EmerNeRF: Emergent Spatial-Temporal Scene Decomposition via Self-Supervision

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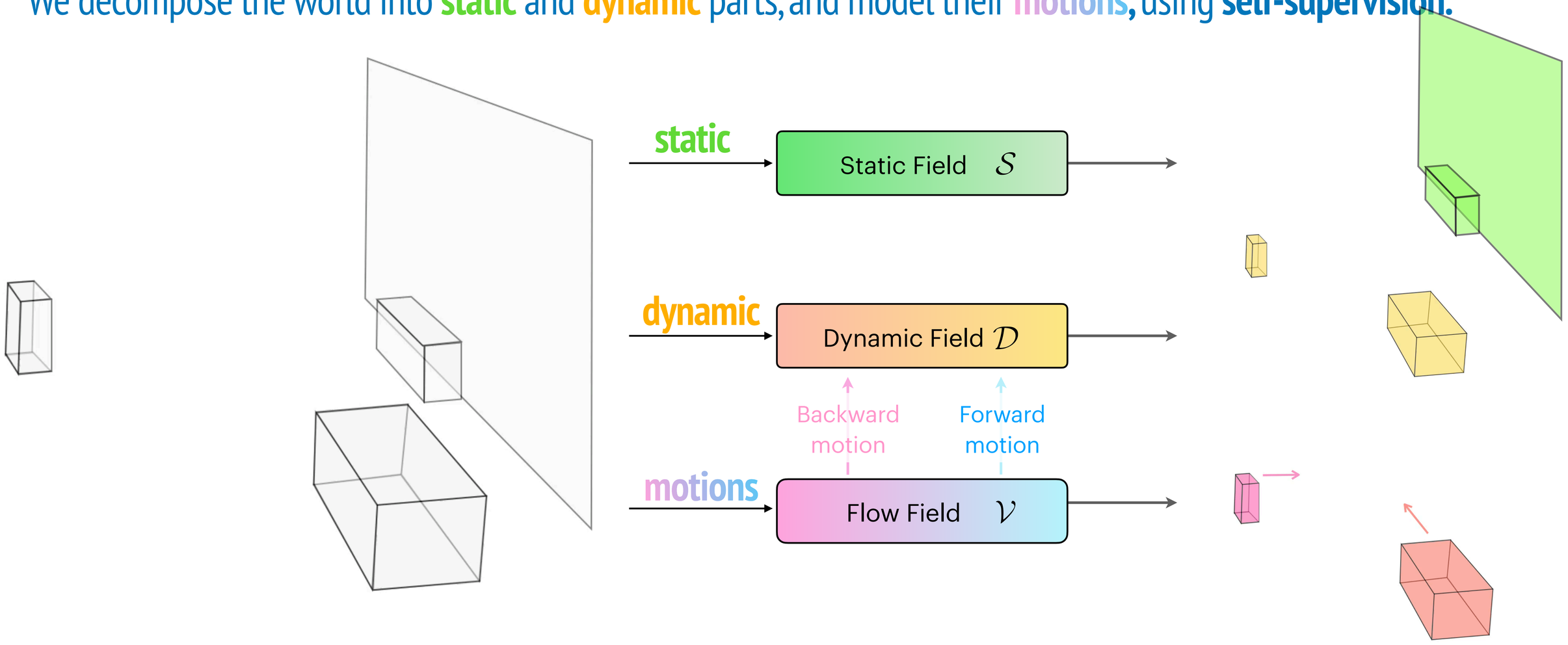
EmerNeRF

- Scalable: Everything is self-supervised. No human annotation is needed.
- Realistic: State-of-the-art photorealistic reconstruction. Perfect for simulations.
- All-in-one-pipeline:
  - Differentiating static/dynamic objects
  - Estimating 3D scene flows
  - Auto-labeling semantic occupancies

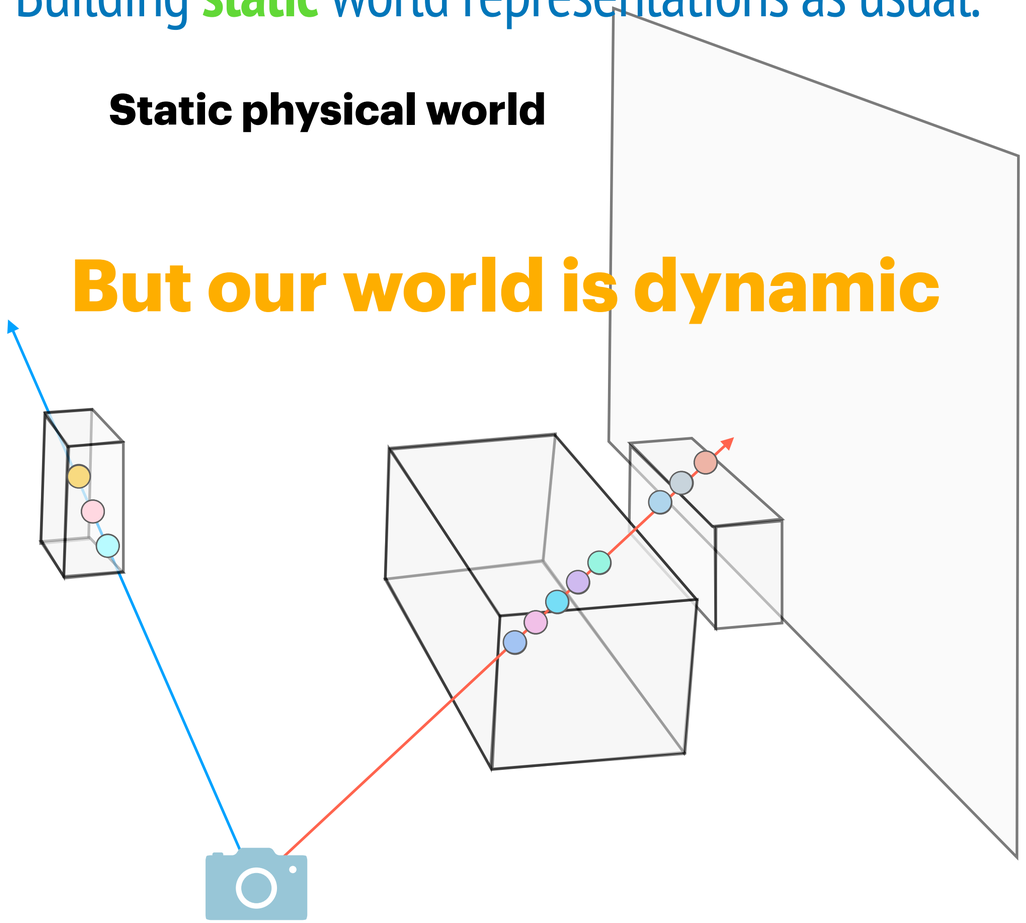
EmerNeRF Overview

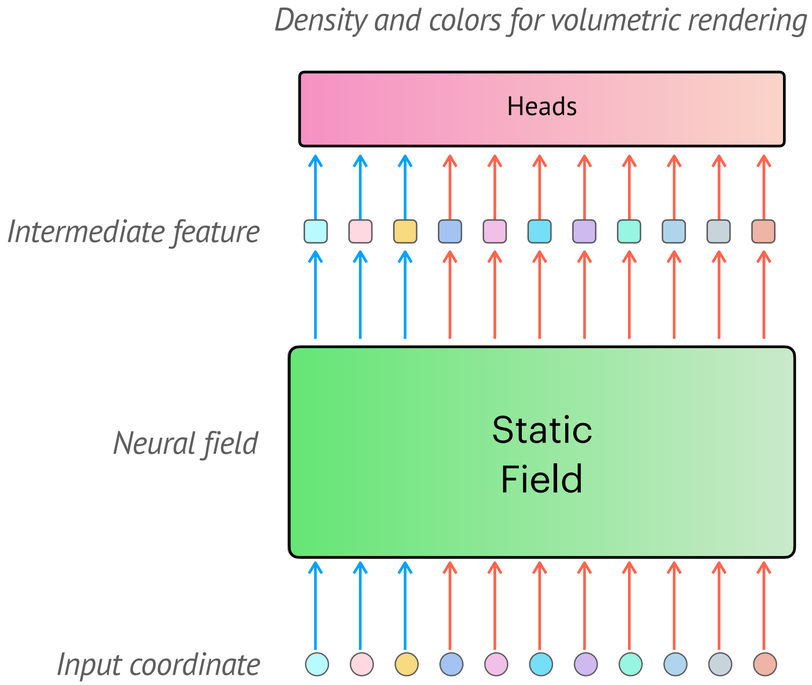
We decompose the world into **static** and **dynamic** parts, and model their **motions**, using **self-supervision.**



EmerNeRF Overview

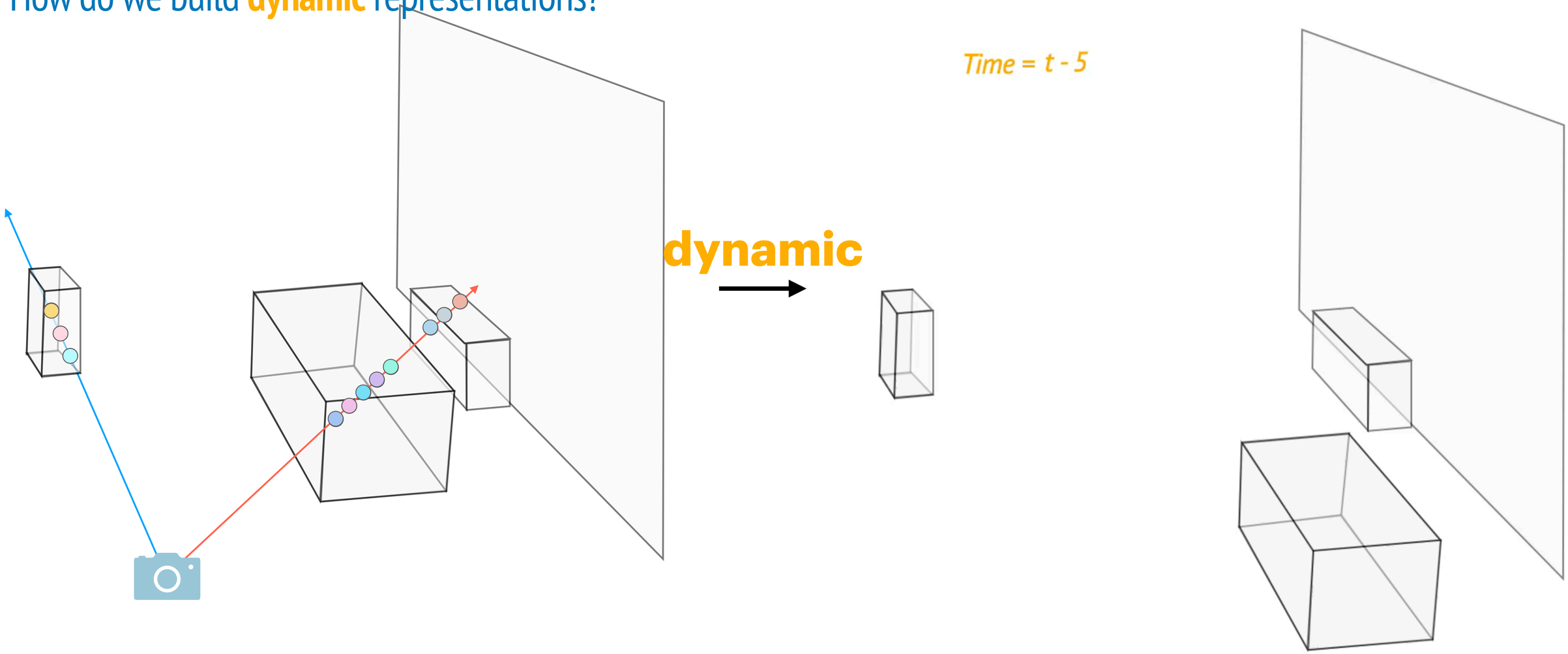
Building **static** world representations as usual.





EmerNeRF Overview

How do we build **dynamic** representations?



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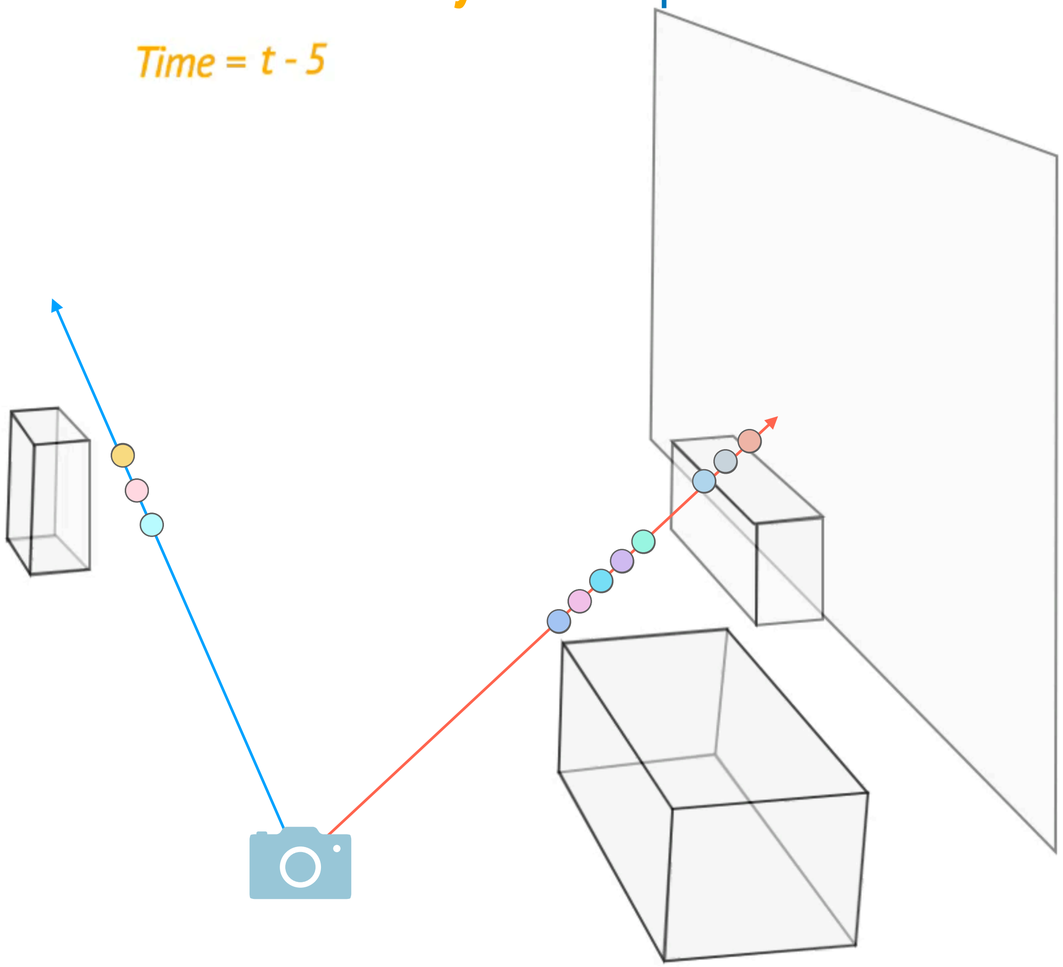
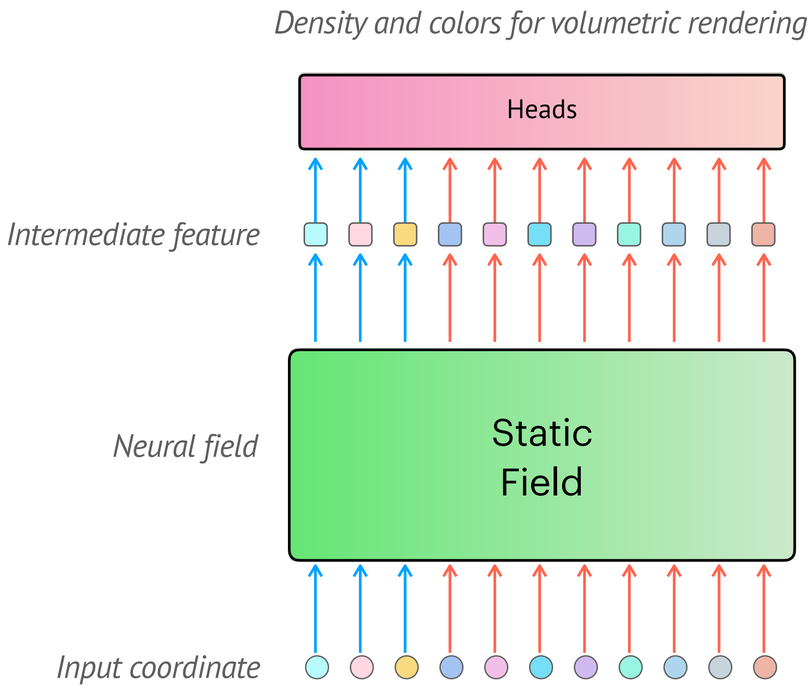


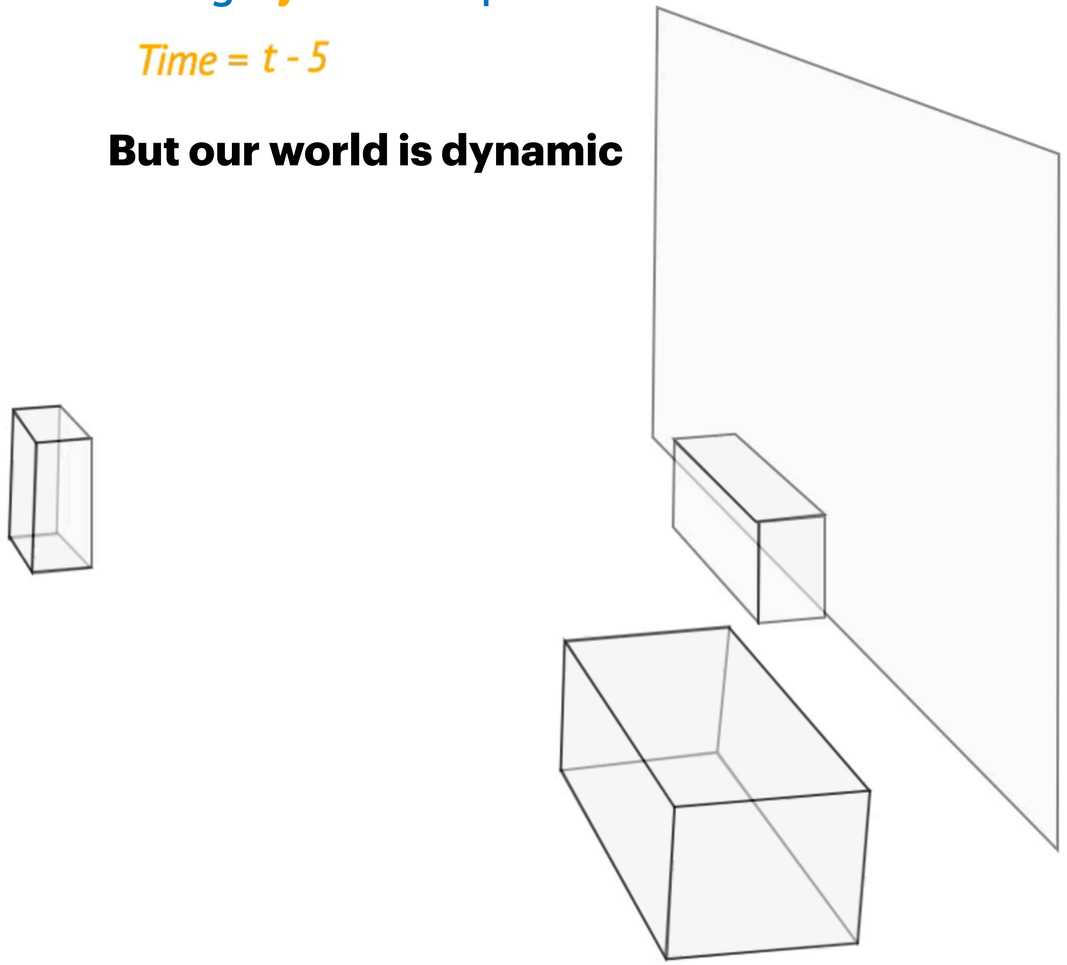


EmerNeRF Overview

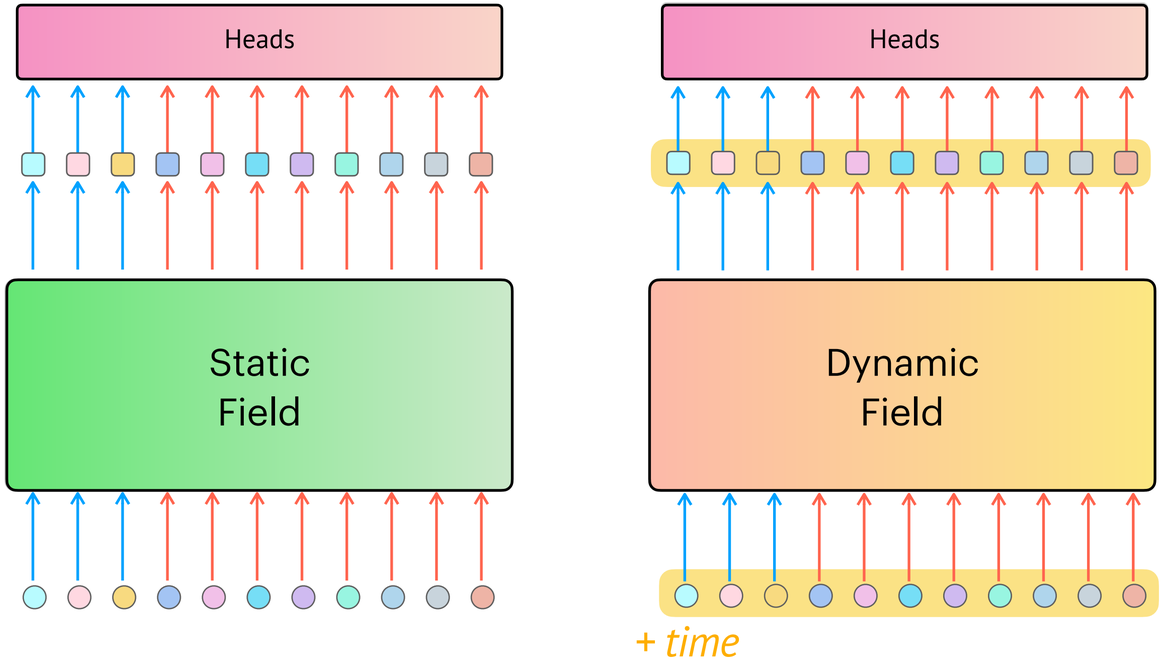
Building dynamic representations

Time = t - 5

But our world is dynamic



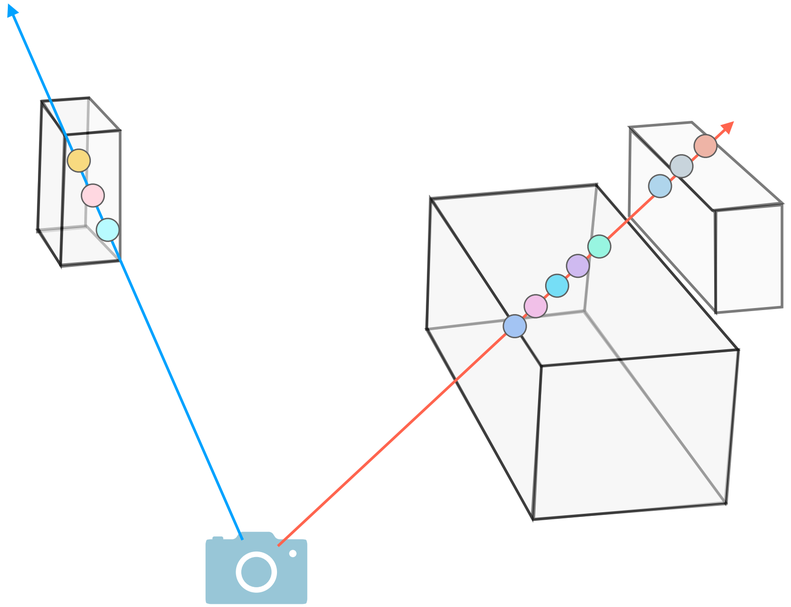
*Building **Spatial-temporal** scene representations*

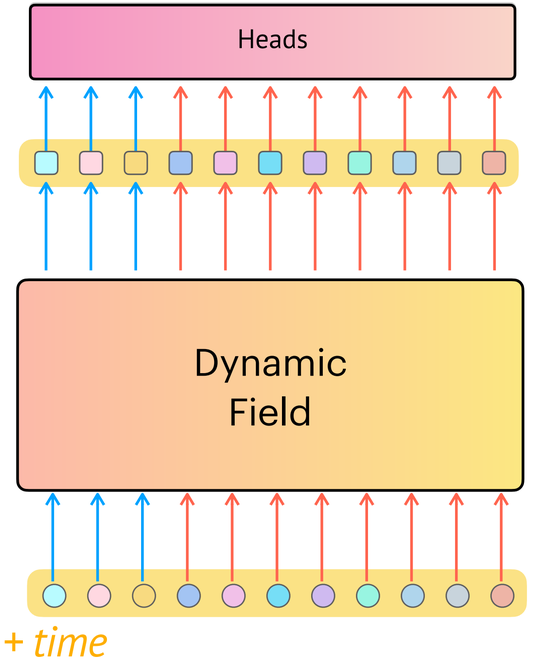


Add time-dimension to the dynamic field

EmerNeRF Overview

Building motion for temporal correspondence





EmerNeRF Overview

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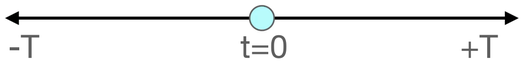
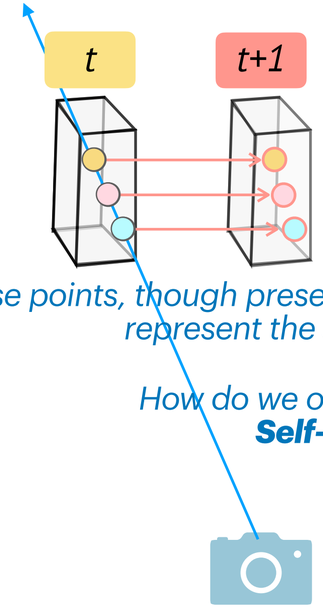
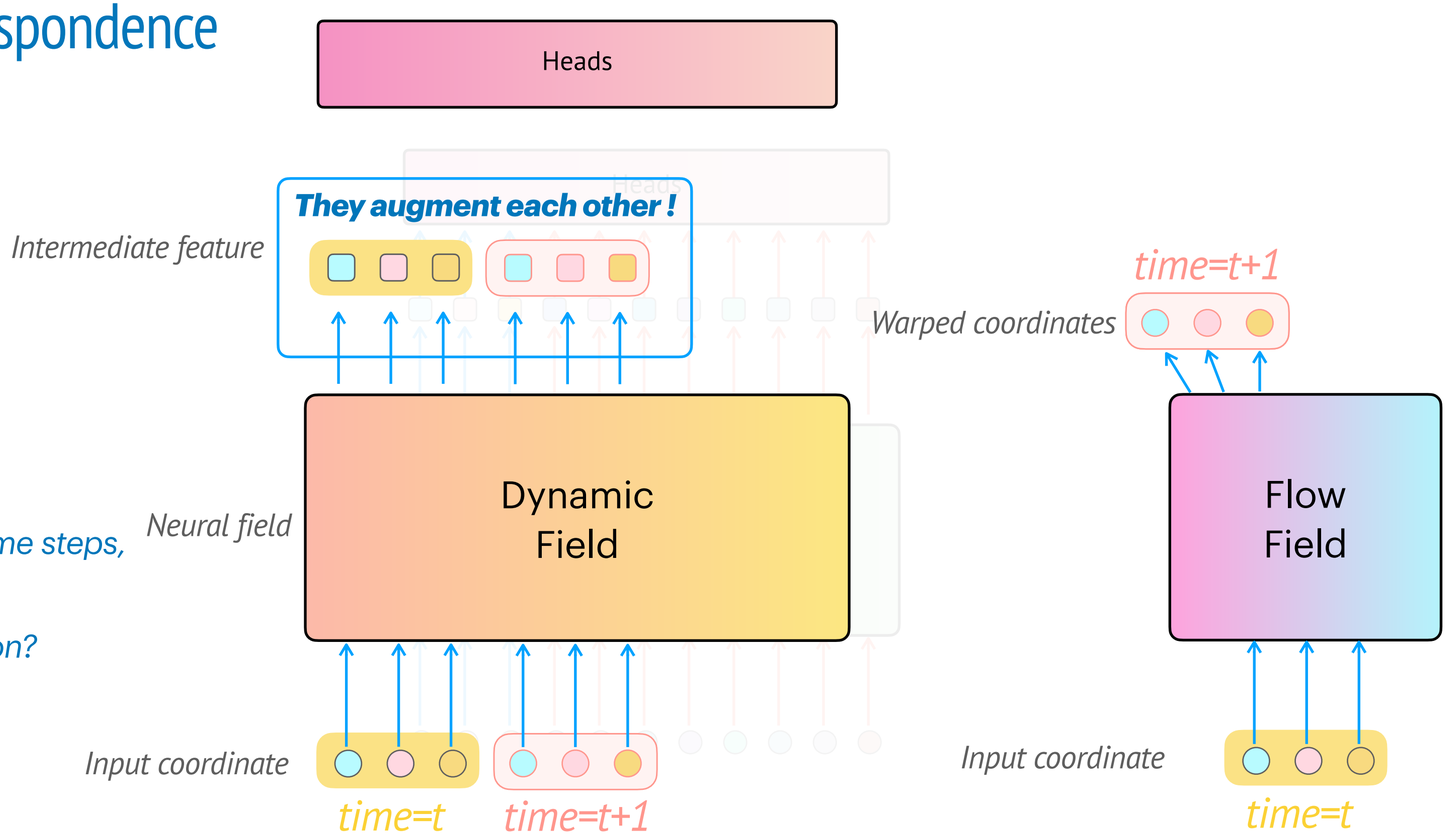


Temporal Equivariance



These points, though presented at different time steps, represent the same particles

How do we obtain transformation?
Self-supervision!



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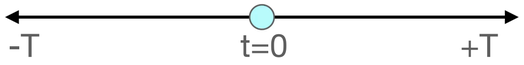

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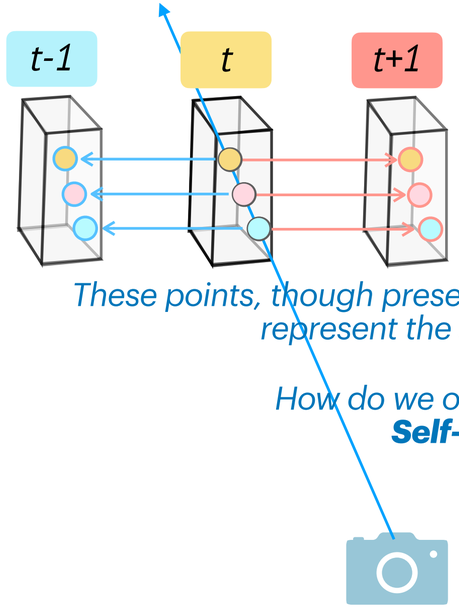

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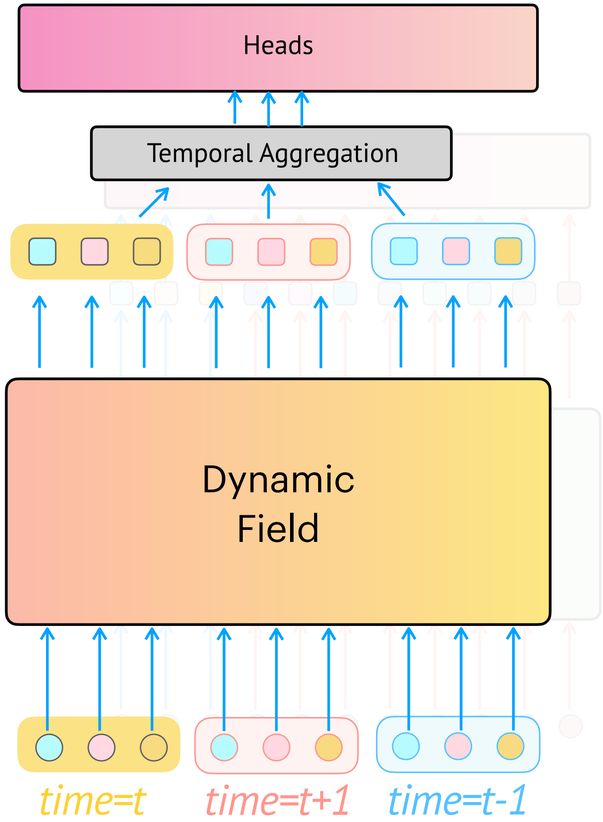

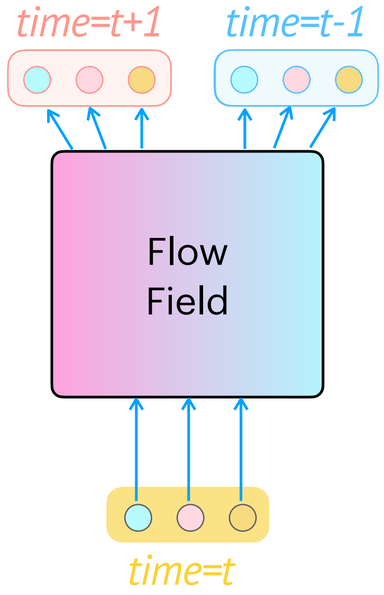

EmerNeRF Capabilities

- With self-supervision, it can do
  - Log Replay
  - Static / Dynamic Decomposition
  - Motion Estimation
  - Semantics Understanding
  - Novel View Synthesis
  - Occupancy Reconstruction

Original Camera Log

Rendered Camera Log

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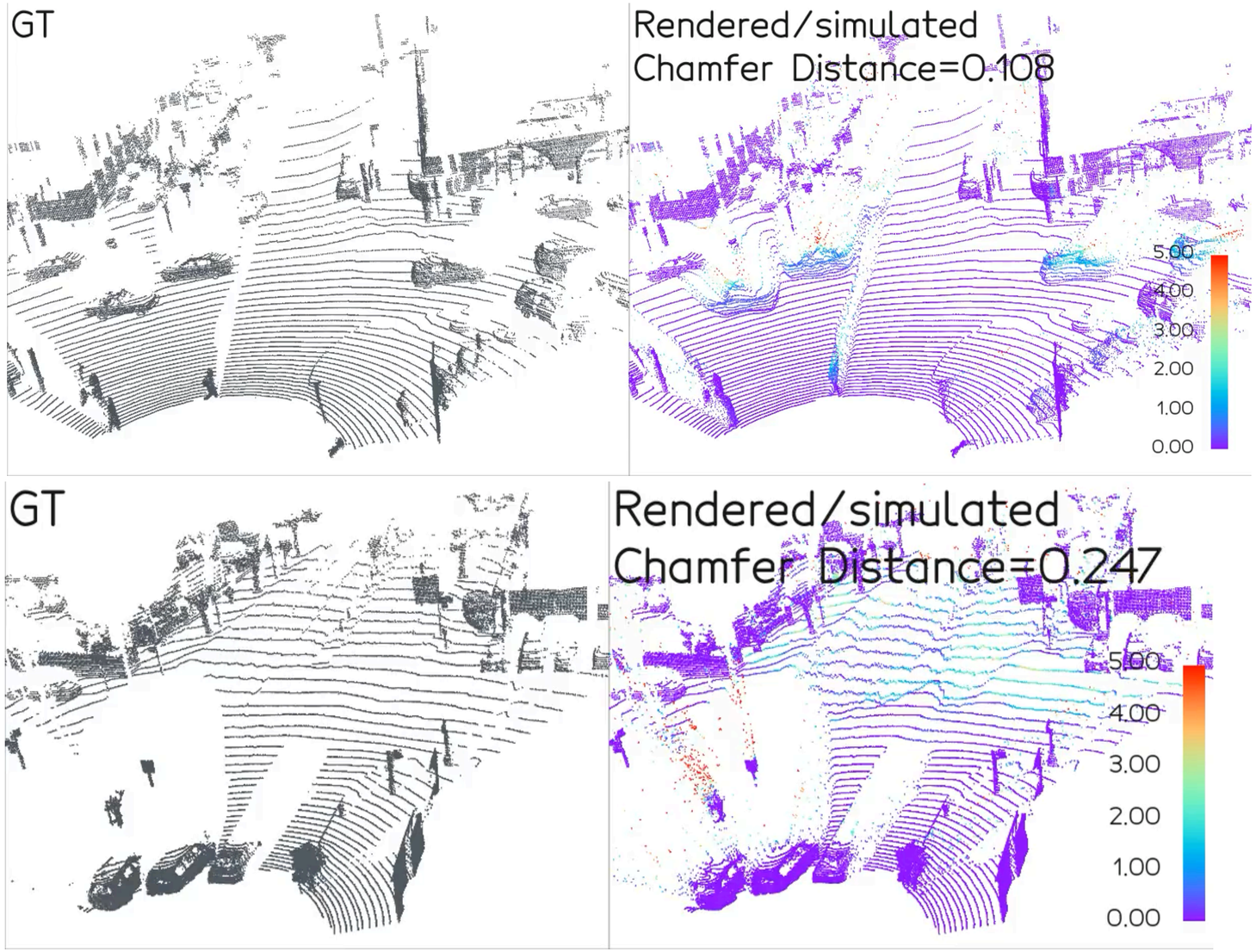

Why neural field scene representation?

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Original Camera Log

Static RGB

Dynamic RGB

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Original Camera Log

Scene Flow estimation.

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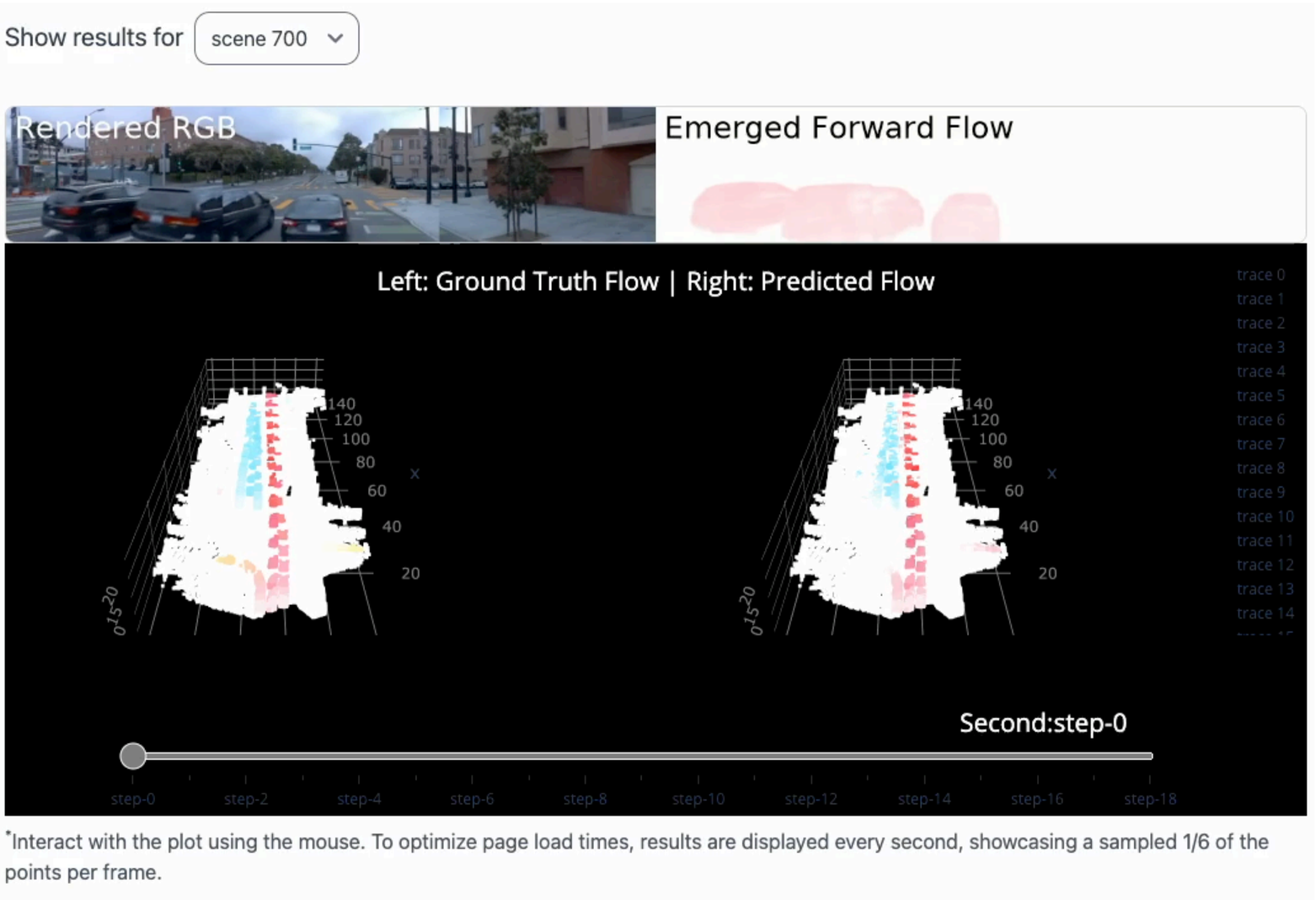

*Interact with the plot using the mouse. To optimize page load times, results are displayed every second, showcasing a sampled 1/6 of the points per frame.

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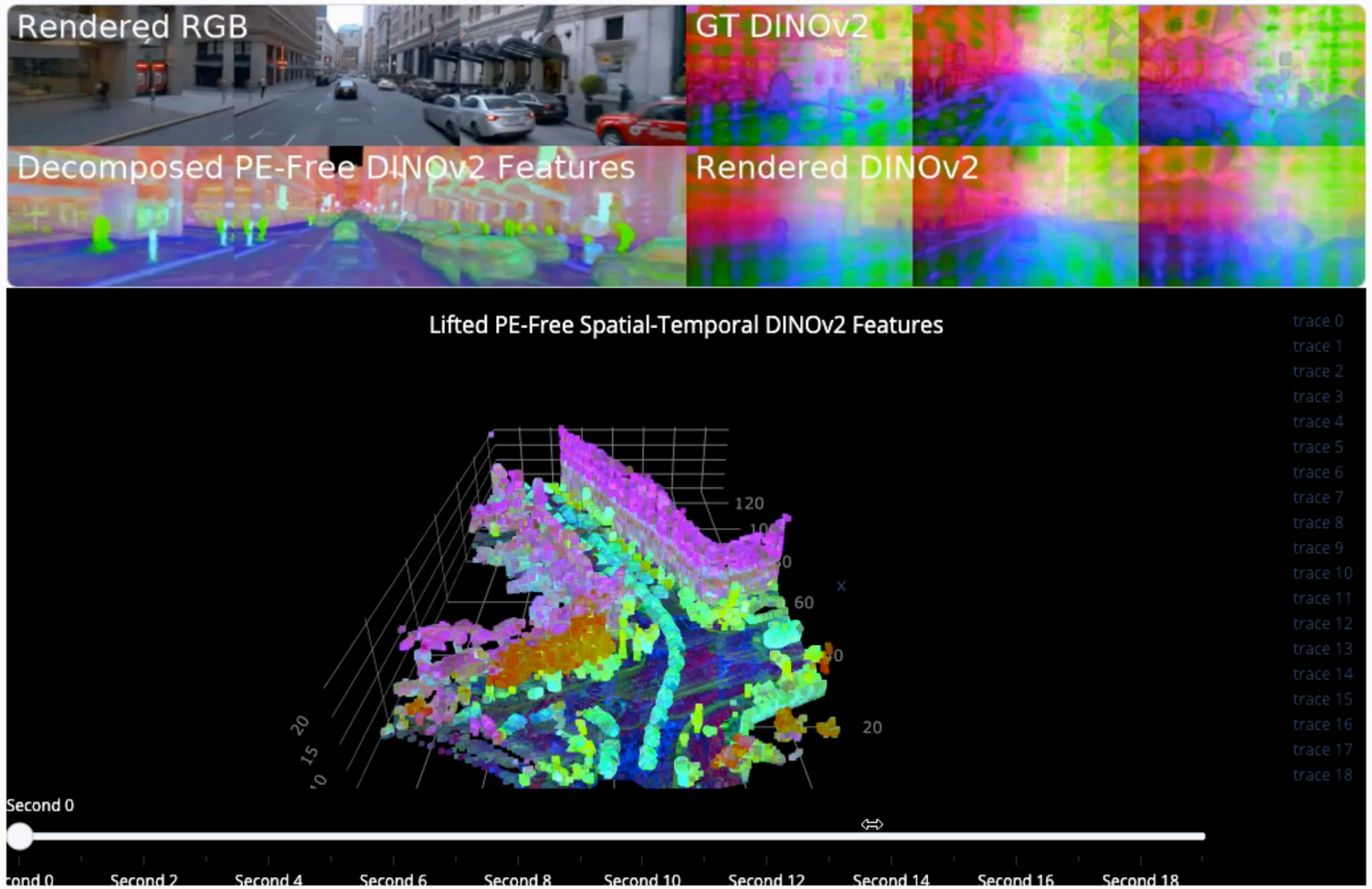

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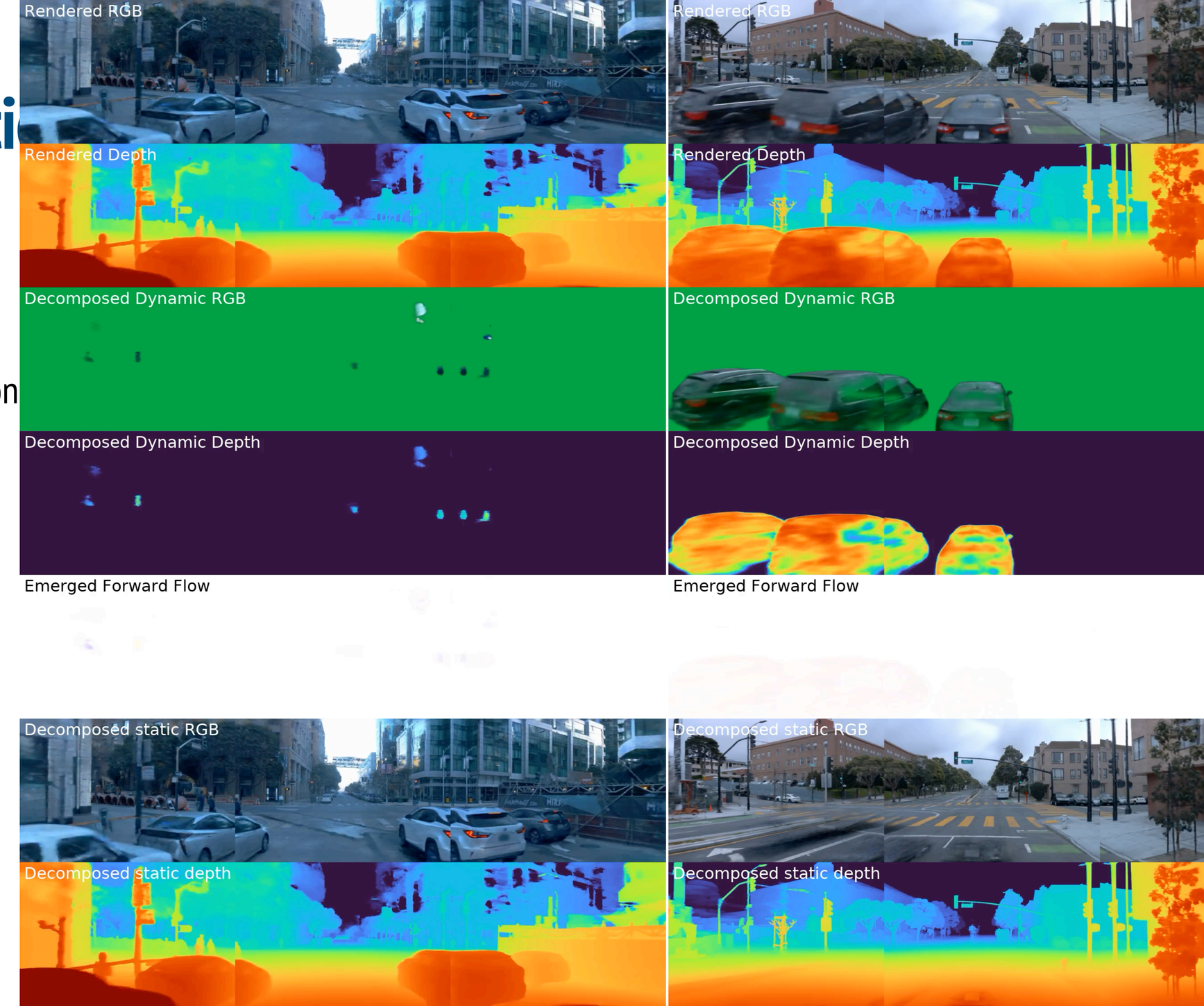

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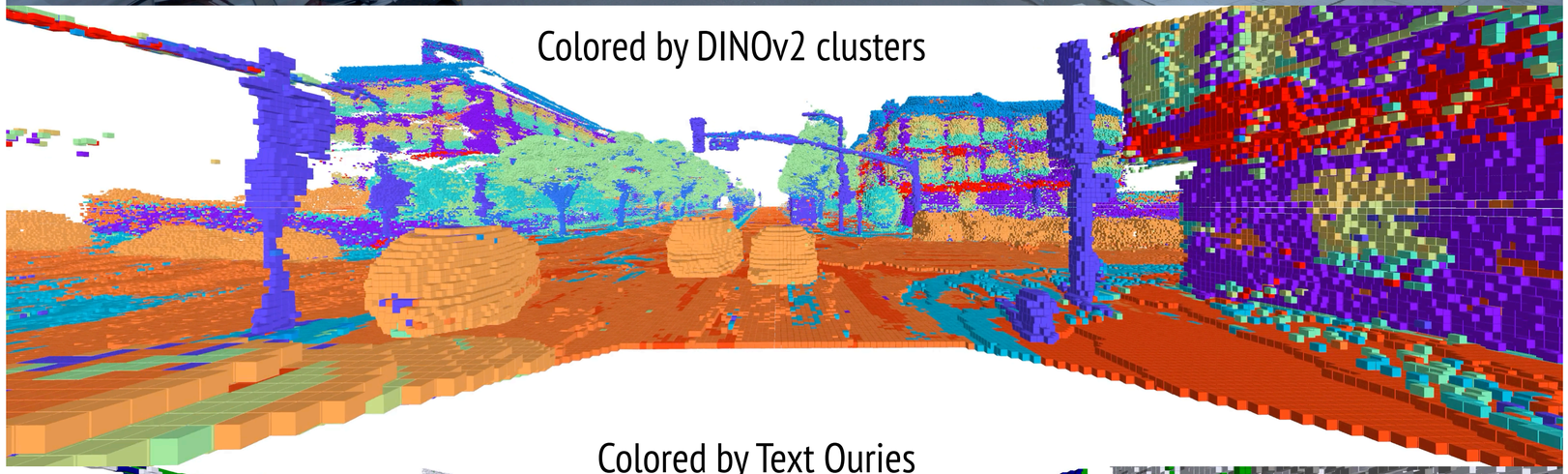
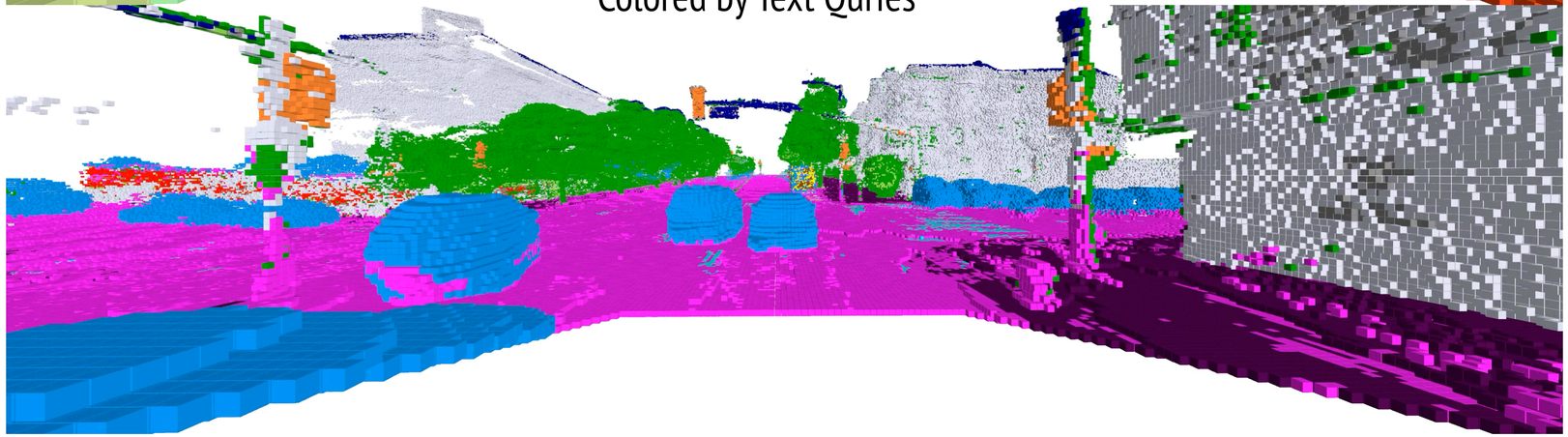
Camera Images

Colored by DINOv2 clusters



Colored by Text Quries



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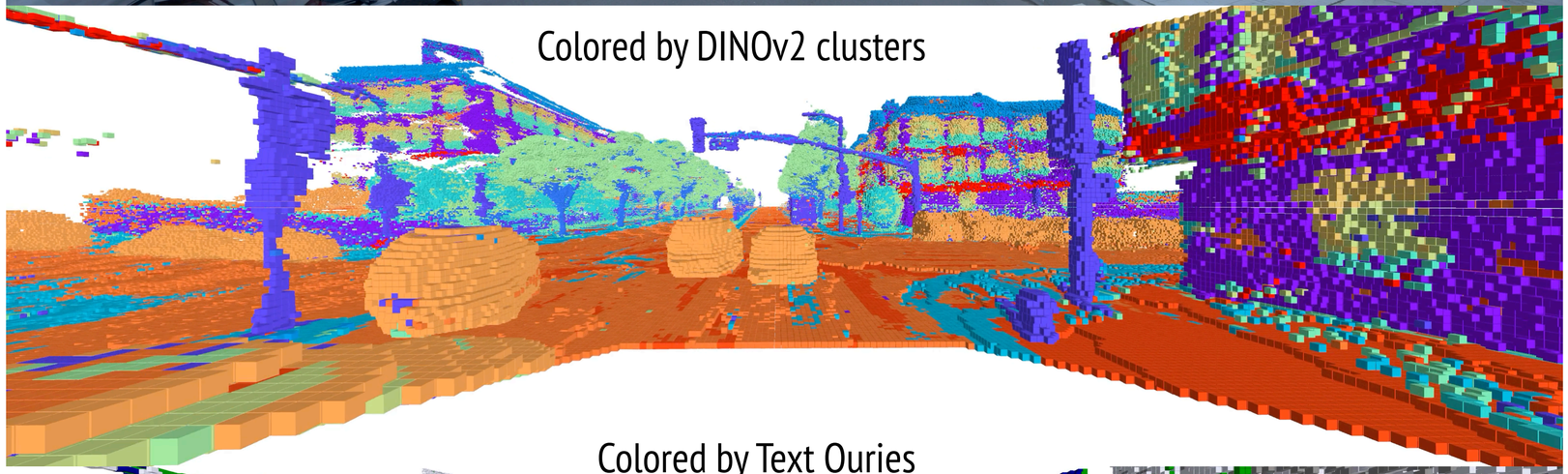

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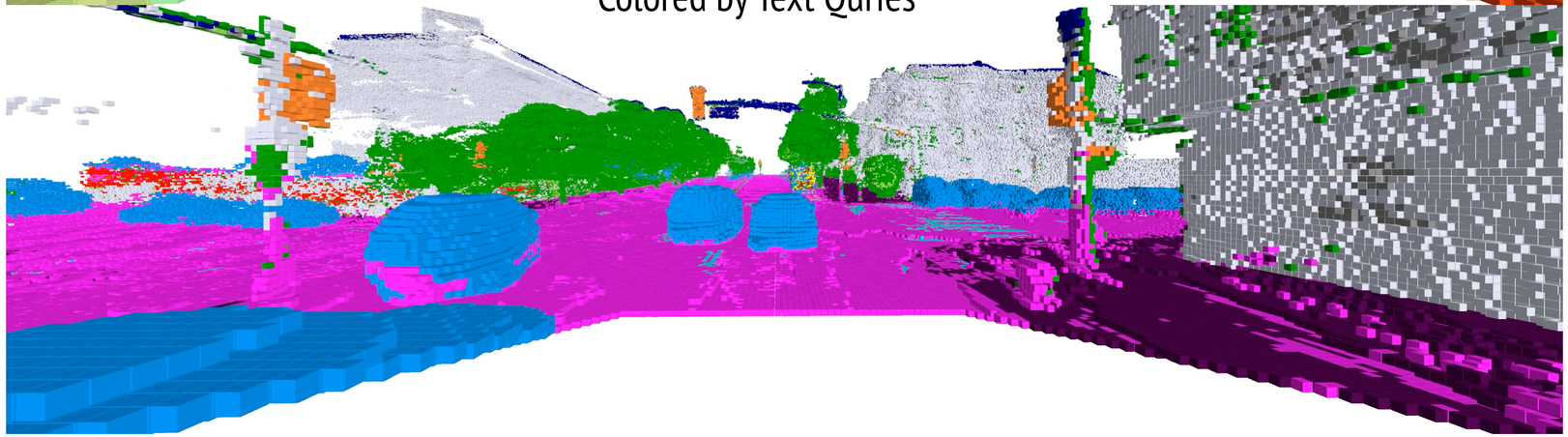

EmerNeRF: Emergent Spatial-Temporal Scene Decomposition via Self-Supervision

- Self-supervised learning to reconstruct dynamic scenarios **at scale**.
- Through **self-supervision**, EmerNeRF learns:
  - **Static-dynamic** scene decomposition
  - Highly accurate 3D **scene flows**
  - **Artifacts-free** foundational models' features
- Please refer to our project page and **open-sourced** code for more details:
  - Project page: https://emernerf.github.io/
  - Code Page: https://github.com/NVlabs/EmerNeRF

Project Page

Thanks for watching!