Agent-Based Modeling of Flood Evacuation Dynamics Driven by Large Language Models

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Take Home Message
(1) We developed an Agent-Based Model (ABM) where each agent is driven by a Large Language Model (LLM).
(2) LLM agents exhibit realistic behaviors such as hesitation, dependency, and non-compliance, providing a more accurate estimation of real-world evacuation risks over idealized models.
(3) Social roles and age significantly influence the LLM agents' decision to evacuate.

Introduction
Urban flood resilience relies on accurate evacuation modeling. Traditional engineering models assume that agents act rationally and obey warnings instantly. However, this fails to capture human hesitation, fatigue, and social friction. Agent-Based Modeling using Large Language Models (LLMs) as the cognitive brain of agents allows inputs of qualitative context such as stamina, family role, and panic.

Method

Case Study
2018 July Storm (Historical-3 day rainfall of 434 mm) in Mikage, Kobe

**Computational Resource**
Supercomputer Fugaku

LLM-driven ABM

Environment
- Flood Depth
- Gov/Media Warnings
- Social Network signals

★ Shelter

▲ Flood Simulation:HEC-RAS
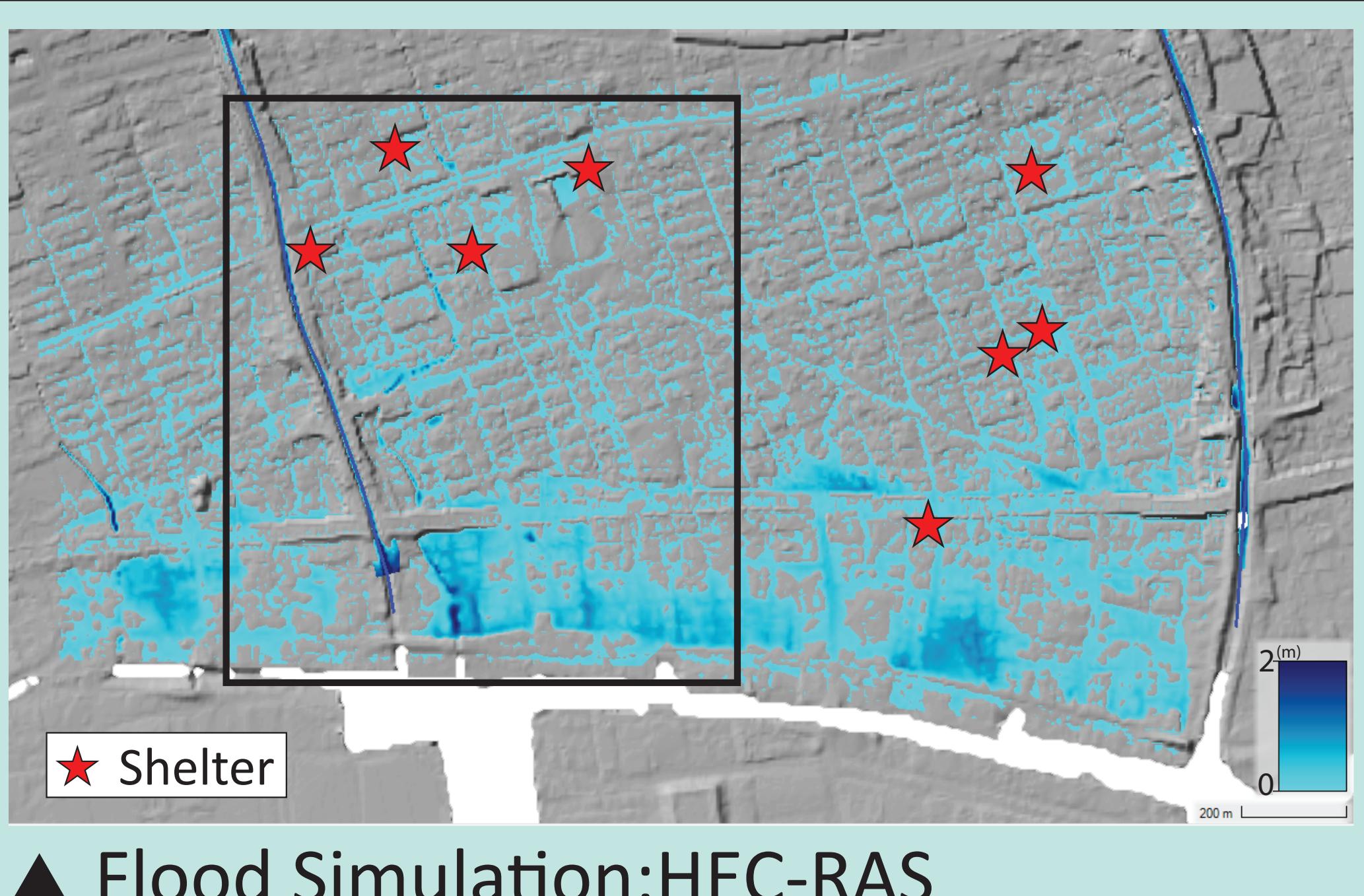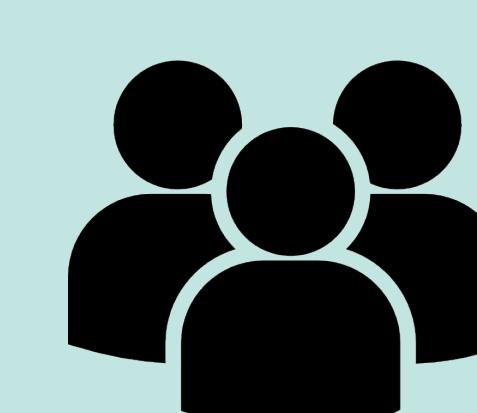
Agents
- Age
- Gender
- Family Role
- Stamina
- Memory

Input Example
You are a 37 year old Female, ..., current stamina is high, ... , current Flood Depth is 0.05m ... .

Physical Simulation
Simulation of Urban MObility (SUMO)
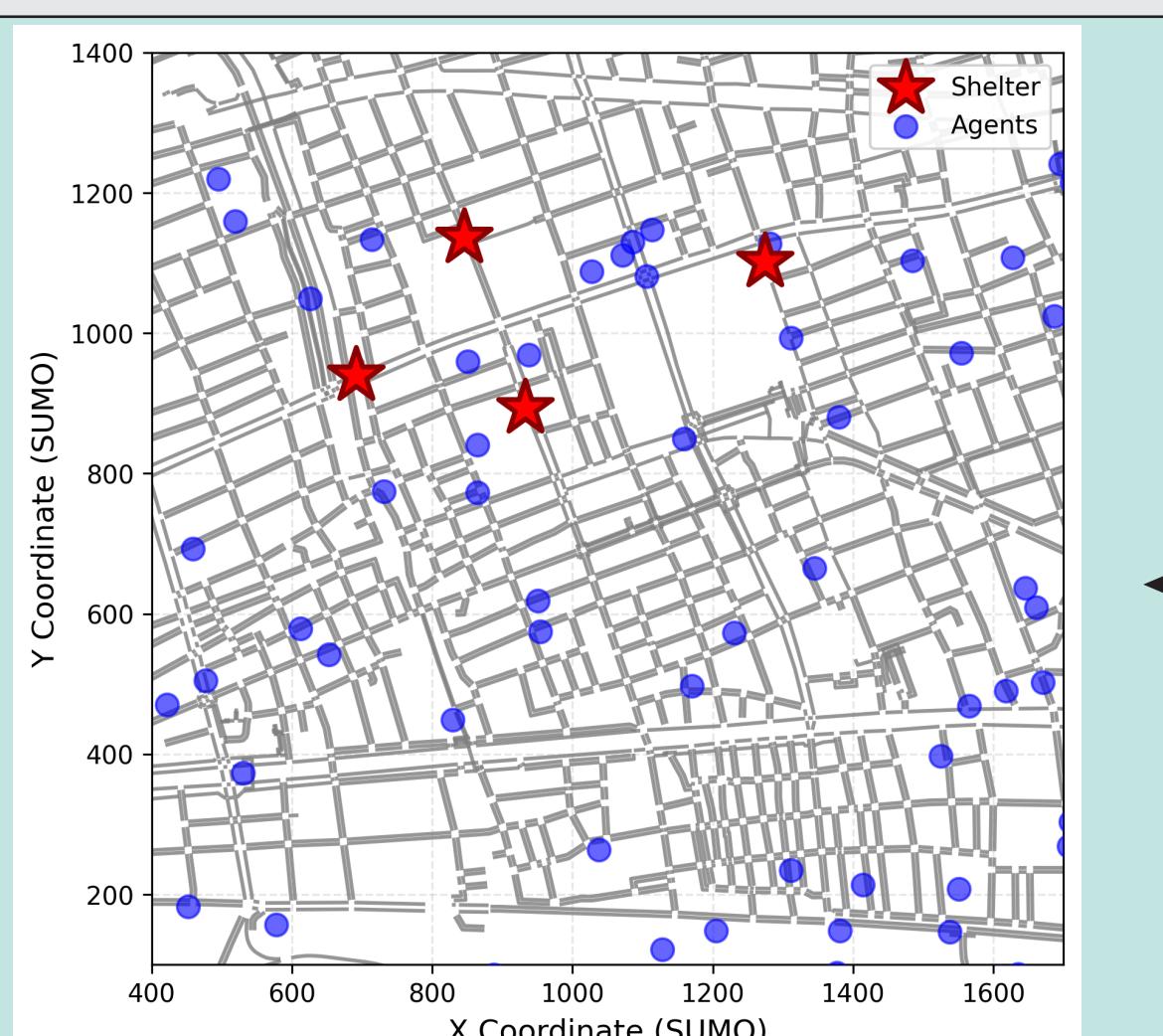
Traffic Control Interface (TraCI)

Stay or Evacuate

Cognitive Loop
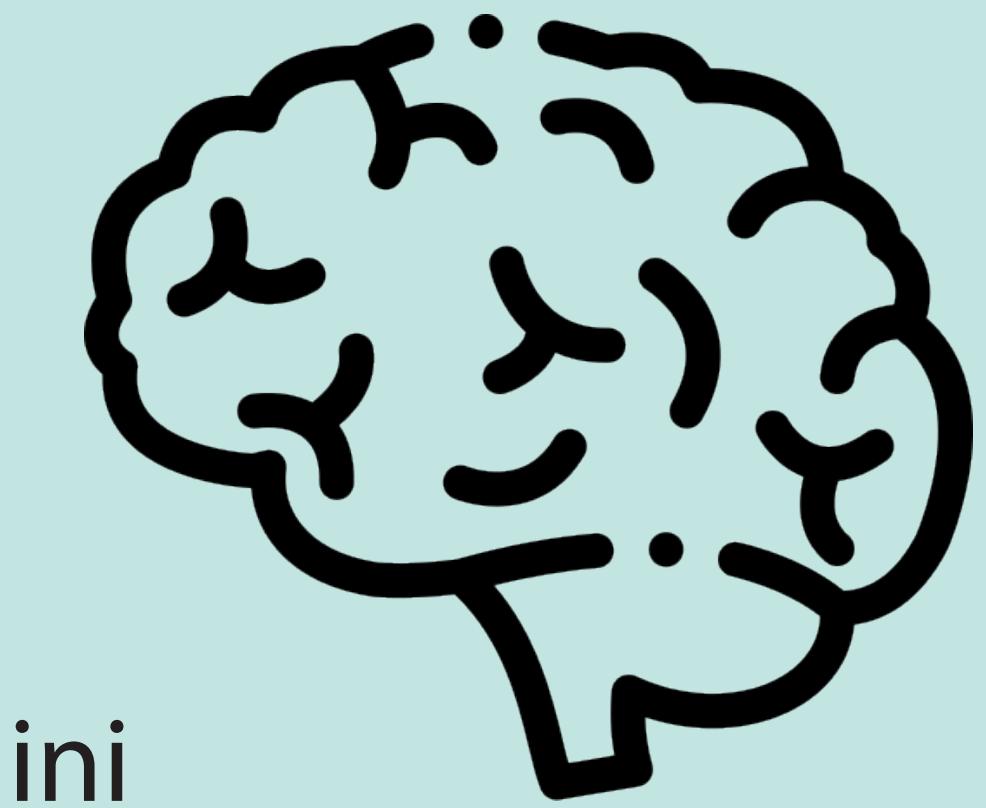
LLM Phi3:mini

Result

ABM vs Idealized Model

- LLM-driven agents display human-like hesitation for evacuation.
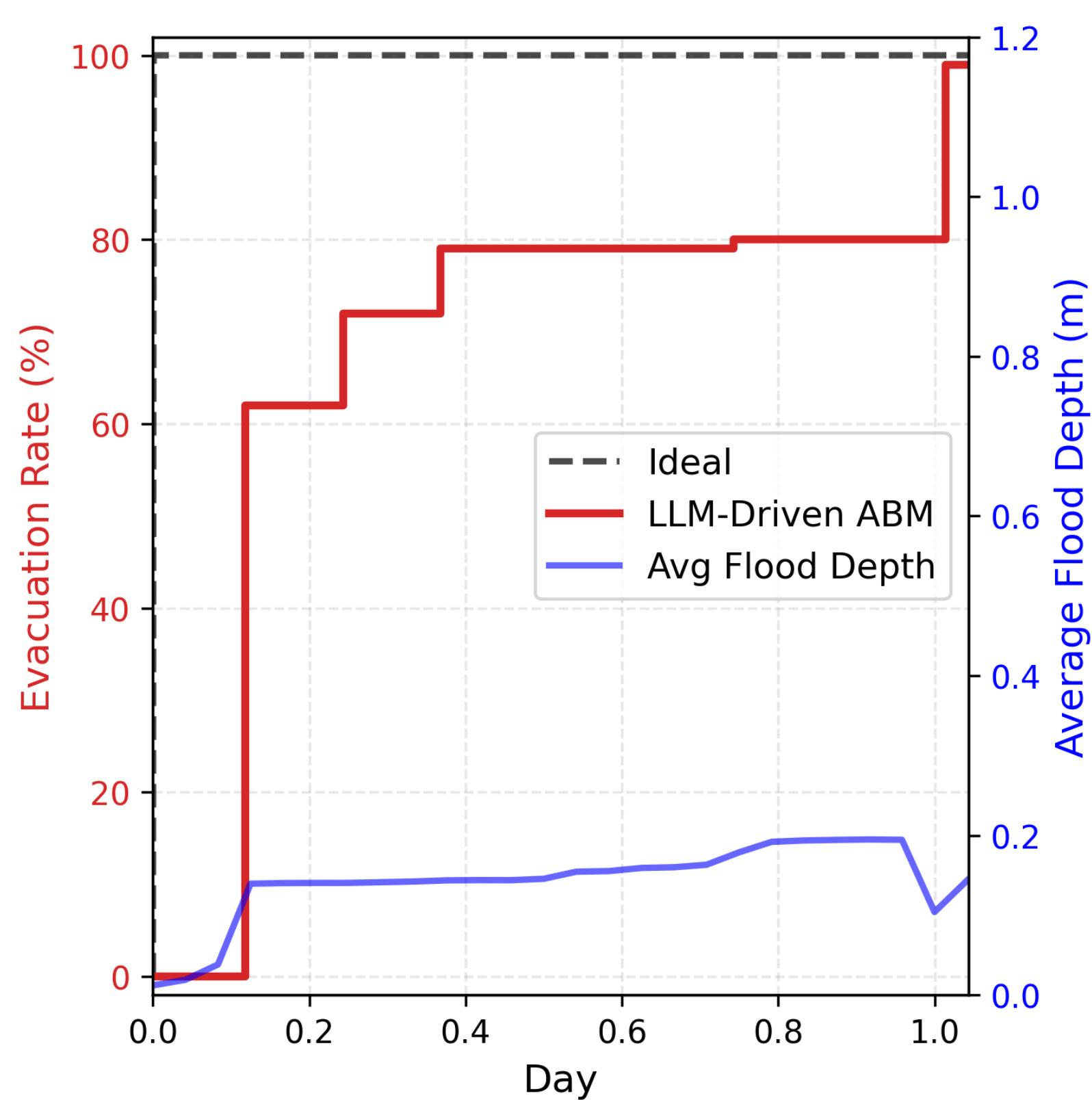
LLM Evacuate vs. LLM Stay
Age
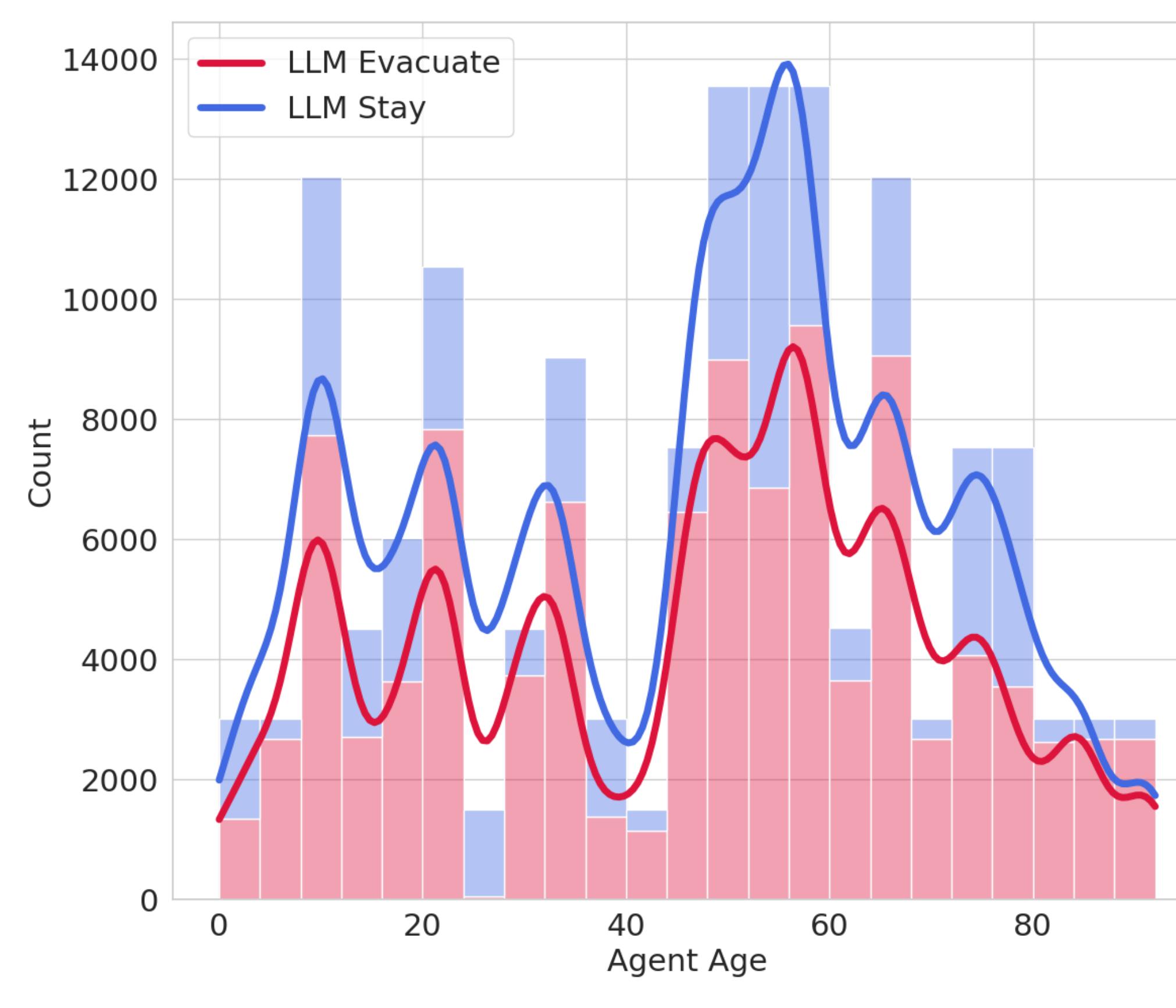
- Adults show the highest evacuation rates
- LLM-driven ABM prioritizes agents capable of independent action to evacuate

Family Role
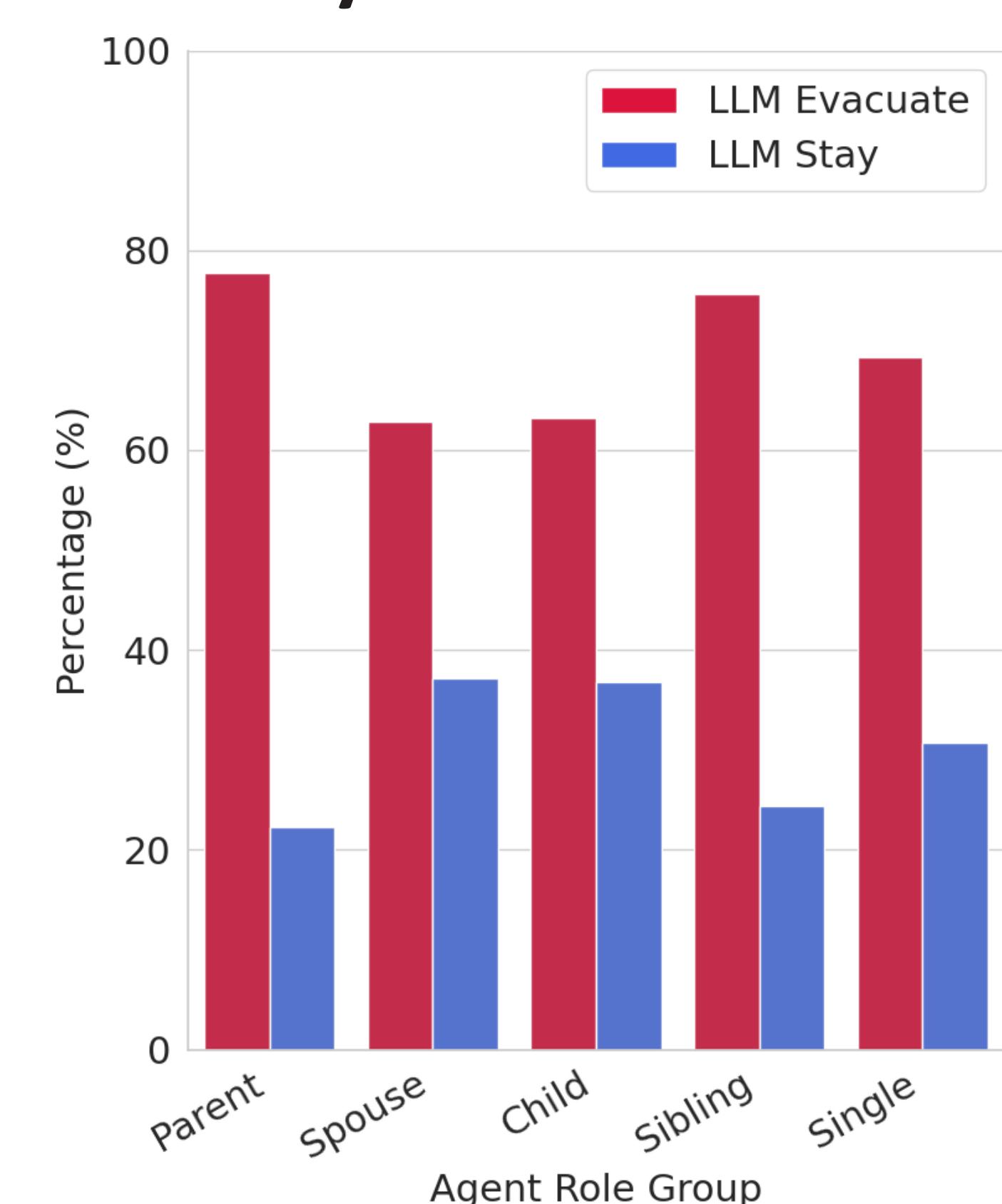
- Parents show the highest evacuation rates
- LLM simulates instinct to protect the household