GOMAA-Geo: Goal Modality Agnostic Active Geo-localization

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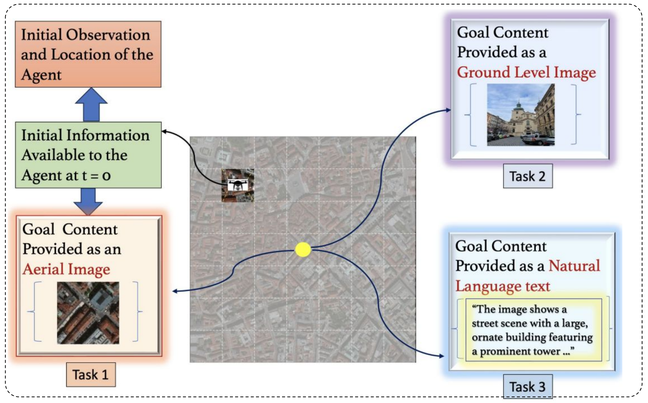
NEURAL INFORMATION PROCESSING SYSTEMS

Code and Model: github.com/mvrl/GOMAA-Geo

Problem Setup



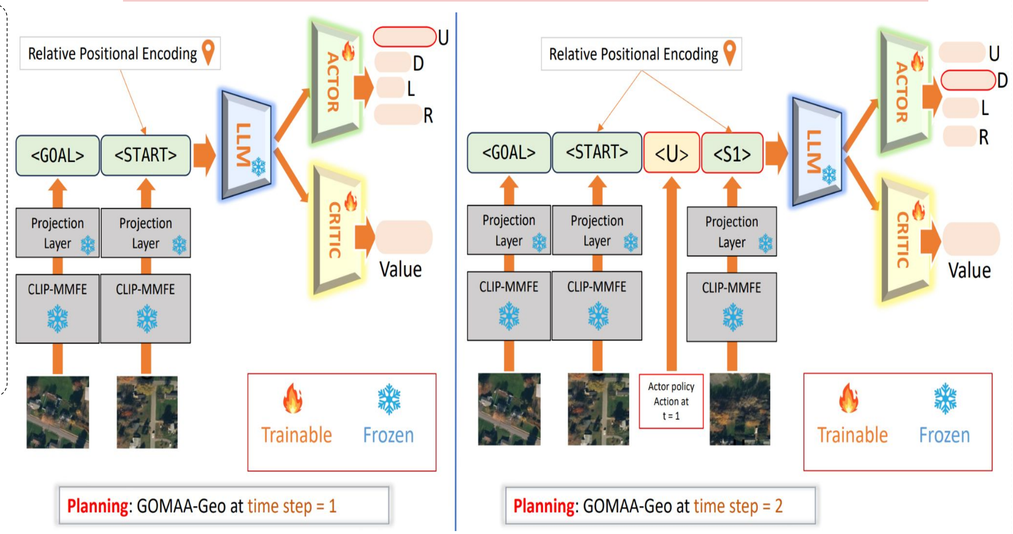
Motivation: Towards automating search-and-rescue

- **Intensifying climate change leads** to increased frequency and severity of **natural disasters**.
- Thus also an **increased need for search-and-rescue missions**.
- **Practical constraints** (e.g. flight time, battery, expert pilots).
- A big potential for an automated approach.

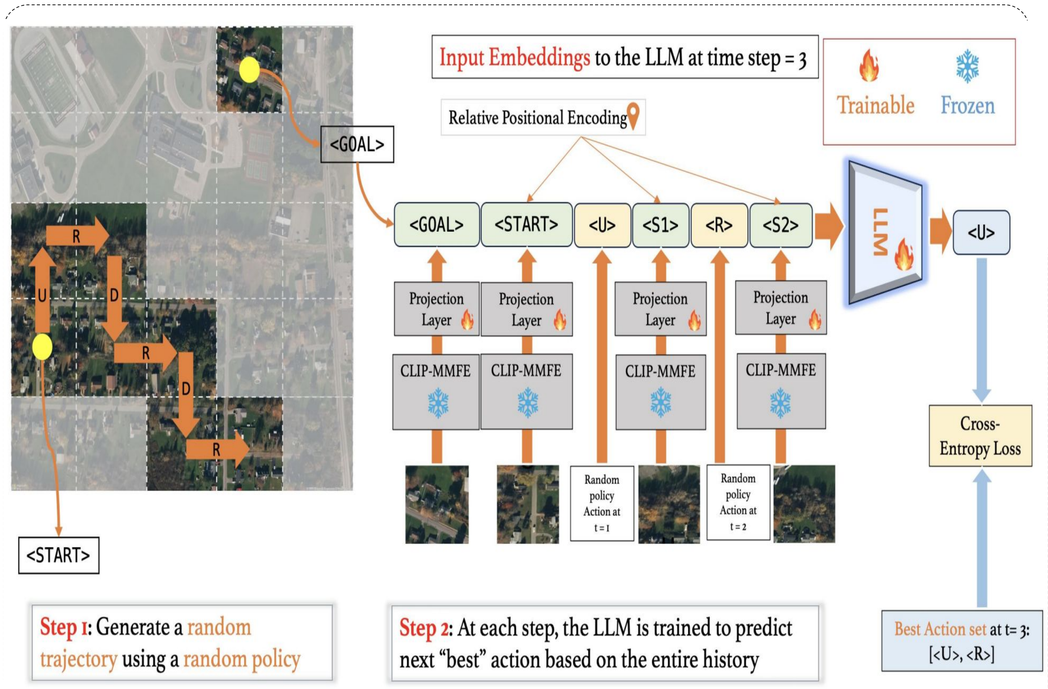
Key steps and components of GOMAA-Geo:

(1) Representation alignment across modalities
(2) RL-aligned representation learning using Goal Aware Supervised LLM Pretraining (*GASP*)
(3) Planning using RL (PPO)

Overview of GOMAA-Geo:



Goal modality agnostic: Zero-shot generalization between:
aerial view | ground level view | natural language text



Experimental results

GOMAA-Geo generalizes well across goal modalities

(only trained using aerial images as goal modality!)

Goal Modality	$\mathcal{C}=4$	$\mathcal{C}=5$	$\mathcal{C}=6$	$\mathcal{C}=7$	$\mathcal{C}=8$
Text	0.4000	0.4978	0.6766	0.7702	0.6595
Ground Image	0.4383	0.5150	0.6808	0.7489	0.6893
Aerial Image	0.4085	0.5064	0.6638	0.7362	0.7021

RL-based planning is crucial (LLM-based predictions alone are not sufficient for solving the AGL task)

Method	$\mathcal{C}=4$	$\mathcal{C}=5$	$\mathcal{C}=6$	$\mathcal{C}=7$	$\mathcal{C}=8$
LLM-Geo	0.2331	0.2591	0.3121	0.3967	0.4051
GOMAA-Geo	**0.4090**	**0.5056**	**0.7168**	**0.8034**	**0.7854**

GOMAA-Geo outperforms alternative methods

(tested on post-disaster, but trained on pre-disaster data)

Method	$\mathcal{C}=4$	$\mathcal{C}=5$	$\mathcal{C}=6$	$\mathcal{C}=7$	$\mathcal{C}=8$
Random	0.1412	0.0584	0.0640	0.0247	0.0236
PPO	0.1132	0.1146	0.1292	0.1665	0.1953
DiT	0.1012	0.2389	0.3067	0.3390	0.3543
AiRLoc	0.1201	0.1298	0.1507	0.1631	0.1989
GOMAA-Geo	**0.4002**	**0.4632**	**0.6553**	**0.7391**	**0.6942**

Visualization of GOMAA-Geo