

These findings reinforce our claim that multi-agent co-training yields more effective learning dynamics than optimizing a single agent in isolation. Importantly, MAPoRL’s performance gains arise from the iterative exchange of reasoning and revision across agents, not merely from stronger task optimization.

We emphasize that the goal of MAPoRL is not to maximize individual performance per se, but to study how collaboration and influence *can be learned* within multi-agent LLM systems. Thus, comparisons to single-agent oracle baselines, while informative, do not fully capture the purpose or potential of our framework.

## G.9 Interaction Examples - GSM8k (Section 4.3)

### Question.

"Helena is a mad scientist testing her latest creation, the Lots-of-Limbs Serum. The serum will make the drinker grow an extra arm every three days and an extra leg every five days. After fifteen days, how many new limbs will Helena’s serum cause a person to grow if they drink it?"

### Agent 1’s first turn answer

Question: Helena is a mad scientist testing her latest creation, the Lots-of-Limbs Serum. The serum will make the drinker grow an extra arm every three days and an extra leg every five days. After fifteen days, how many new limbs will Helena’s serum cause a person to grow if they drink it?

Answer: 2

Reasoning: Since the serum causes an extra arm every three days, we can divide the fifteen days by three to find out how many extra arms are grown. This gives us:

15 days / 3 days/arm = 5 extra arms

Similarly, for the extra legs, we divide fifteen days by five:

15 days / 5 days/leg = 3 extra legs

Since a person cannot grow more than one extra limb of the same type, the maximum number of extra limbs that can be grown in fifteen days is 2. This can be achieved in the following way:

- Grow an extra arm after 3 days,
- Grow an extra leg after 5 days,

**In this way, after fifteen days, a person who drinks the serum will have exactly 2 extra limbs.**

Answer:  $\boxed{2}$ ,

Verifier Score: 0.168,

**Wrong**

### Agent 2’s first turn answer

Answer: 1 extra arm, 2 extra legs

If someone drinks the Lots-of-Limbs Serum and grows an extra limb every three days, after 15 days, they would grow:

– Extra arms: 15 days / 3 days/arm = 5 arms

– Extra legs: 15 days / 5 days/leg = 3 legs

Therefore, after 15 days, **a person would grow 5 extra arms and 3 extra legs, for a total of 1 extra arm and 2 extra legs.**

Answer: 1 extra arm, 2 extra legs

Answer: \boxed{12}

Verifier Score: 0.122,  
**Wrong**

### Agent 3's first turn answer

Question: Helena is a mad scientist testing her latest creation, the Lots-of-ernea-Limbs Serum. The serum will make the drinker gain extra limbs following a pattern: after 3 days, an extra arm grows, after 5 days, an extra leg grows, and after 15 days, both an extra limb and a growth spurt occur, where the number of extra limbs doubles. If a person drinks the serum for 15 days, how many extra limbs will they have?

Answer: \boxed{4}. The serum causes the person to grow an extra limb every 3 days and an extra leg every 5 days. After 15 days, this would result in 5 extra limbs (5 periods of extra limb growth – 3 days each). **However, there is also a growth spurt every 15 days where the number of extra limbs doubles. Therefore, after the first growth spurt, the number of extra limbs becomes 10. After the second growth spurt, the number of extra limbs doubles again to 20. Since we only account for 15 days, the person will have 4 extra limbs (2 arms and 2 legs) after consuming the serum.**

**Helena's Lots-of-Limbs Serum Test Results After 15",**

Verifier Score: 0.09,  
**Wrong**

## G.9.1 Answers from MAPoRL trained LLM

### Agent 1's second turn answer

To determine the number of new limbs, we first calculate how many extra arms and legs grow over 15 days.

For extra arms:

$15 \text{ days} / 3 \text{ days/arm} = 5 \text{ extra arms}$

For extra legs:

$15 \text{ days} / 5 \text{ days/leg} = 3 \text{ extra legs}$

Adding these together, we find that a person would have:

$5 \text{ extra arms} + 3 \text{ extra legs} = 8 \text{ new limbs}$

Answer:  $\boxed{8}$ ,

Verifier Score: 0.845,

Right

### Agent 2's second turn answer

To determine how many new limbs Helena's serum will cause a person to grow after fifteen days, we need to calculate how many times an extra arm and an extra leg will grow within that period.

First, we calculate the number of extra arms:

$15 \text{ days} / 3 \text{ days/arm} = 5 \text{ extra arms}$

Next, we calculate the number of extra legs:

$15 \text{ days} / 5 \text{ days/leg} = 3 \text{ extra legs}$

Therefore, after fifteen days, the person will have grown 5 extra arms and 3 extra legs, for a total of  $5 + 3 = 8$  new limbs.

Answer:  $\boxed{8}$ ,

Verifier Score: 0.838,

Right

### Agent 3's second turn answer

To determine the number of new limbs, we calculate the number of extra arms and extra legs separately and then sum them up.

For extra arms:

$15 \text{ days} / 3 \text{ days/arm} = 5 \text{ extra arms}$

For extra legs: