Understanding Text Using Agent Based Models

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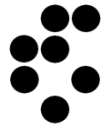


Outline

- Introduction
- Problem Description
- Approach Description
- Demonstration
- Discussion

Introduction

- AI can be used for commonsense inferences
  - COMET, MultiCOMET
  - Inferences are precise, but unexplainable
  - Lack structure to explain & predict events
- Agent Based Models
  - Simulate complex agent interactions
  - Can’t understand stories in greater depth
  - No commonsense reasoning
- We propose a system to:
  - understand short text-based stories
  - generate & simulate explainable stories

Problem Description

- Given the text of a short story
- Create an Agent-based world model with
  - Story description that is
    - machine understandable
    - actionable
    - representative of story's dynamics
    - encodes implicit knowledge
  - Simulation of the story & potential variations
    - includes key story elements & relevant details
    - explainable agent actions
  - Question answering
    - explicit & implicit story elements

Little Red Riding Hood

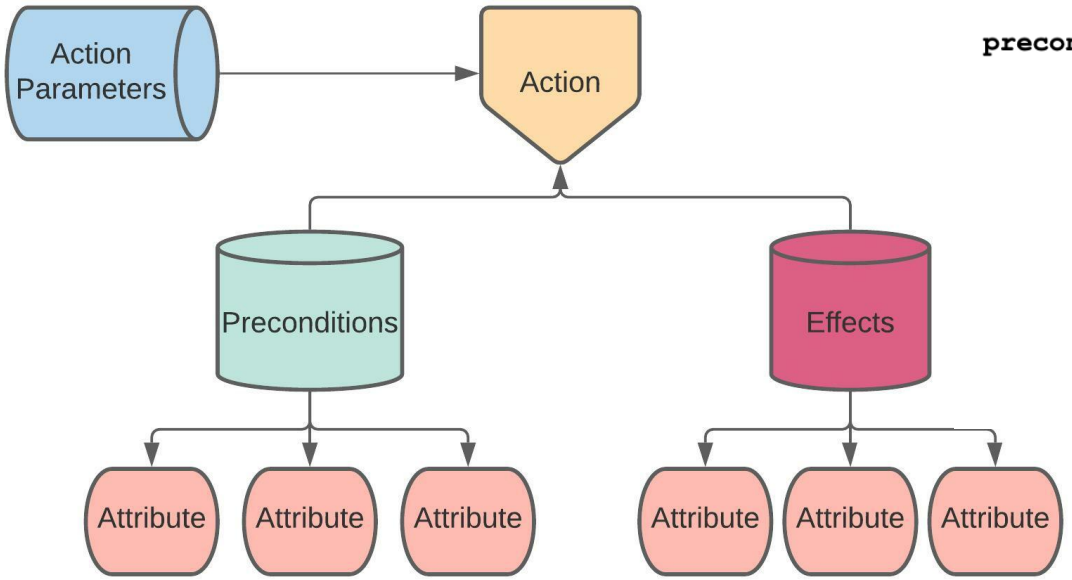
by Leanne Guenther

Once upon a time, there was a little girl who lived in a village near the forest. Whenever she went out, the little girl wore a red riding cloak, so everyone in the village called her Little Red Riding Hood.

One morning, Little Red Riding Hood asked her mother if she could go to visit her grandmother as it had been awhile since they'd seen each other.

Approach Description: Agent Attributes & Actions

- Attribute: any agent-related information
  - Location, inventory of items, awareness of other agents…
- Action:
  - Parameters – action-specific inputs
  - Preconditions – if true, then execute action
  - Effects – attribute value changes

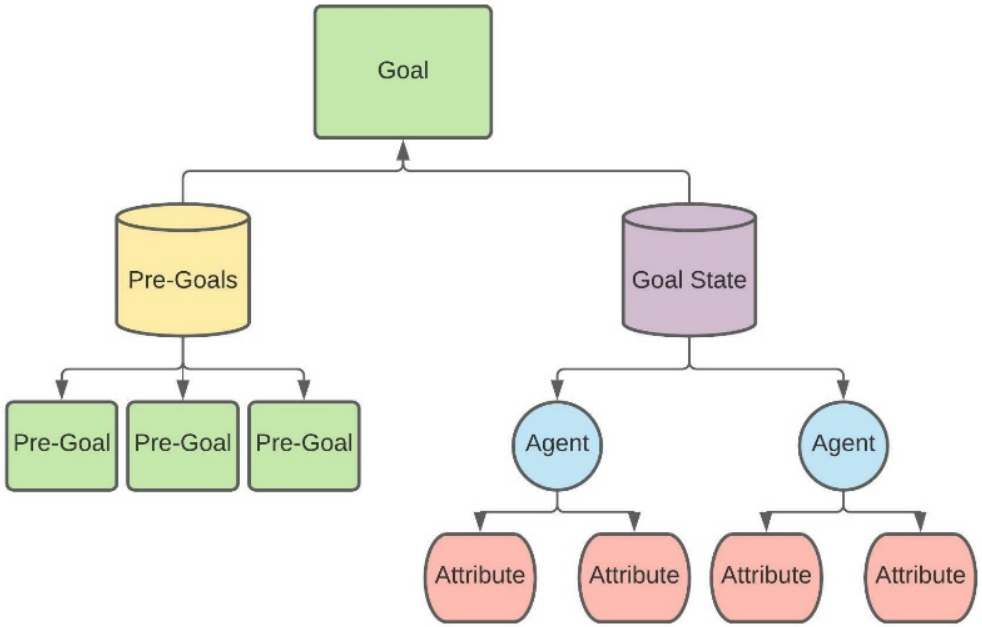


Pseudocode Example

```
action: Eat (?monster, ?victim, ?location)
precondition: knows(?monster, ?victim),
              alive(?monster), alive(?victim),
              ¬eaten( ?victim),¬full(?monster),
              at(?monster, ?location),
              at(?victim, ?location),
              ?monster ≠ ?victim
effect: eaten(?victim)
        in(?victim, ?monster), full(?monster),
        ¬at(?victim, ?location)
```

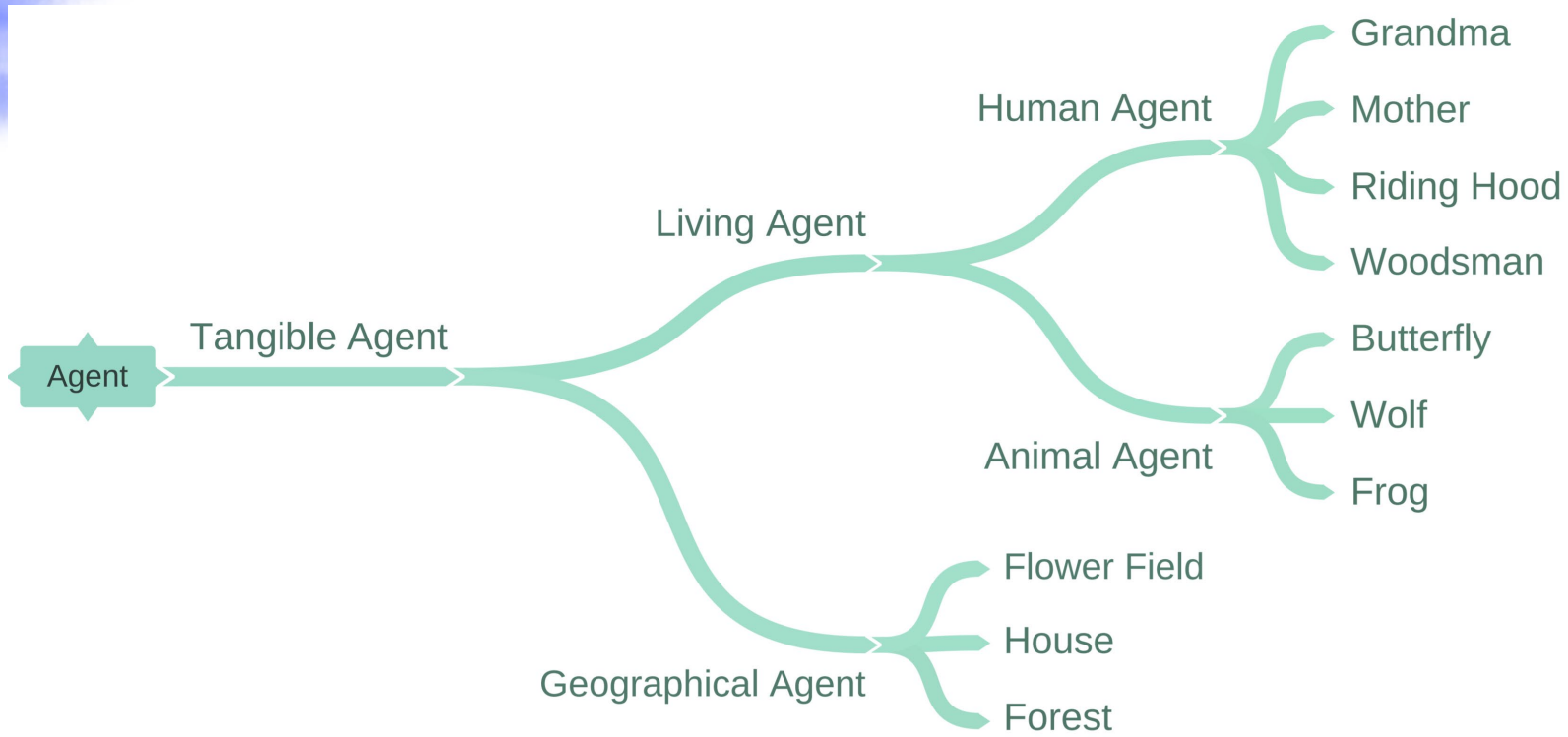
Approach Description: Agent Goals

- Goal
  - Pre-Goals
    - Completed before agent can start working towards the goal
  - Goal State
    - Set of agents with specific attribute values
    - Describes world model's state upon goal completion



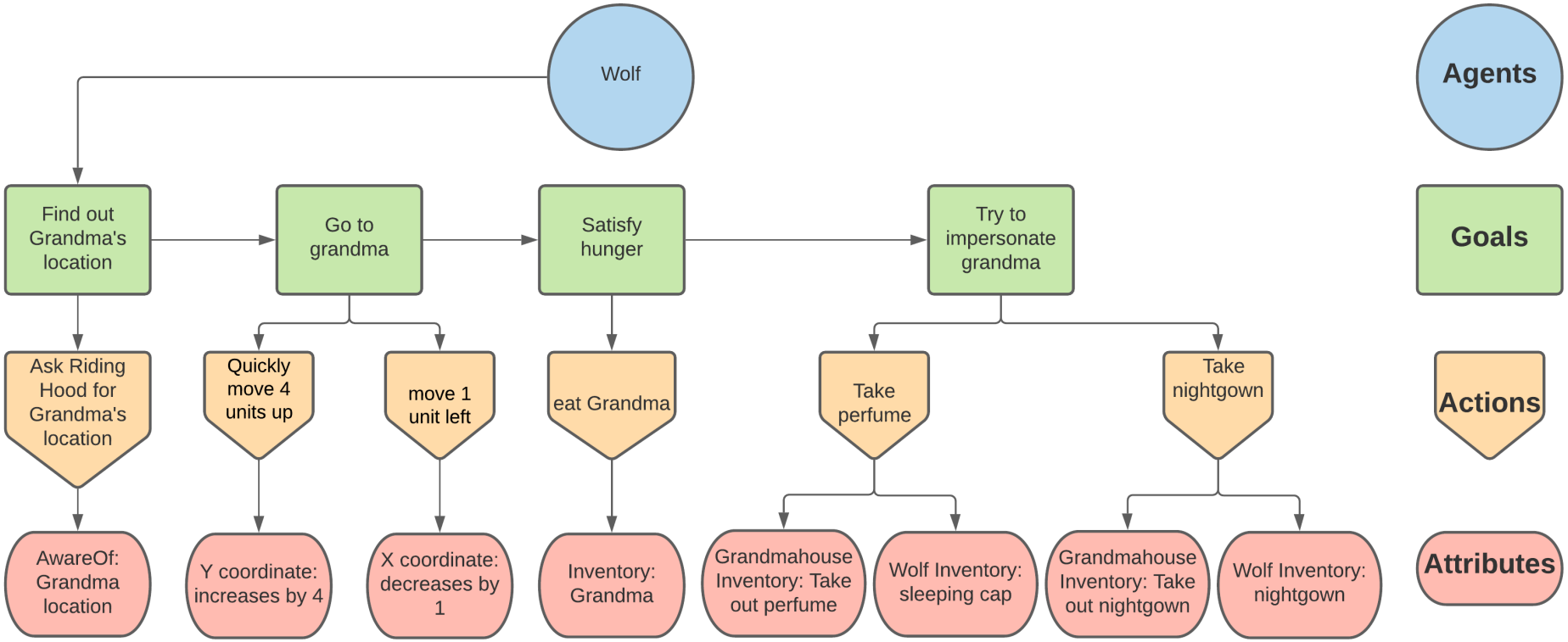
Approach Description: Defining Agents

- Agents are defined through hierarchy
- Agent type determines attributes, actions and goals of agent



Example Agent

Partial representation of the Wolf agent



Approach Description: Story Simulation

- Identify key story elements
- Manually define world model
  - Initialize story context (agents, agent attribute values)
  - Set up story dynamics (agent goals, if any)
- Automatically simulate story
  - Agents choose best action to execute at each time unit

```
1 Until All Active Goals Not Complete
2   For Random Agent
3     For All Possible Actions
4       Simulate Action
5       If Action brings Agent closest to its Goals
6         Set this as new Best Action
7     Execute the Best Action
```

Demonstration: Initialization

- Example story: ‘Little Red Riding Hood’
- Restructured into 73 simplified sentences
- Identified 23 key events involving 7 main agents
- Define world model to match story setting
  - Set of agents
  - Initial agent attribute values
  - Agent goals

1. Discuss visiting Grandma with Mother
2. Get flowers for Grandma
3. Visit Grandma
4. …

1. Mother
2. Riding Hood
3. Flower Field
4. Butterfly
5. Wolf
6. Grandma
7. Woodsman

**********	grandmahouse,grandma	**********forest13	*******forest14,wolf
**********forest1	**********	**********forest5	**********forest12
****forest4,woodsman	**********	**********forest8	**********forest10
**********forest3	**********	**********forest7	**********forest11
**********forest2	**********	***forest6,butterfly	**********forest9
******flower field 1	******flower field 2	******flower field 3	**********
**********	**********	**********	**********
**********	**********	**********	**********
**********	******rhhouse,mother	**********	*********riding hood

Demonstration: System Output

- Textual description of each executed action
  - Who executed which action? Who else was involved?
  - Why was the action executed?
- Agent location configuration
  - X, Y grid – slots include list of agents at the location

```
At 42 minutes, riding hood put flowers into grandma's inventory, in order to give grandma gifts
******************************|grandmahouse,wolf,woodsman,grandma,riding hood|******************
************************forest1|******************************|************************forest5|
************************forest4|******************************|************************forest8|
************************forest3|******************************|************************forest7|
************************forest2|******************************|***************forest6,butterfly|
******************flower field 1|******************flower field 2|******************flower field 3|
******************************|******************************|******************************|
******************************|******************************|******************************|
******************************|******************rhhouse,mother|******************************|

At 43 minutes, woodsman moved 1 unit right, in order to get rid of wolf
******************************|grandmahouse,grandma,riding hood|**********forest13,wolf,woodsman|
************************forest1|******************************|************************forest5|
************************forest4|******************************|************************forest8|
************************forest3|******************************|************************forest7|
************************forest2|******************************|***************forest6,butterfly|
******************flower field 1|******************flower field 2|******************flower field 3|
******************************|******************************|******************************|
******************************|******************************|******************************|
******************************|******************rhhouse,mother|******************************|
```

Demonstration: Simulate Story Dynamics

- Actions by 3 agents, 14 goals
- 48 actions, 12 unique action types
- 5 main story segments
  - Riding Hood discusses visiting Grandma with Mother **(6 actions)**
  - Riding Hood meets Wolf and goes to Grandma **(23 actions)**
  - Wolf eats Grandma and tries to impersonate her; Riding Hood arrives at GrandmaHouse and cries for help **(6 actions)**
  - Woodsman saves Grandma and takes Wolf away, Riding Hood gifts Grandma **(13 actions)**

```
At 16 minutes, riding hood looked at butterfly, in order to enjoy nature
At 17 minutes, wolf became aware of grandma's location by asking riding hood, in order to find out grandma's location
At 18 minutes, wolf quickly moved 4 units up, in order to go to grandma
At 19 minutes, wolf moved 1 unit left, in order to go to grandma
At 20 minutes, wolf ate grandma, in order to satisfy hunger
At 21 minutes, riding hood looked at butterfly, in order to enjoy nature
At 22 minutes, riding hood looked at butterfly, in order to enjoy nature
At 23 minutes, wolf took grandma perfume from grandmahouse's inventory, in order to try impersonating grandma
At 24 minutes, wolf took nightgown from grandmahouse's inventory, in order to try impersonating grandma
At 25 minutes, riding hood looked at butterfly, in order to enjoy nature
At 26 minutes, wolf took sleeping cap from grandmahouse's inventory, in order to try impersonating grandma
At 27 minutes, riding hood looked at butterfly, in order to enjoy nature
```

Discussion

- Main Contributions
  - Approach to explainable story understanding
  - System generating stories, given set of agents with attributes & goals
  - Publicly available source code: github.com/AMGrobelnik/Understanding-Text-Using-Agent-Based-Models
- Future Work
  - Integration of commonsense inferences (MultiCOMET)
  - Dynamic goals – change based on agent's environment
  - Simultaneous goals for all goal types
  - Describe more complex phenomena
    - real-world events, geopolitics,…
  - User evaluation of system's performance