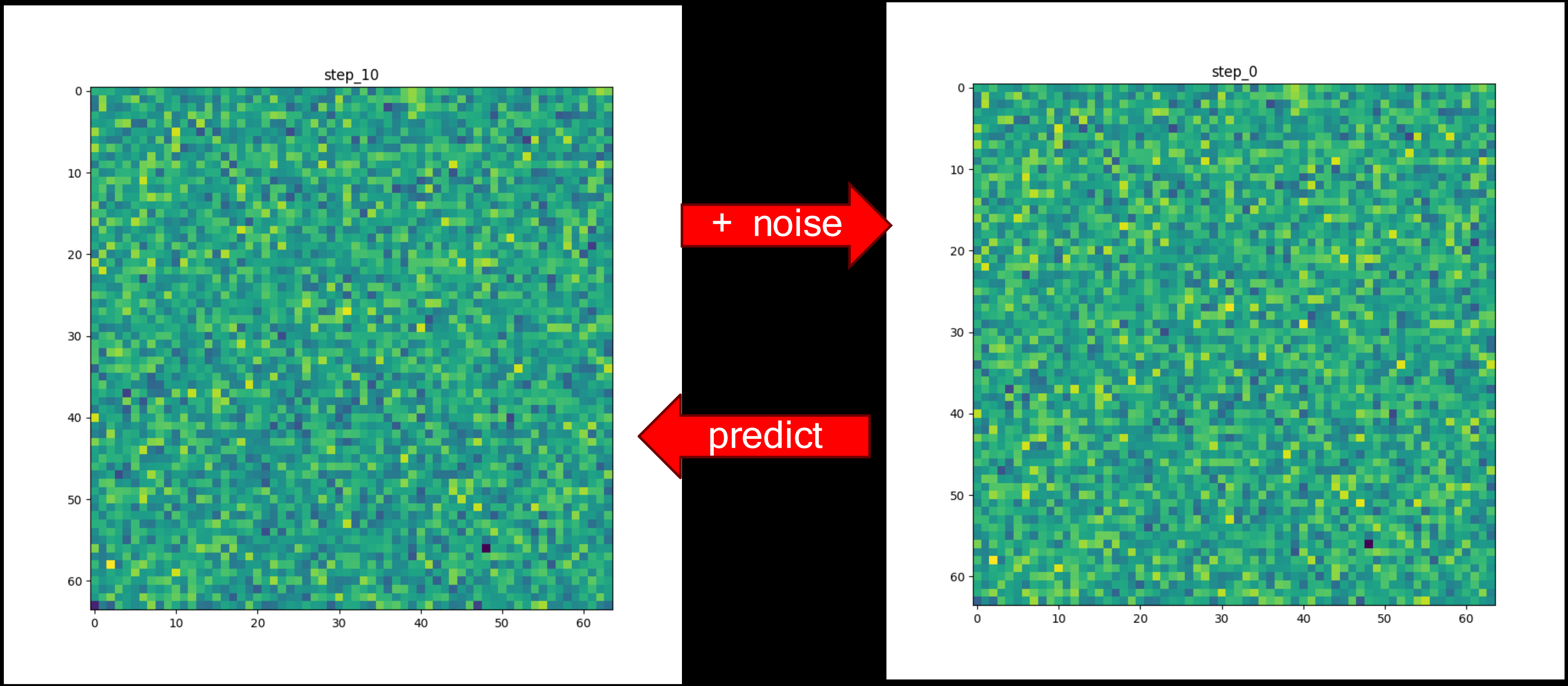

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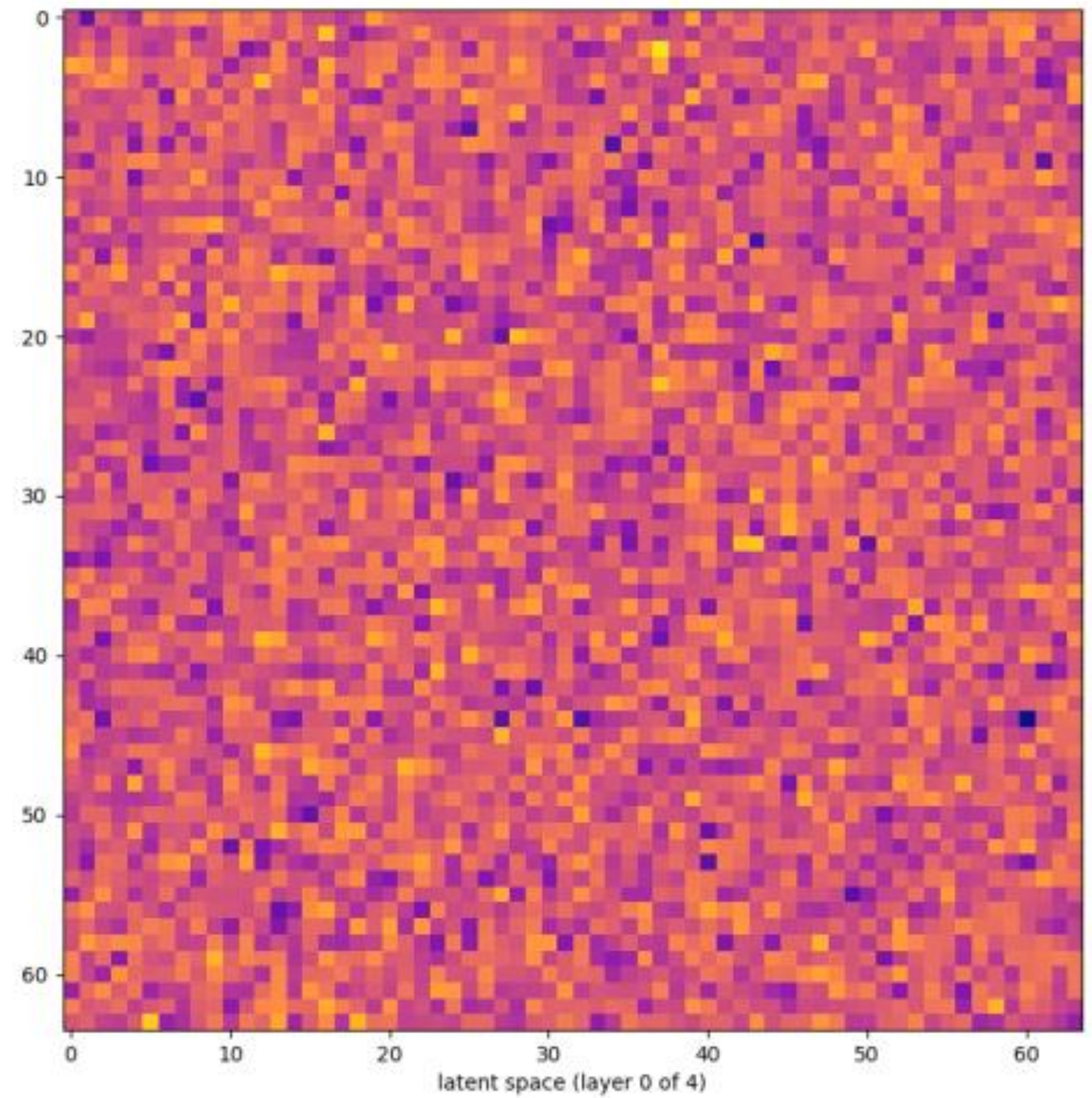
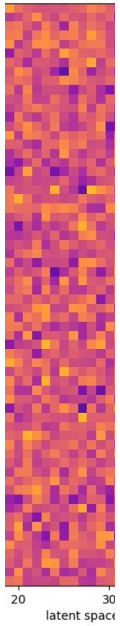
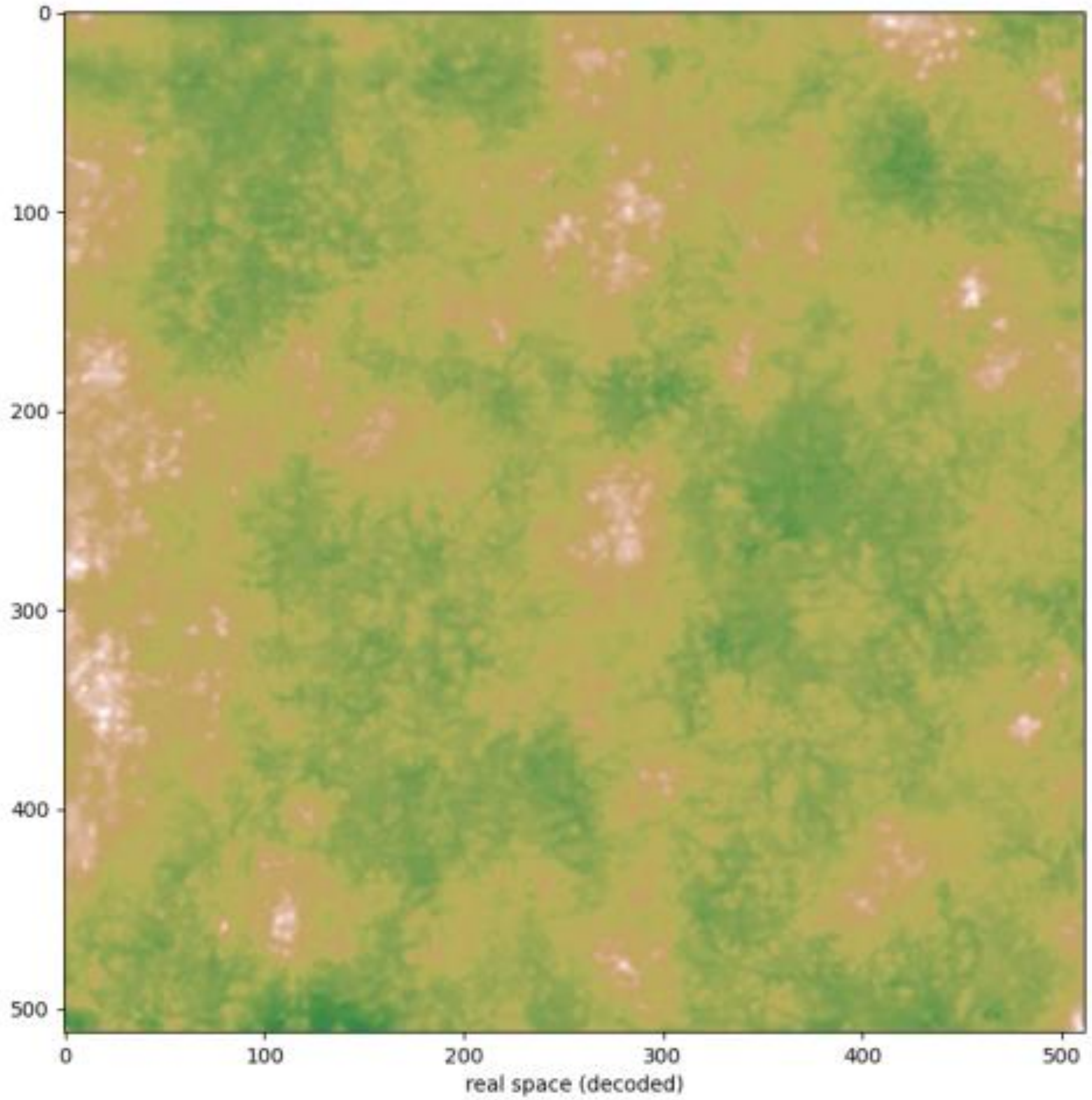



DENOISING S

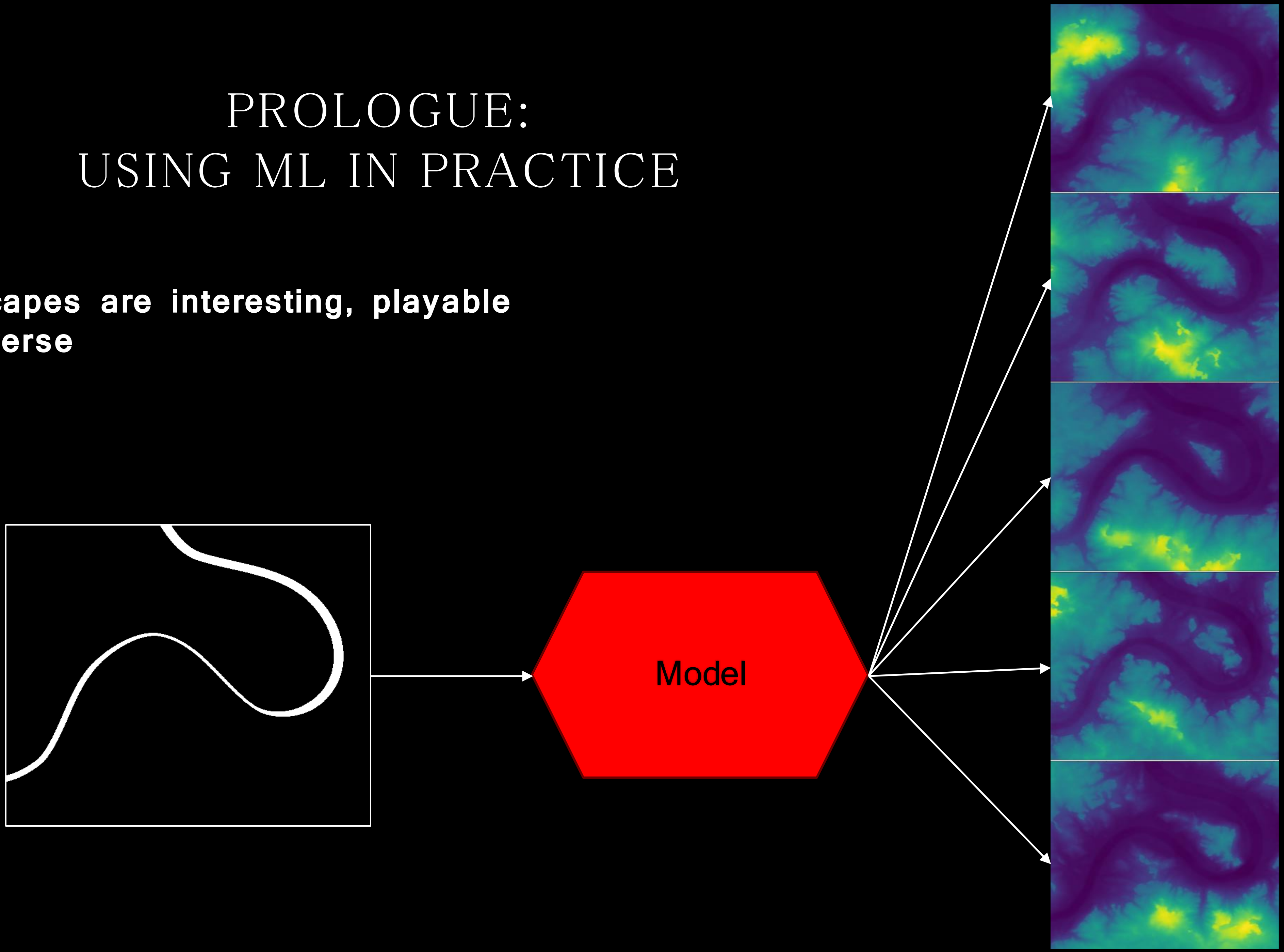
Z

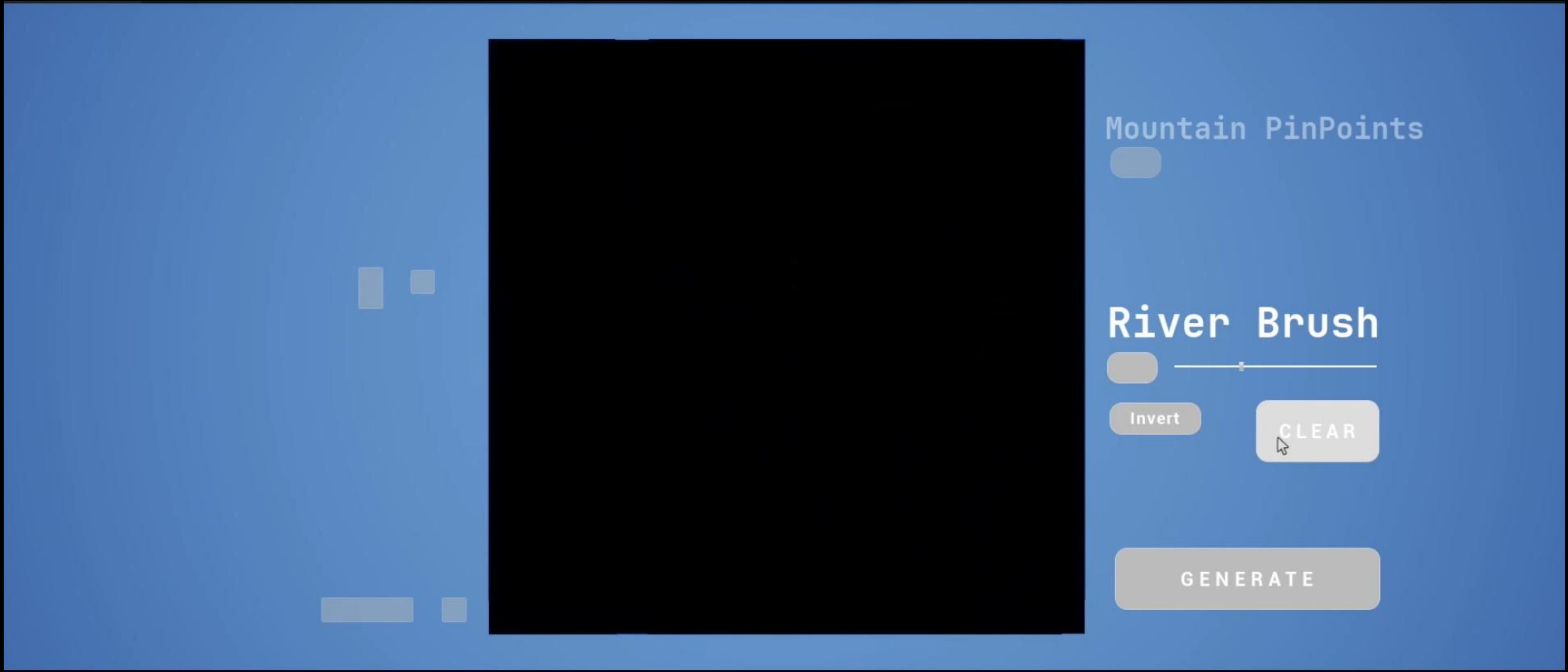


# PROLOGUE:
# USING ML IN PRACTICE

- Landscapes are interesting, playable but diverse

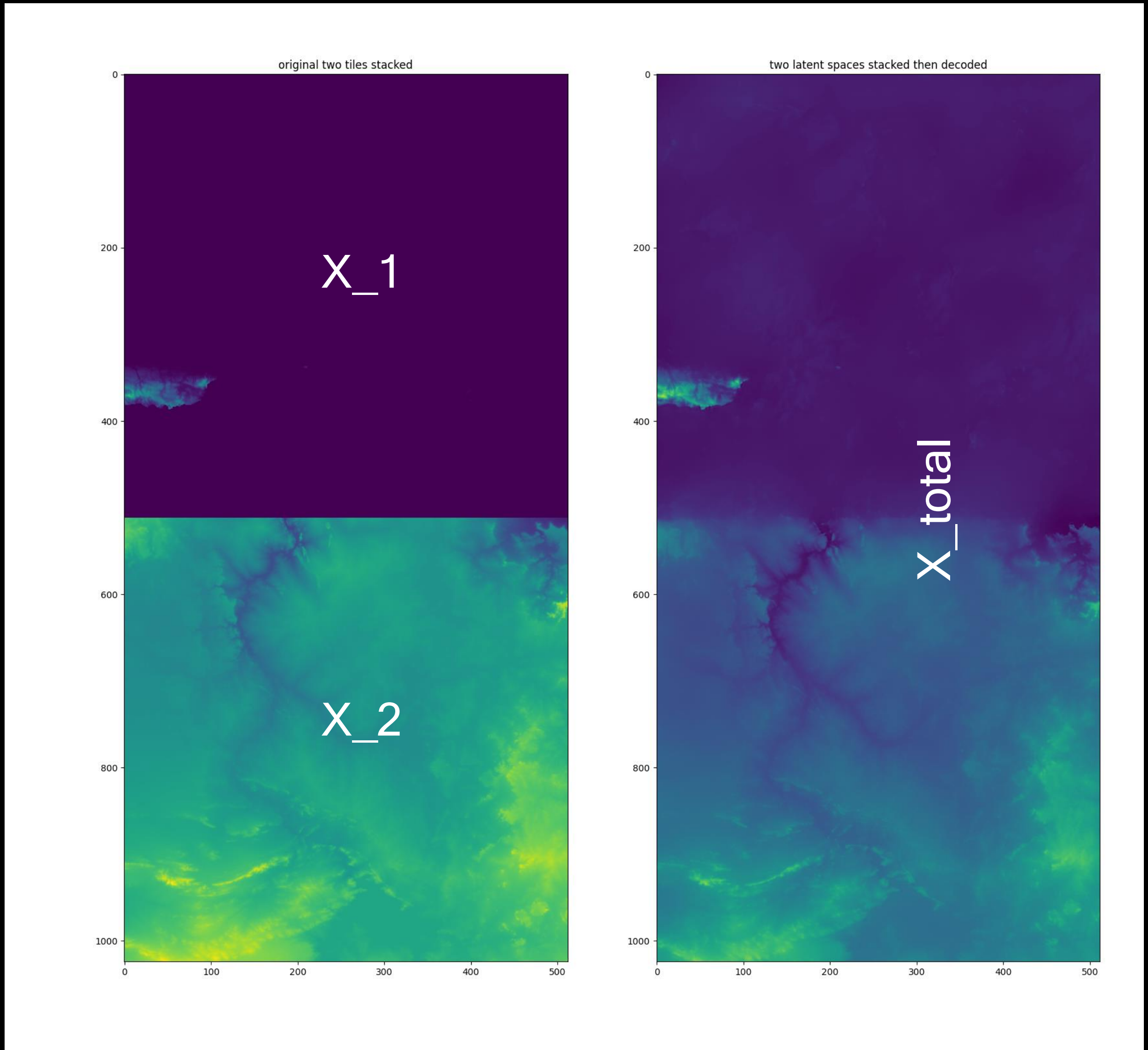



Mountain PinPoints
River Brush
Invert
CLEAR
GENERATE

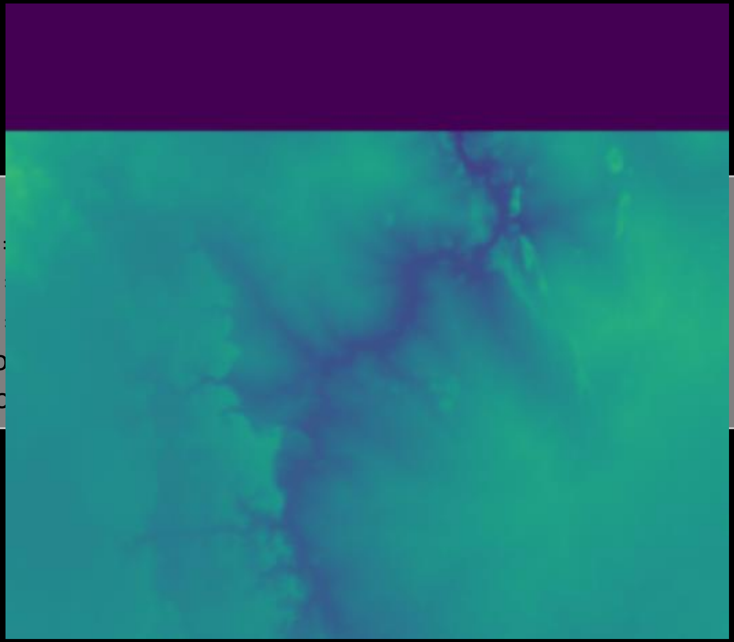

35.599
UE5-CL-18065
MLSeed : 314,159
GO HERE
36.426
YOU'RE HERE
Metres
Feet
Grasslands
Water
MLSeed : 1,371,199,075
36.216

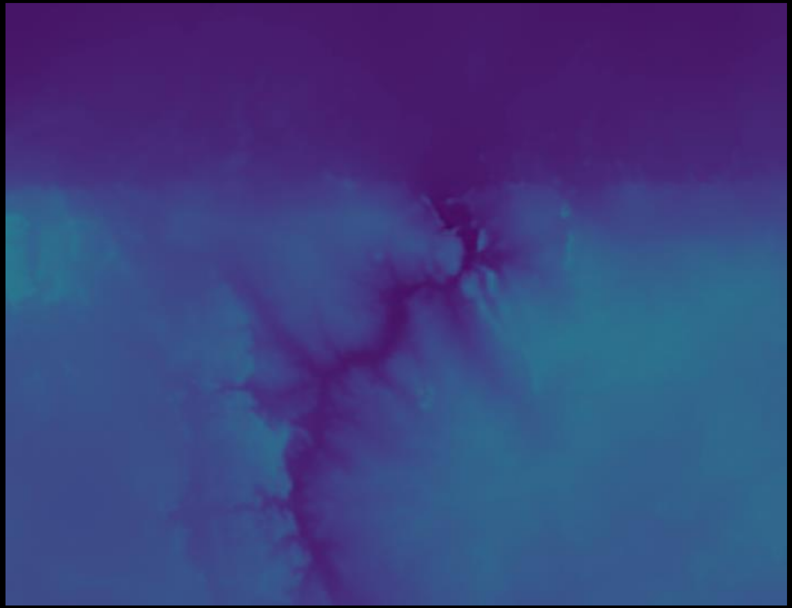
# NEXT STEPS: LATENT SPACE EXPLORATION

# NAÏVE STACKING OF LATENTS




vae
Z_1
Z_2
Z_to
X_to

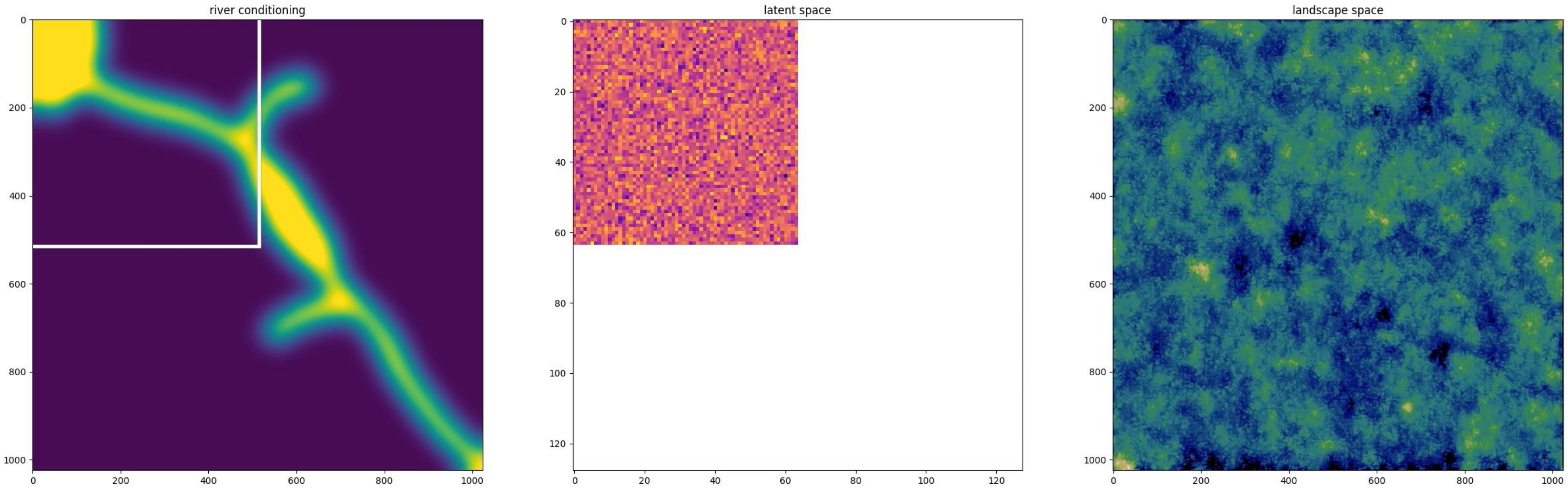


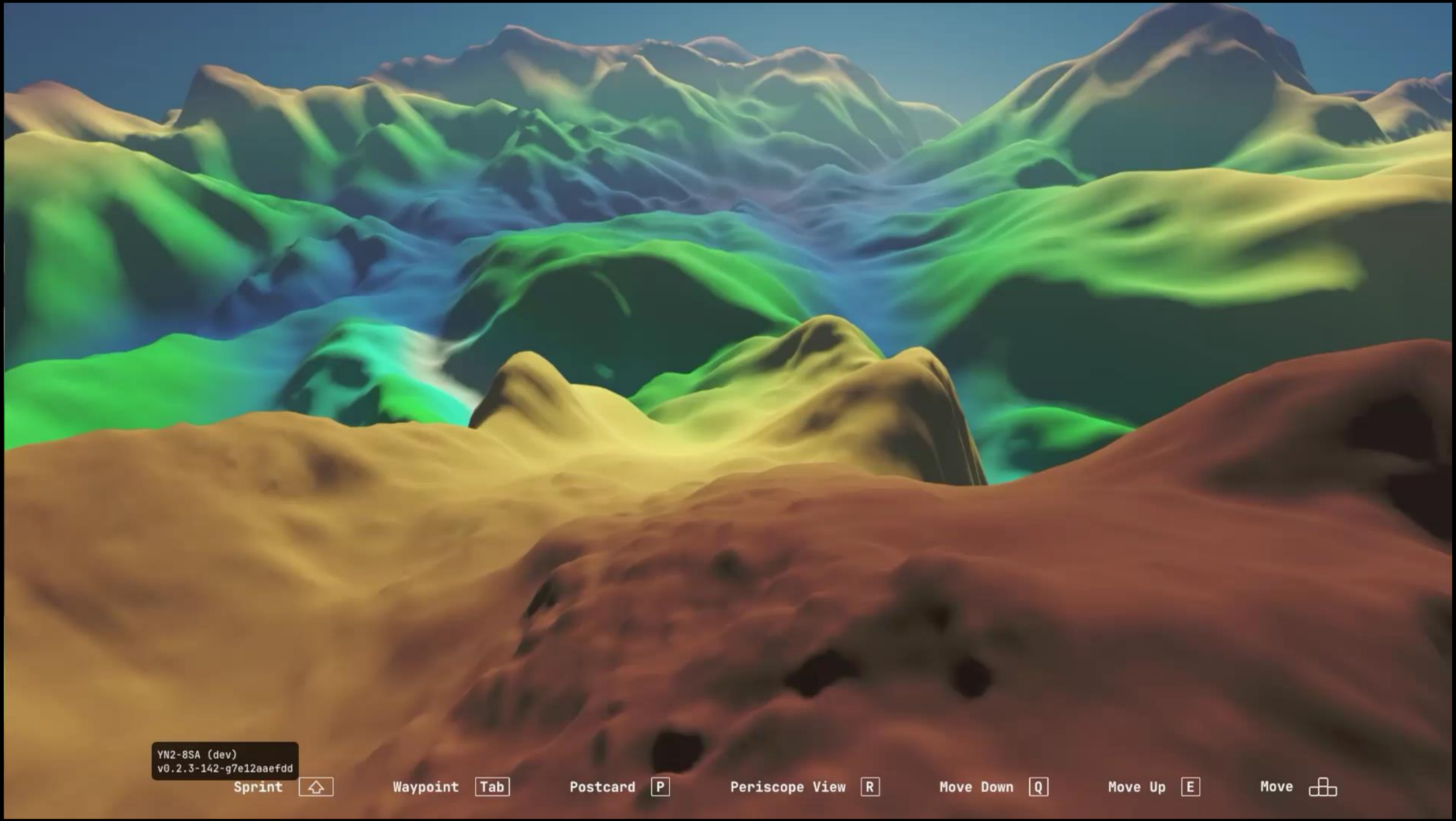




Relevant modules: diffusers.AutoencoderKL, numpy.stack(!)

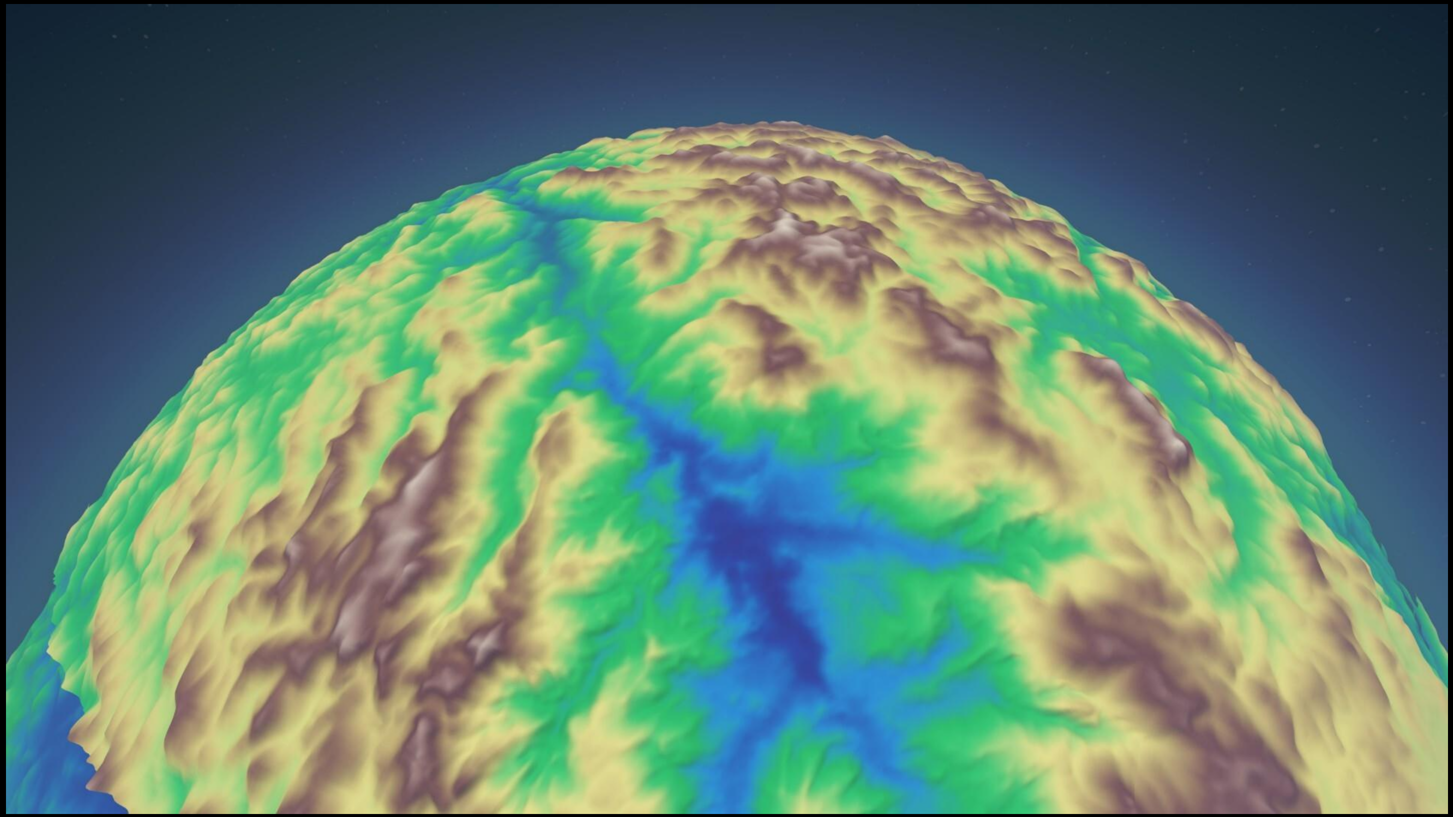
# LATENT TILING




YN2-8SA (dev)
v0.2.3-142-g7e12aaefdd
Sprint
Waypoint Tab
Postcard P
Periscope View R
Move Down Q
Move Up E
Move

# FROM 64KM2 TO THE WORLD

- **Open questions**
  - How do we scale this to planets?
  - Can we force a VAE to be local?
  - At what scale does it make sense to:
    - swap to real space
    - swap to procedural generation



# THANKS, AND WE'RE HIRING!

- MLOps Engineer
- Interns
- Speculative applications

- Apply online or chat to me or Eddie about it!

https://playerunknownproductions.net/careers