OUTLINE

Introduction

Challenges of Building UFMs

Overview of UFMs
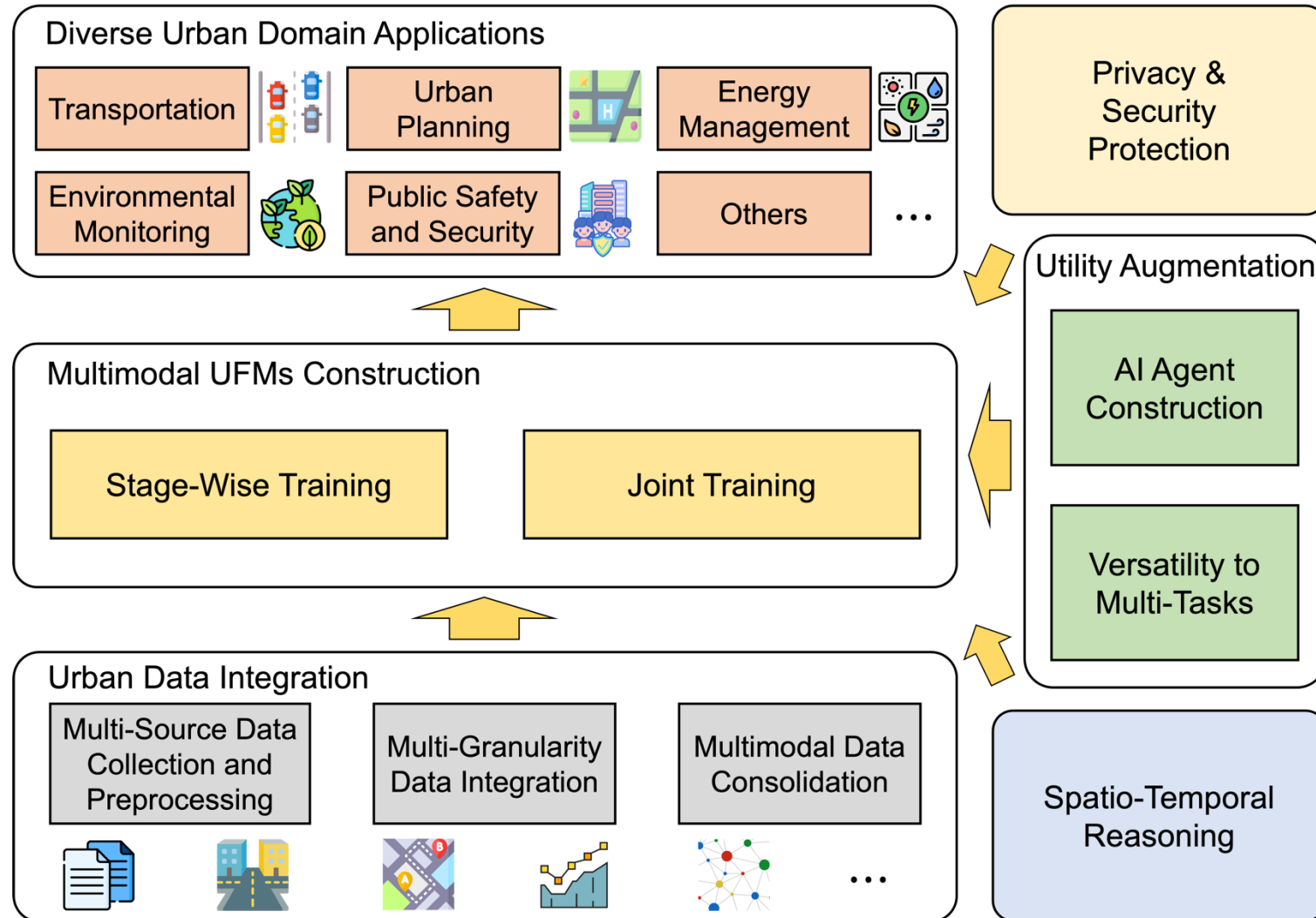
Prospects of UFMs

Summary

Prospective Framework of UFMs

- **Future UFMs may be a multi-agent system with a world simulator**

A prospective framework for building versatile multimodal UFMs.

Novel Urban Data Integration Method

➢ **Multi-source Data Collection and Preprocessing**

- Collect, select, augment multi-source urban data
- Preprocess and transform multi-source urban data

➢ **Multi-granularity Data Integration**

- Data standardization
- Hierarchical data structuring
- Data cross-referencing

➢ **Multimodal Data Consolidation**

- Data encoding
- Data alignment
- Multimodal data fusion

Multimodal UFM Construction

Stage-wise Training

Constructing unimodal FMs separately

⬇

Aligning unimodal FMs using multimodal urban data

V.S.

Joint Training

Optimizing the entire multimodal UFM jointly using multimodal urban data

Multimodal UFM Construction

Stage-wise Training

Joint Training

Pros:
1) Flexibility in integrating more modalities;
2) Can leverage established FMs.

urban data

V.S.

Pros:
1) End-to-end training;
2) Mutual enhancement among multimodal data.

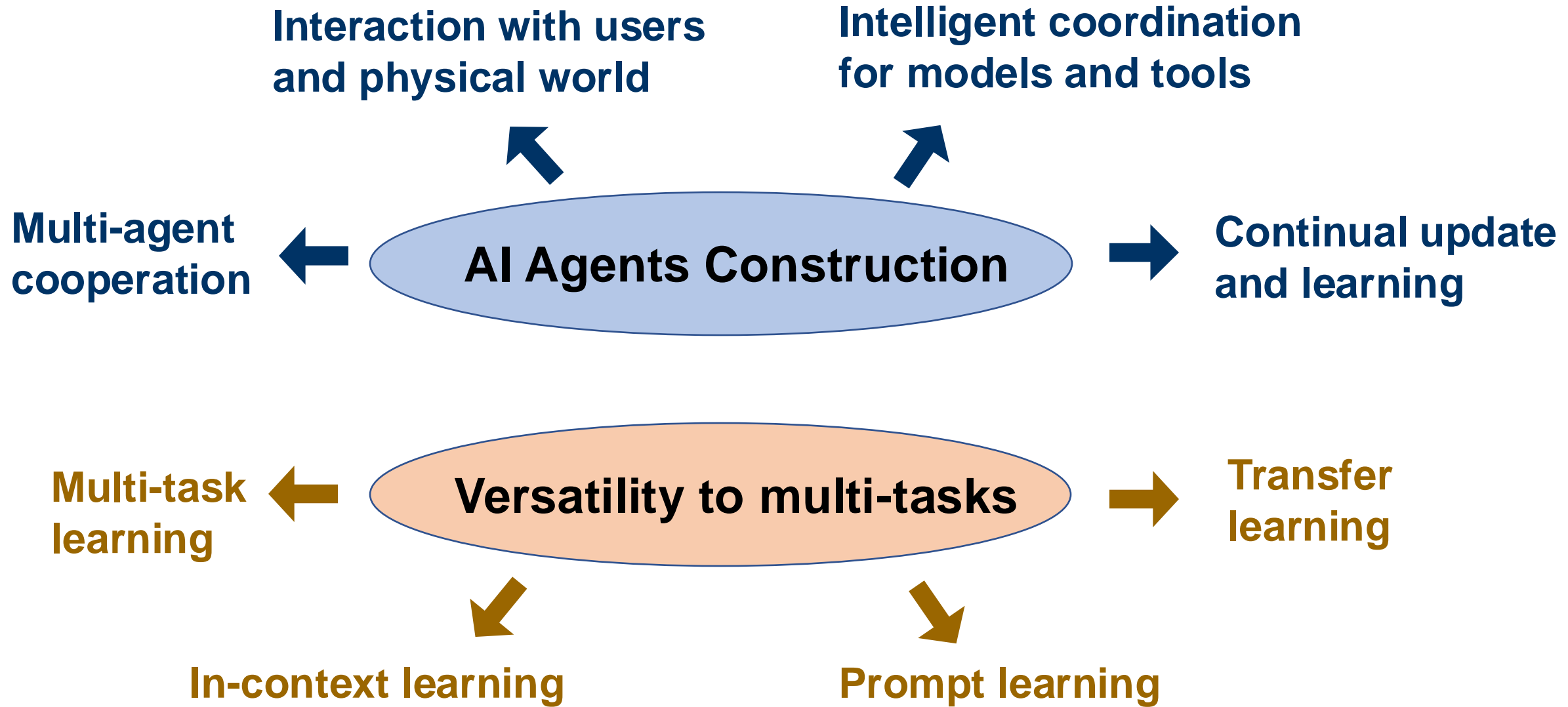# Spatio-Temporal Reasoning Skill Enhancement

Spatial Reasoning

- Tool invocation (GIS tool, GeoKG, database)
- Universal location embeddings
- Cross-modal geospatial alignment
- High-level geospatial capability learning

Temporal Reasoning

- Time embedding
- Temporal contextualization
- Sequence modeling

Utility Augmentation

Interaction with users
and physical world

Intelligent coordination
for models and tools

Multi-agent
cooperation

AI Agents Construction

Continual update
and learning

Multi-task
learning

Versatility to multi-tasks

Transfer
learning

In-context learning

Prompt learning

World Simulation

➢ **Latest generative models, e.g., Nvidia Earth-2, Sora, opens a new window to nexus the physical and cyber world.**
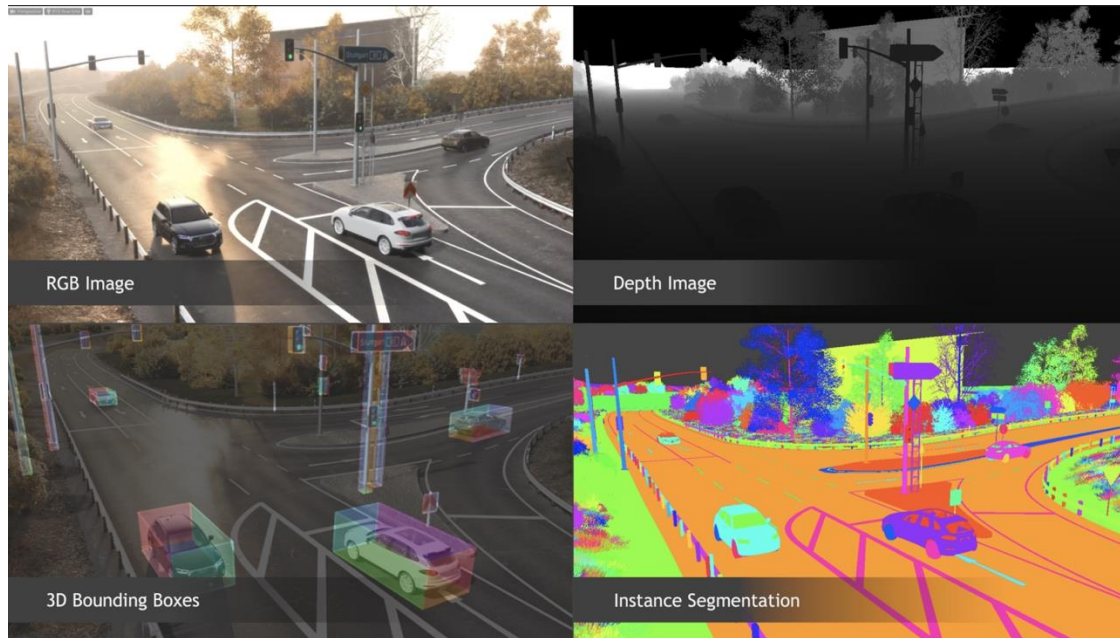
NVIDIA DRIVE Sim powered by Omniverse
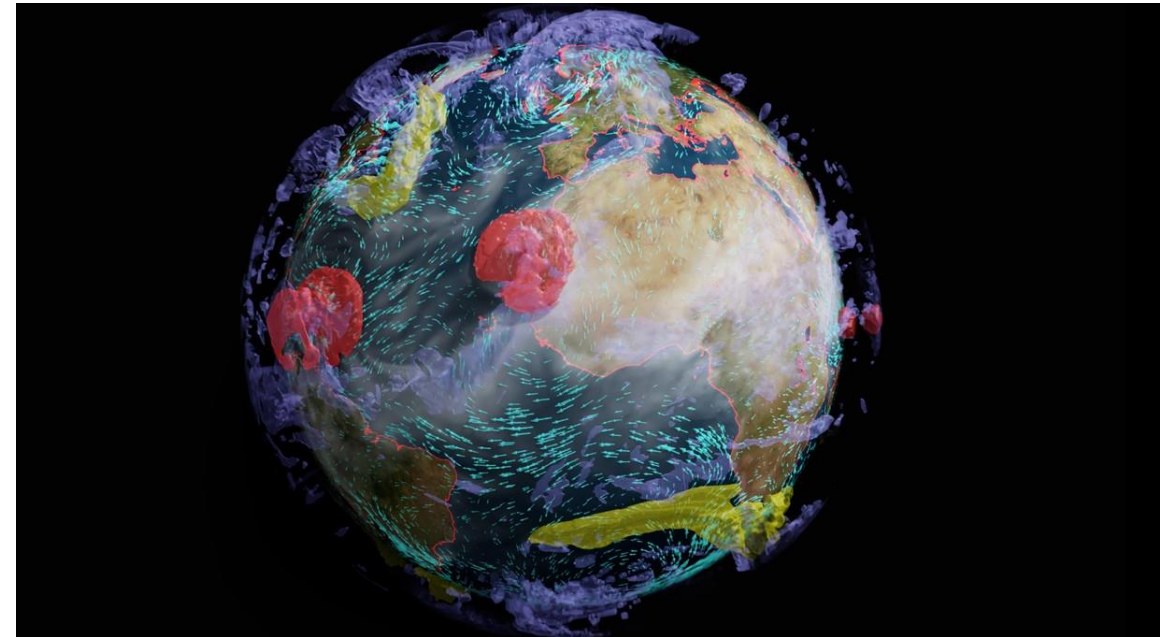
Earth-2 used to predict weather

Privacy, Security and Ownership

📊 Privacy preservation

- ➢ Federated learning of UFMs based on isolated and private data
- ➢ Prevention of user privacy leakage in user-UFM interactions
- ➢ Privacy-preservation of large model parameters

🛠 Security protection

- ➢ System and model level protection of malicious attacks
- ➢ Alignment of UFMs to human preference
- ➢ Defending generation of harmful, disruptive, and hallucinate outputs

▦ Data and model pricing

- ➢ Data pricing: contribution measurement and incentive for collaborative learning
- ➢ Model pricing: incentive for UFM development

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Conclusion

- **Summary**
  - Definition of *Urban Foundation Models (UFMs)*
  - Challenges of constructing UFMs
  - Taxonomy of existing UFM studies
  - A systematic review of Urban Foundation Models
  - Prospects of UFM studies

- **Future Work**
  - Integration of multi-source, multi-granularity and multimodal urban data
  - Enhancing spatiotemporal reasoning capabilities
  - Understanding urban dynamics and providing timely urban insights

The ultimate question: What are the ideal form of cities and societies?
We cannot achieve what we cannot imagine.

One More Thing

- We are preparing a special issue of Urban Foundation Model on ACM Transactions on Intelligent Systems and Technology (TIST)

- Tentative submission DDL: February 2025

- Topics of interest include, but not limited to theory, data, model architecture, training algorithm, evaluation, application, trustworthy issues, and ethic discussions

Please stay tuned!

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Thank you!
Q & A

Tutorial Website **Survey Paper** **Github**

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