

Map Diffusion - Text Promptable Map Generation Diffusion Model

Marcin Przymus, Piotr Szymański

Background

- Development of generative models in recent years
 - Image generation, conditioned on prompts
 - e.g. Stable Diffusion can generate high-quality images based on textual description
 - Has a multitude of applicable domains
 - Streamline graphic tasks
 - Rapid visualization of thoughts
- City design generation using GAN

Introduction

- **Map Diffusion**

- A diffusion model to generate maps based on prompts
- Makes it easier for people to create maps
- Facilitates the use of geographic information

Training Data Preparation

- Requires geographical dataset with rich prompts
 - No such dataset available
- Data collection
 - Open Street Map
 - 62 cities from 4 continents, 164,662 tiles
 - Contains tags attached by users

KEYS

building · highway · name · source · amenity · surface · addr:street · shop · addr:housenumber · landuse · natural · leisure · addr:city · addr:postcode · access · barrier · oneway · tourism · operator · maxspeed · man_made · waterway...

[See all keys...](#)

TAGS

building=yes · highway=residential · building=house · highway=service · surface=asphalt · highway=track · natural=tree · highway=footway · waterway=stream...

[See most common tags...](#)

RELATION TYPES

multipolygon · restriction · route · boundary · associatedStreet · public_transport · destination_sign · site · waterway · route_master · building · enforcement · street · turnlanes:turns · connectivity · provides_feature...

[See all relation types...](#)

SOME POPULAR KEYS



REPORTS

Reports show the tag data from different angles. They often bring together data from several sources in interesting ways. Some of the reports can help with finding specific errors.

- [Characters in keys](#)
- [Database statistics](#)
- [Frequently used keys without wiki page](#)
- [Historic development](#)
- [Key lengths](#)
- [Language comparison table for keys in the wiki](#)
- [Languages](#)
- [Similar keys](#)
- [Wiki images](#)
- [Wiki pages about non-existing keys](#)

[See all reports...](#)

ABOUT

OpenStreetMap uses **tags** of the form **key=value** to add meaning to geographic objects. Taginfo collects information about these tags from several sources to help you understand what they mean and how they are used.

[More about taginfo...](#)

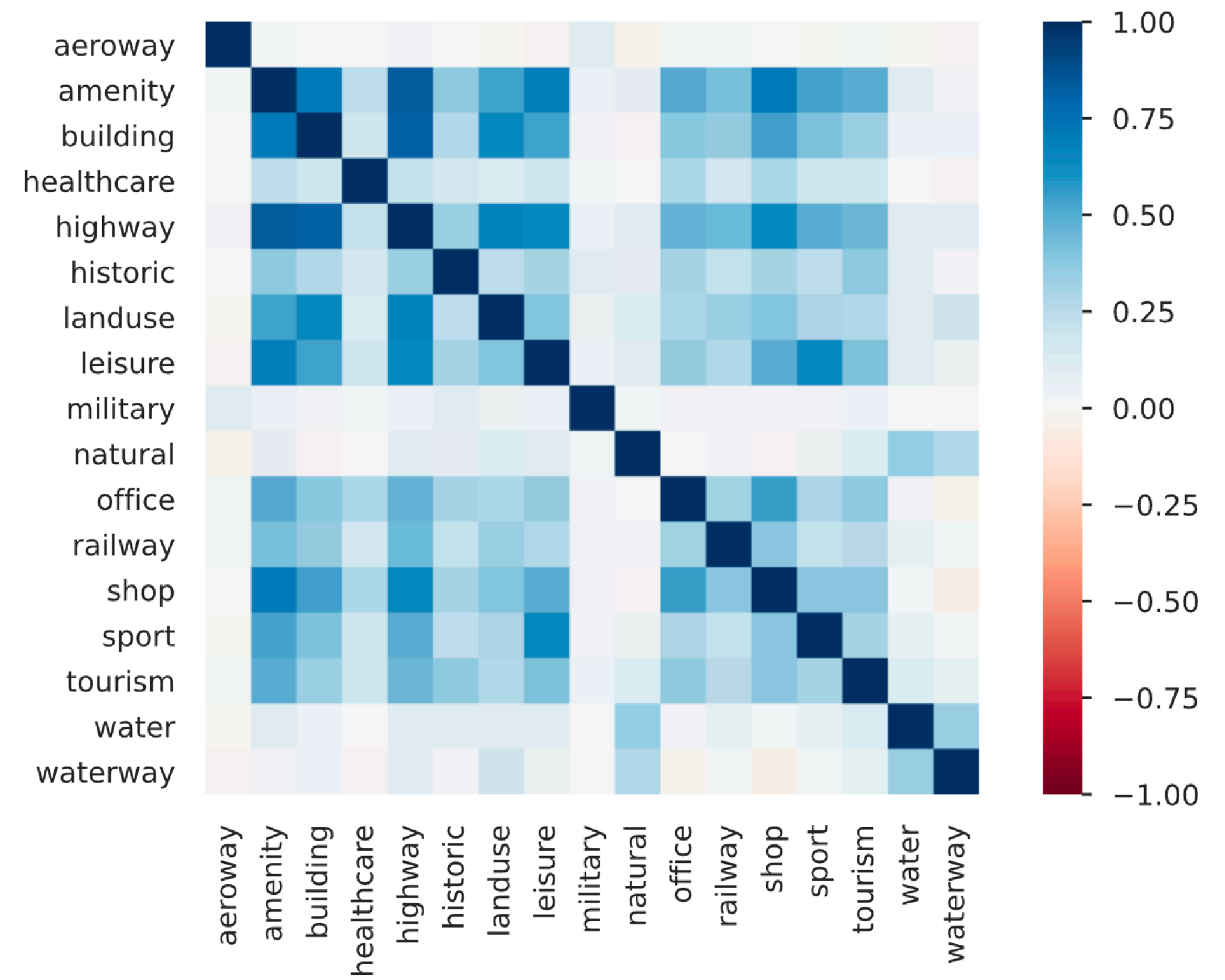
INTERNATIONAL

This is the main taginfo site. It contains OSM data for the whole planet and is updated daily.

[→ See other taginfo sites...](#)







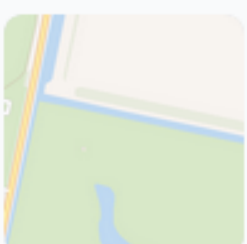

Training Data Preparation

- Correlation between tags
- Popular tags
 - Traffic related tags
 - highway
 - Residential related tags
 - building, parking
- Average tile contains more than 40 buildings



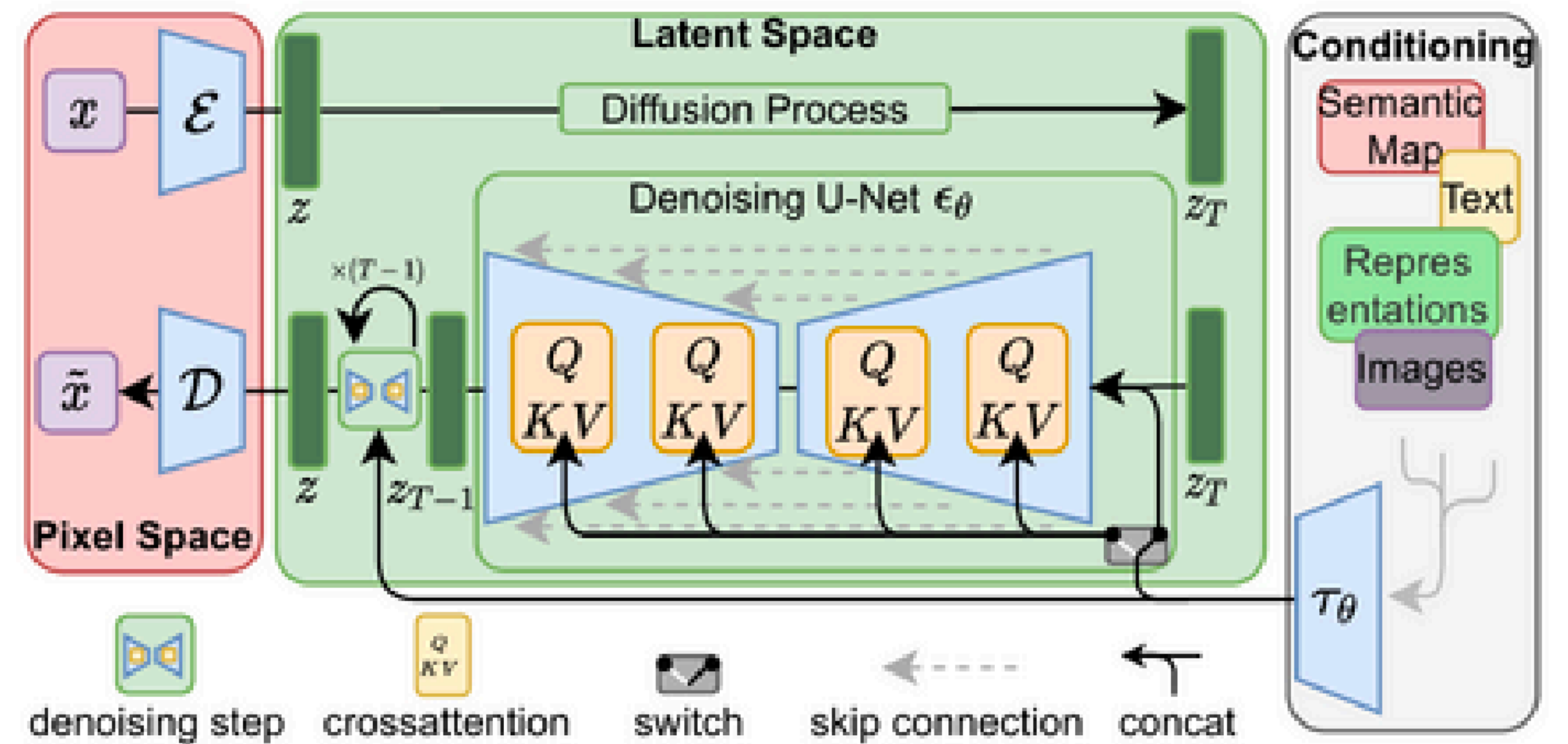
Training Data Preparation

- Problem of inconsistent tagging
 - Use only a subset of major tags
- Caption generation
 - Constructed with 10 tags or less

	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway service, 1 highway path, 1 natural water, 1 landuse forest, 1 highway tertiary.
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway path, 1 natural water, 1 highway track, 3 landuse forests , 1 highway tertiary.
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway service, 1 natural water, 1 leisure garden, 1 leisure nature reserve, 2 landuse forests , 3 highway tertiaries .
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway service, 2 natural waters , 1 leisure nature reserve, 1 landuse forest, 1 highway tertiary.
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway path, 6 natural waters , 4 highway unclassifieds , 1 leisure nature reserve, 1 building, 2 landuse forests , 2 building warehouses , 2 highway...
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway unclassified, 1 highway cycleway, 4 building warehouses , 1 landuse industrial, 1 highway path, 4 landuse forests , 3 building industrials , 5 highway...
	OSM from Amsterdam, Netherlands, Europe of city area containing: 1 highway service, 1 highway path, 3 natural waters , 1 building construction, 2 buildings , 1 natural scrub, 10 landuse forests , 1 highway tertiary.
	OSM from Amsterdam, Netherlands, Europe of city area containing: 2 highway services , 3 natural waters , 1 waterway drain, 8 landuse forests .

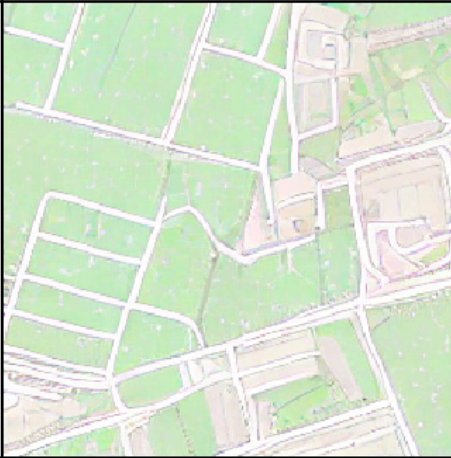
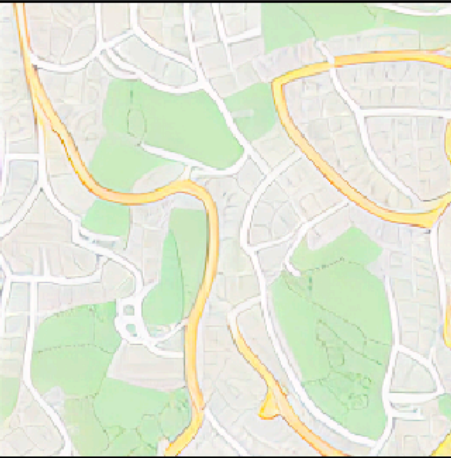
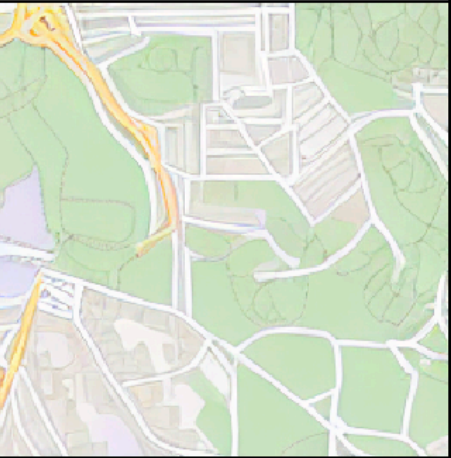

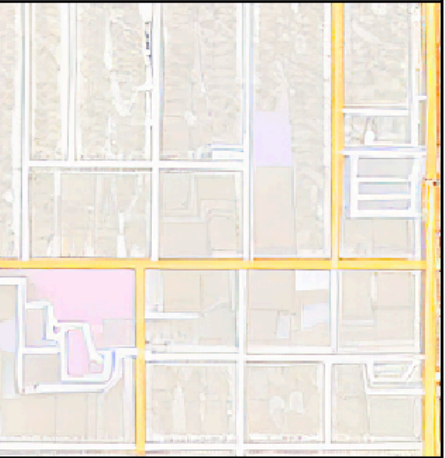
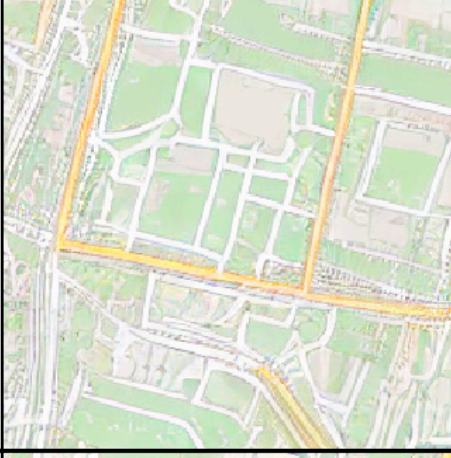
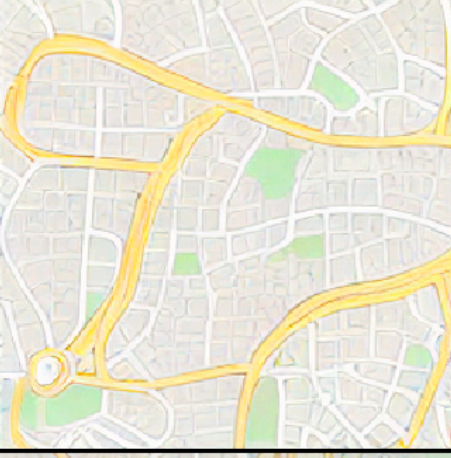
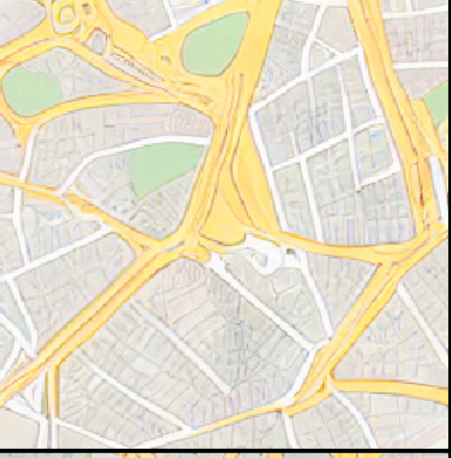
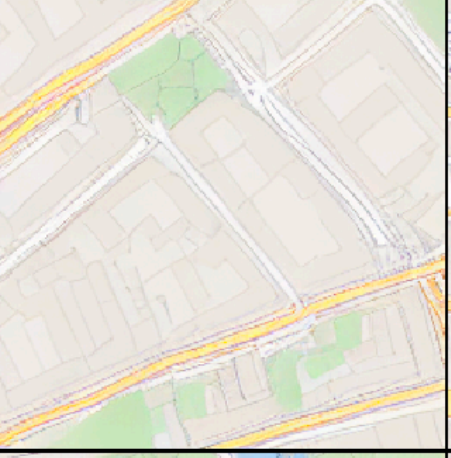


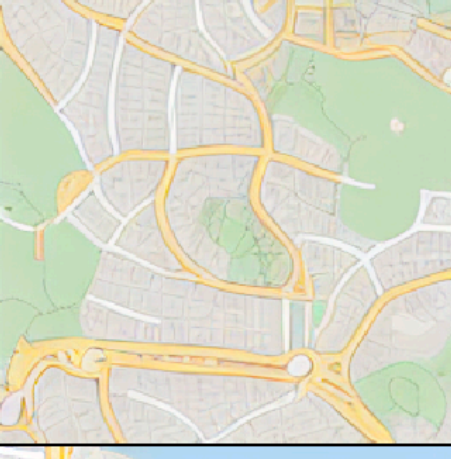
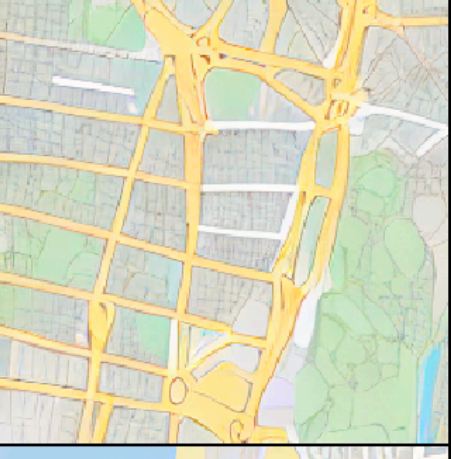
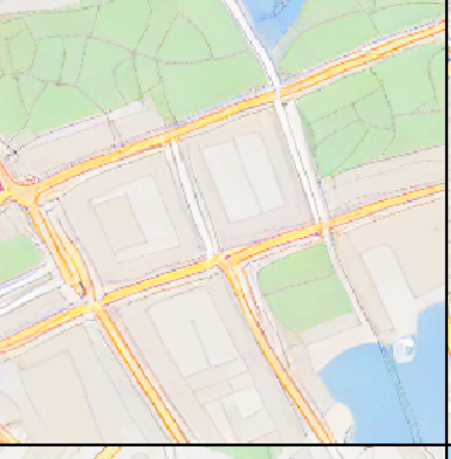
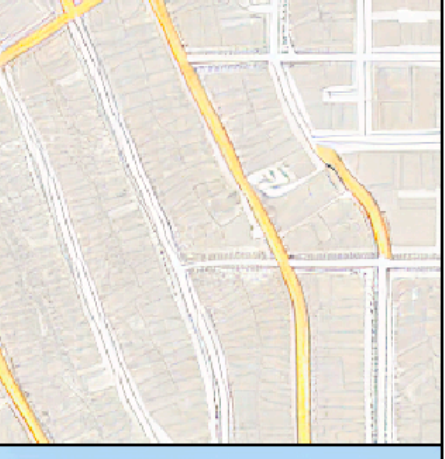

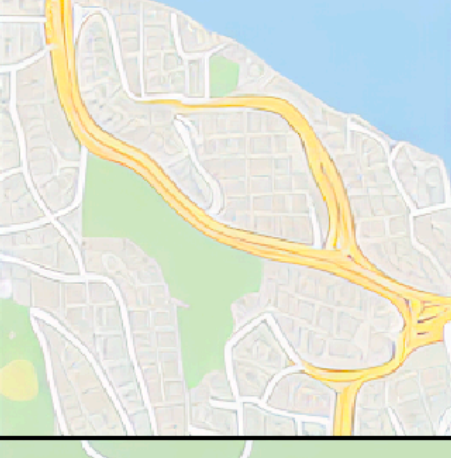
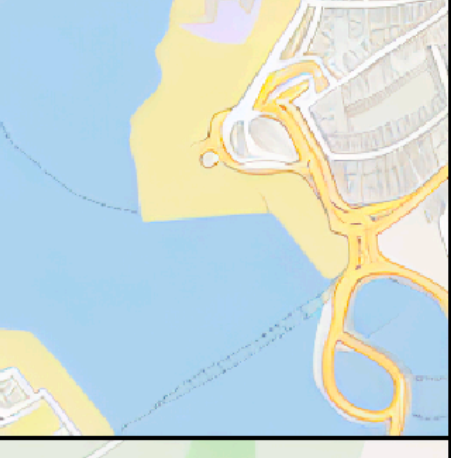



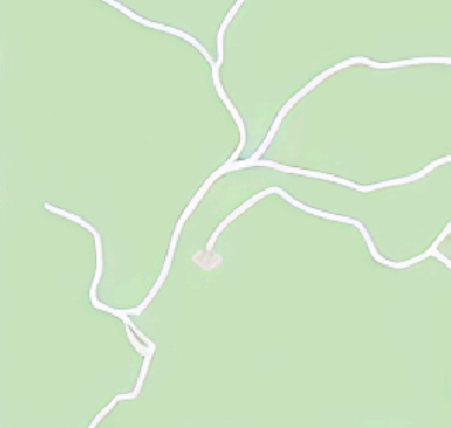
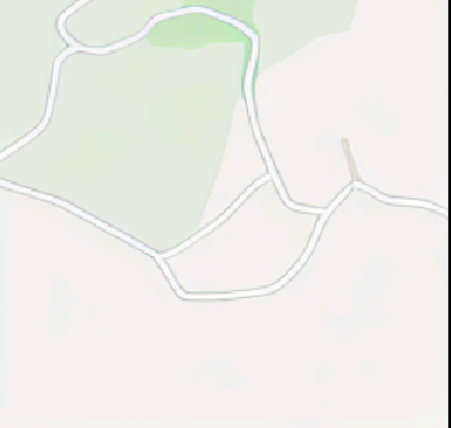

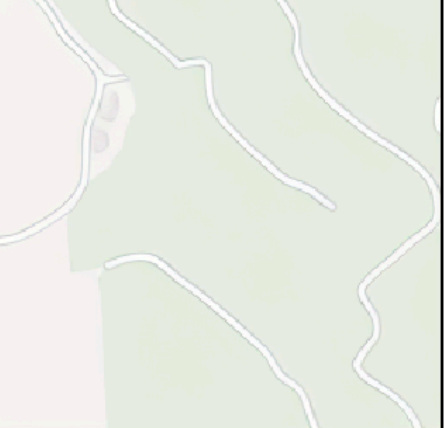
Method

- Uses Stable Diffusion for map generation
 - Utilizes VAE to reduce the dimension of image
 - Performs diffusion process in latent space
 - U-Net is used to denoise image
 - CLIP is used to encode prompt into embedding
 - Use cross-attention layers for conditioning



Experiments

- Quantitative analysis
 - Fréchet Inception Distance (FID)
 - Measured on 10,000 samples
 - Achieved 35.01 FID
 - The quality of images is acceptable

	Wrocław, Poland, Europe	Jerusalem, Israel, Asia	Lisbon, Portugal, Europe	Stockholm, Sweden, Europe	Los Angeles, United States, North America
Residential area					
City centre					
Park					
Sea coast					
Green area					

Wrocław, Poland,
Europe

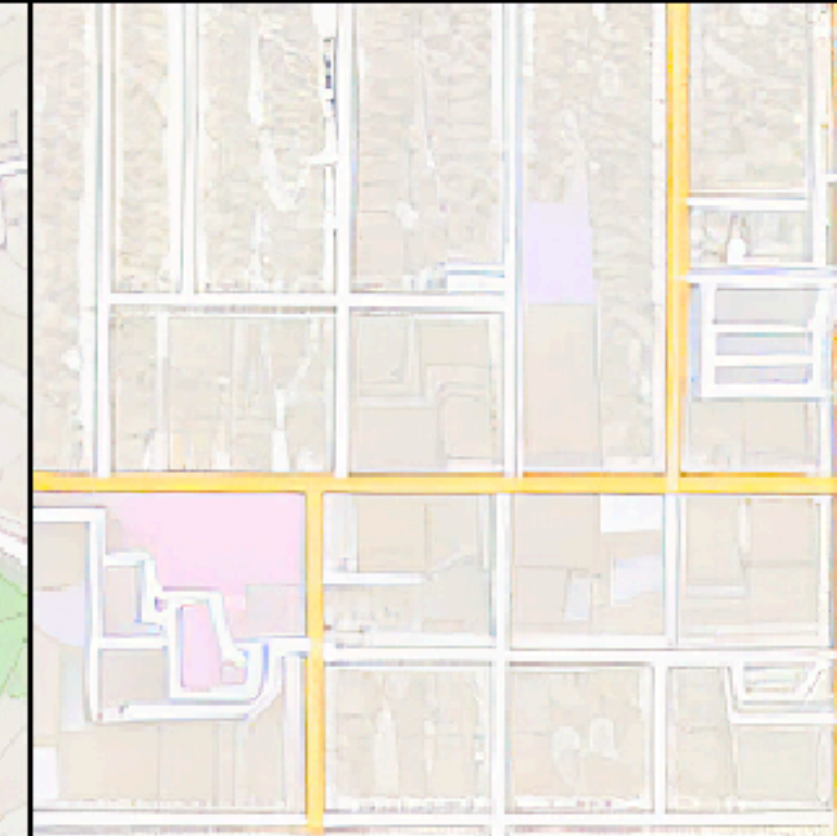
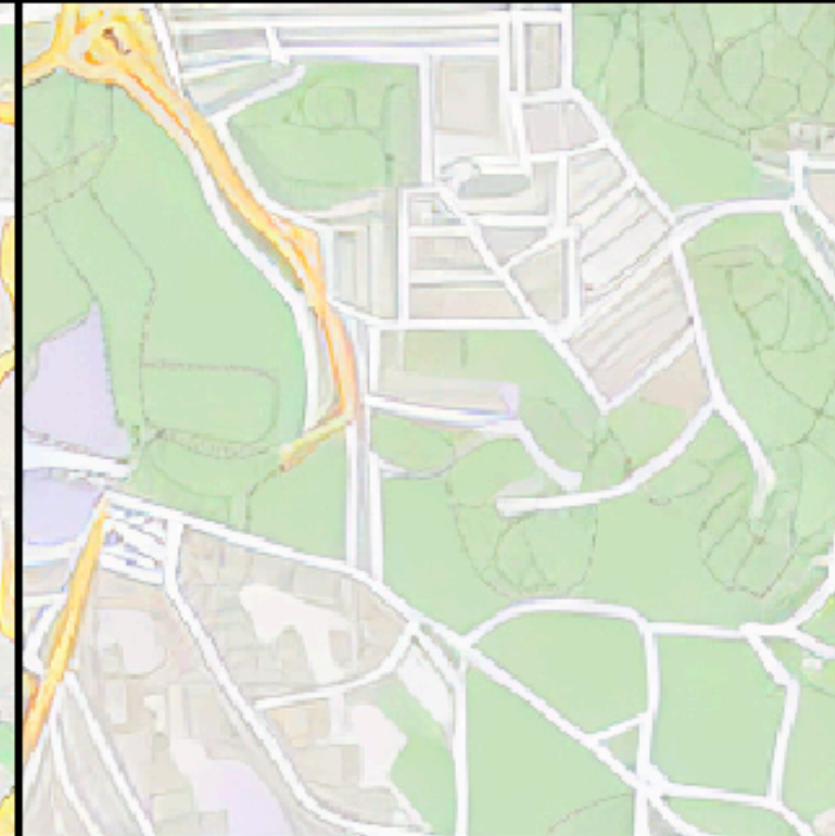
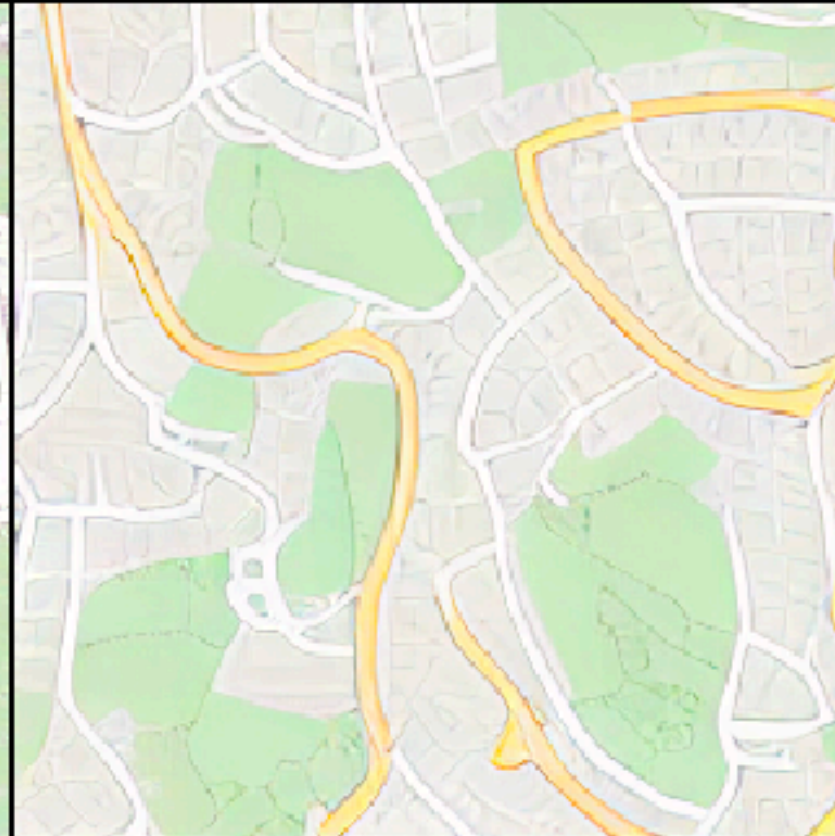
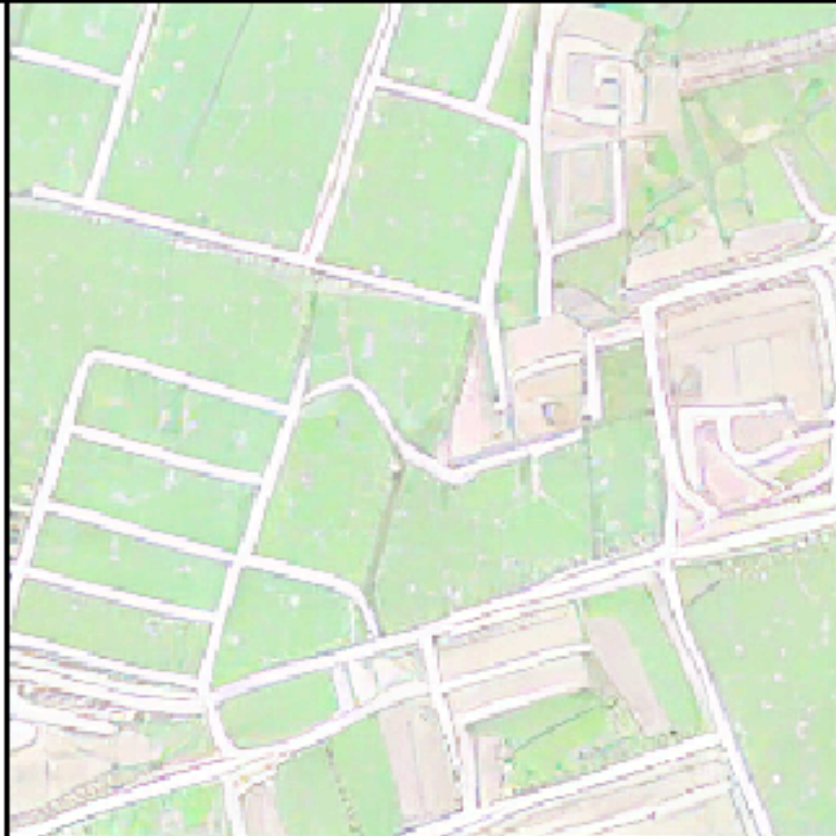
Jerusalem, Israel,
Asia

Lisbon, Portugal,
Europe

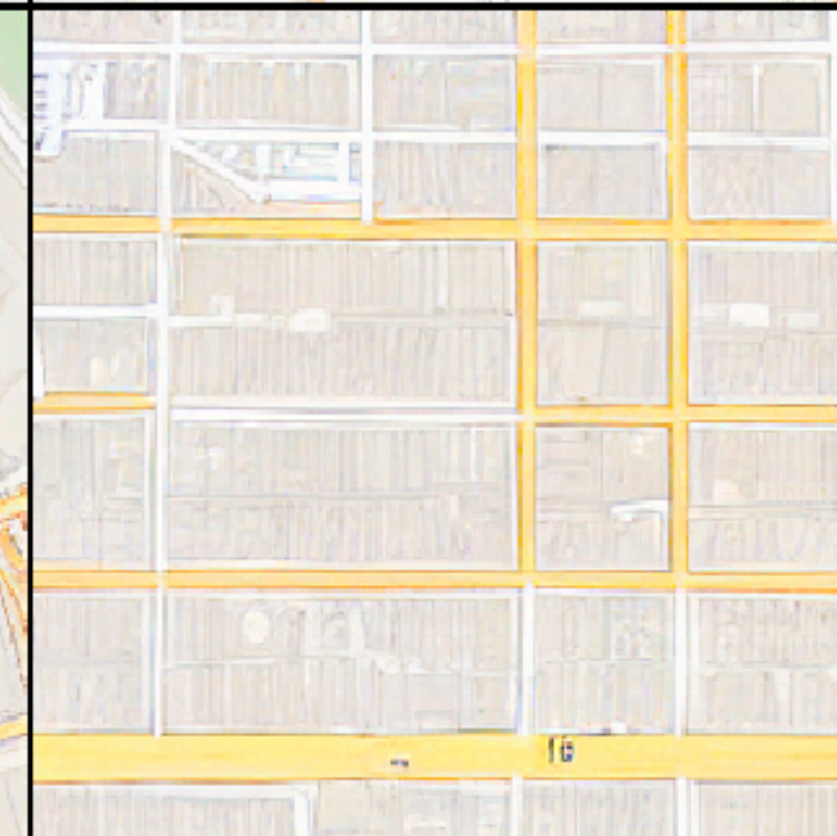
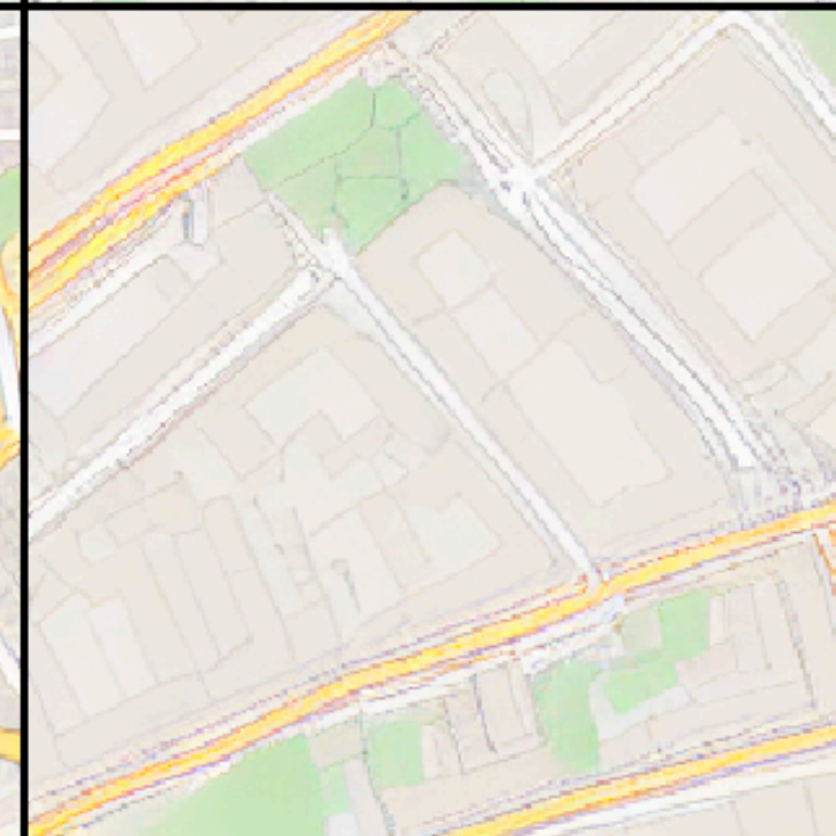
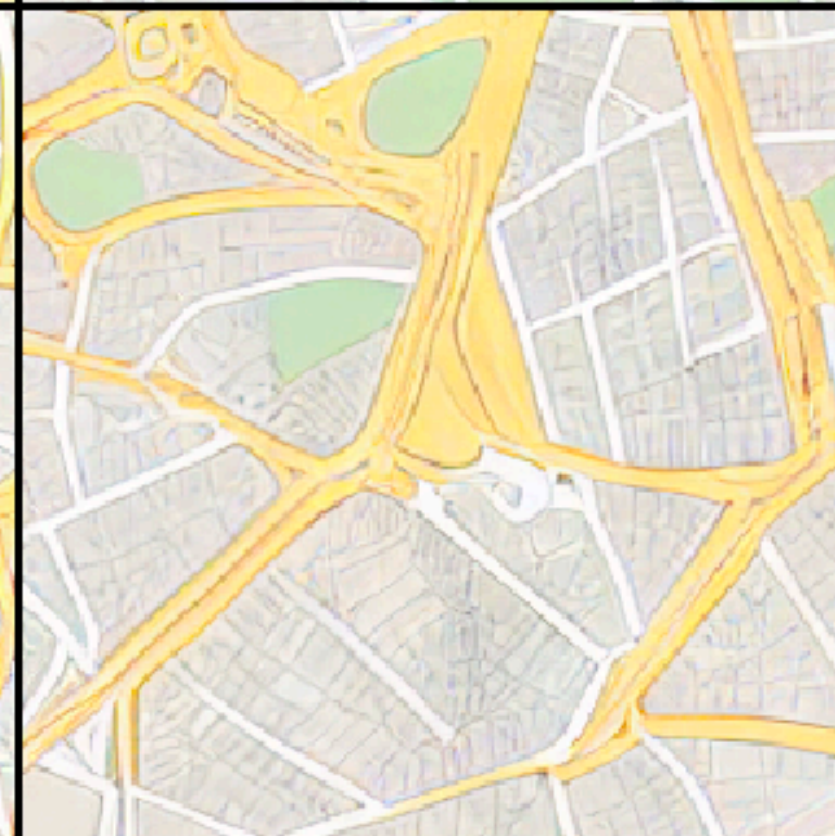
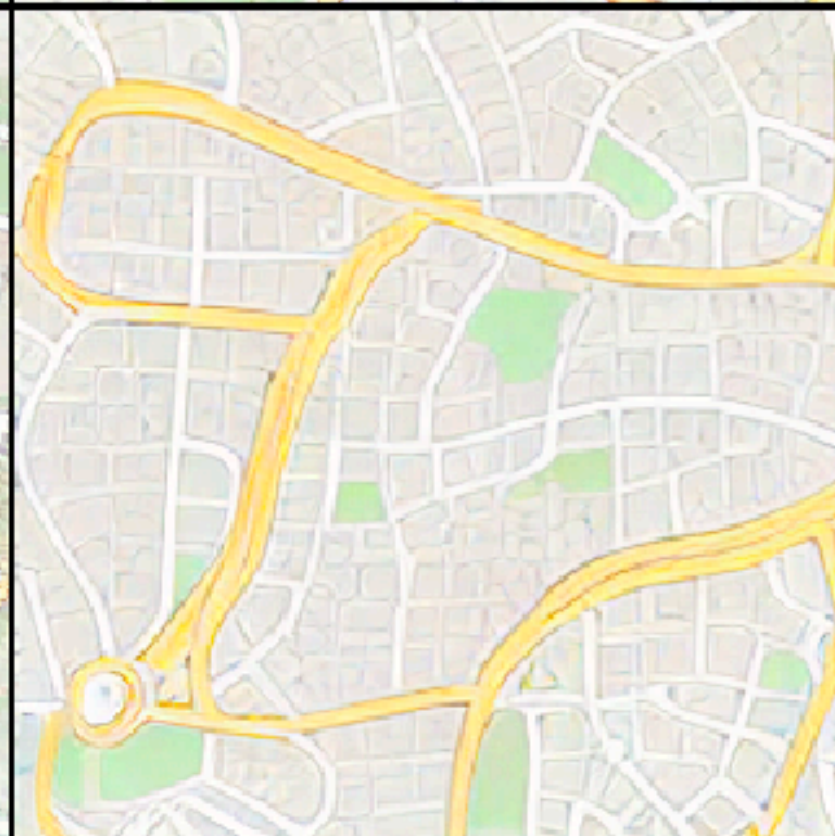
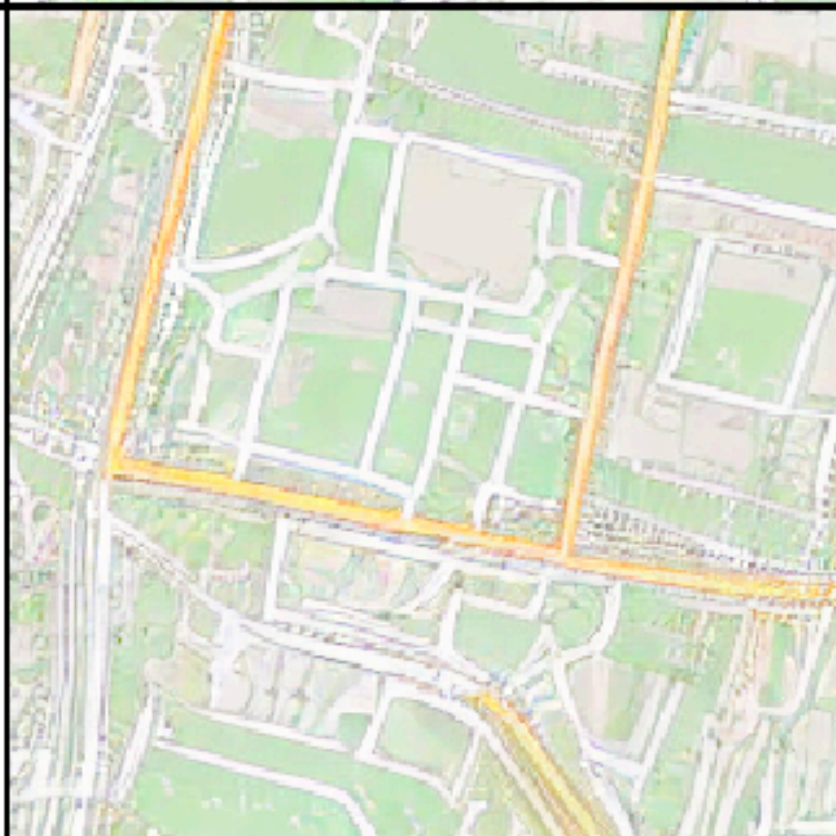
Stockholm, Sweden,
Europe

Los Angeles, United
States, North
America

Residential area



City centre



Experiments

- Qualitative analysis
 - Los Angeles: Manhattan-like grid shape
 - Ignores park prompt
 - Wrocław: Full of green area
 - Difficult to generate urbanized area
 - Lisbon: Too many main streets
 - Roads are wrongly connected
 - Stockholm: Shapes of some buildings are not good

	USA, North America	PL, Europe	Wrocław
Seattle			
Chicago			
Los Angeles			

Conclusions

- Introduced Map Diffusion
 - Along with its dataset
 - Can generate tiles of reasonable quality
 - Can be guided by prompts
- Future goals
 - Inpainting task
 - Larger map size

Thank you for your attention