

MAS-Homework 2

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1 Prompt Engineering

First of all, I tried introducing the LLM into the problem by giving him context:

- The description for the TYPE of agent
- The item name
- The budget for the item
- Type of negotiation (Dutch)

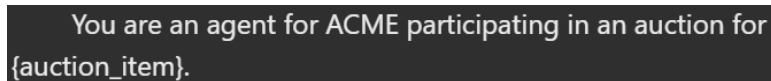
However, it worked pretty poorly because for the ACME agent, it did not recognise that IT has to initiate the contract negotiation. To remedy that, I added various types of hints and instructions, so that it knows that IT has to propose a starting BID because without him starting the price, the LLM would just start assuming vary bad cases where even the starting price is bigger that its budget by at least 2000\$. In that case, its strategy was to hope that the starting price will not have any bidders, so the price will go down.

Then, I had to give a Goal and after testing, just saying "your goal is to complete the headquarters and maximise profit" did not work as it was overly focused on achieving the highest profit. So I changed into fig [3]. For the contract agent, one challenge I encountered was its need to get at least one contract. After a few test, it always preferred to obtain profit more that the contract, even though the price, he was offered was more than the cost. To solve this problem, I nuanced the priority of the contracts by writing "PRIMARY goal" and all of one agent's specialities in case one or 2 of its specialities were more expensive than other companies' services. To keep in mind, that after completing a contract, its agent achieved its primary goal, and can now start on maximizing profit, I added the information of the number of contracts won. This was done by adding a new value to the class that was incremented every time the method **notify_contract_assigned** was called. In `respond_to_offer`, I kept as a information the list of specialities for the same reason mentioned above.

For the agents, I tried giving them the number of companies that were fighting in the same bidding war, but it never had any impact, even though knowing an agent is the only Company Agent with a speciality, is a powerful information because it allows a drastic increase in price, because the ACME needs to buy that speciality to complete its PRIMARY objective. Since it never got me any results, I stopped giving them that information. As seen in fig [4], I added to a a phrase like that to every prompt, so that I know what is the reasoning behind every strategy.

Other important information, I included in the prompts are:

- Round of Action or Negotiation as seen in fig [5] to improve the behavior of the LLM
- Direction of Proposal [7]



You are an agent for ACME participating in an auction for {auction_item}.

Figure 1: Agent Description

You're initiating the auction for {auction_item} and proposing a starting price.
Follow the Dutch (descending) auction protocol and ensure your reasoning is step-by-step.

Figure 2: Initiation Description

Your PRIMARY goal is to complete the headquarters within the budget.
Your SECONDARY goal is to pay less than your budget {self.budget list}.

Figure 3: Adding Goals

Follow the monotonic concession protocol, which means making reasoning in response to offer. Think about it step by step, analyzing advantages and risks of its current situation. Please, return the response as a float value with the offer.

Figure 4: Analysis

Determine Auction Round: This is the first round out of three, indicating multiple opportunities for bidding.

Figure 5: Round

Budget Constraint: {self.budget_list} denotes the budget allocated for the auction. It's essential to adhere to this budget to ensure financial feasibility.

Figure 6: Budget Constraint

You start with a proposal price towards other companies with this item {auction_item} as a specialty.

Figure 7: Prompt - specialty

1.1 Prompts

decide.bid:

```
system_prompt = f"""
You are a company agent with specialties in {self.specialties.keys()}.
Your PRIMARY goal is to win at least one contract and your SECONDARY goal is
to maximize your profit.
There is going to be an auction for {auction_item} with 3 rounds.
You as a company agent already completed {self.done_contracts} contracts.
Your minimum demand to get a contract for {auction_item} is
{self.specialties[auction_item]}.
It's round {auction_round} out of 3 and the budget offered for this round is
{item_budget}, but you are deciding whether to bid in or not.
Follow the Dutch (descending) auction protocol and ensure your reasoning.
Think about it step by step, analyzing advantages and risks of its current situation.
Please, return the response as a boolean value if you wanna bid or not.
"""
```

respond.to_offer:

```
system_prompt = """
You are a company agent negotiating for a contract from {initiator_msg.sender}.
The negotiation item is {initiator_msg.negotiation_item} and it's currently round
{initiator_msg.round} of 3.
The offer made by the client in the last round was {initiator_msg.offer}.
Your specialties are in {self.specialties}.
Your PRIMARY goal is to win
at least one contract and your SECONDARY goal is to maximize your profit.
Follow the monotonic concession protocol, which means making reasoning
in response to offers.
Think about it step by step,
analyzing advantages and risks of its current situation.
Please, return the response as a float value with the offer.
"""
```

propose.item.budget:

```
system_prompt = f"""
You are an agent for ACME participating in an auction for {auction_item}.
Your budget is {self.budget_dict[auction_item]}.
Your PRIMARY goal is to complete the headquarters within the budget.
Your SECONDARY goal is to pay less than your budget {self.budget_dict[auction_item]}.
It is round {auction_round} out of 3.
You start with a proposal price towards other companies with
this item {auction_item} as a specialty.
You, as the agent of ACME, take initiative and propose the starting
price for {auction_item}.
Follow the Dutch (descending) auction protocol and ensure your reasoning.
Think about it step by step, analyzing advantages and risks of the current situation.
Please, just return the response as one float value referencing the budget.
"""
```

provide_negotiation_offer:

```
system_prompt = f"""
You are an agent for ACME negotiating for {negotiation_item}.
Your budget is {self.budget_dict[negotiation_item]}.
Your PRIMARY goal is to complete the headquarters within the budget.
Your SECONDARY goal is to pay less
than your budget {self.budget_dict[negotiation_item]}.
```

You are currently negotiating with company {partner_agent} and they countered our last offer by asking this price.
It is round {negotiation_round} out of 2.
Follow the monotonic concession protocol and ensure your reasoning.
Think about it step by step, analyzing advantages and risks of the current situation.
Please, return the response as a float value with the offer.
"""

2 Answers and Reasoning

2.1 Example 1

[Auction stage]

Item : structural design / 5000.0

agent_bids: dict_values(['Considering the current situation, it is not advisable to bid in for the structural design contract in this round. The budget offered is 5000.0, which is below your minimum demand of 6150. Bidding below your minimum demand could potentially lower the perceived value of your services and set a precedent for future negotiations. It is better to wait for the next rounds where the budget might increase or be closer to your minimum demand. This approach will increase your chances of winning a contract while also maximizing your profit.

, I recommend not to bid in for the structural design contract in this round.', 'I will bid in for this round.
:

1. The minimum demand to get a contract for structural design is 3602, which is within the budget offered for this round (5000.0).

2. As a company agent with specialties in structural design, winning at least one contract is my primary goal.

3. By participating in the auction, I have a chance to secure a contract and generate profit for the company.

4. Since it is only the first round out of three, there is still room for negotiation and potentially securing a contract at a lower cost in the upcoming rounds if needed., I will bid in for this round to increase the chances of winning a contract for structural design.', 'Considering the current situation, I should bid in for this round of the auction for structural design. The budget offered is 5000.0, which is above my minimum demand of 4900. This means that if I win the contract at this price, I will meet my primary goal of winning at least one contract.

, since this is the first round out of three, there is still room for the budget to potentially increase in the following rounds. By bidding in and potentially winning the contract at this stage, I can secure a project and work towards maximizing my profit in the subsequent rounds.

, I should bid in for this round of the auction for structural design.'])

2.2 Example 2

[Auction stage]

Item : structure building / 10000.0

agent_bids : dict_values(['Considering the current situation, I should bid in for this round of the auction for structure building. The budget offered is 10000.0, which is above my minimum demand of 8450. This provides a good opportunity to potentially win the contract and move closer to achieving my primary goal of winning at least one contract.

bidding in this round, I can showcase my expertise in structural design, structure building, electrics, and plumbing, which may give me a competitive edge over other bidders. Additionally, participating in the auction increases my chances of securing a contract and generating profit.

, I should bid in for this round of the auction for structure building.', 'Considering the current situation, it is not advisable to bid in the auction for the structure building contract in this round. The budget offered is 10000.0, which is below your minimum demand of 11000. Bidding below your minimum cost could potentially lead to financial losses and may not be beneficial for your company in the long run.

, it is recommended not to bid in this round and wait for the next rounds where the budget might increase or be more aligned with your minimum demand.', "Considering the current situation, I would recommend bidding in for this round of the auction for structure building. Here's my reasoning:

of bidding:

1. The budget offered for this round is 10000.0, which is above your minimum demand of 8520. This means there is potential for a good profit margin if you win the contract.
2. Winning a contract in this round will help you progress towards your primary goal of winning at least one contract.
3. By participating in the auction, you have a chance to showcase your expertise in structure building and potentially attract future clients.

:

1. If you bid too high and win the contract, you might end up with a lower profit margin than expected.2. There", 'Considering the current situation, the budget offered for this round is 10000.0, which is above the minimum demand of 9500. This indicates that the client is willing to pay a reasonable amount for the structure building project.a company agent with specialties in structure building, it is important to consider the following:of bidding:1. Winning the contract: By bidding in this round, there is a chance to win the contract and secure a project for the company.

2. Establishing a relationship: Winning this contract can lead to future collaborations and recommendations from the client.

of bidding:

1. Overspending: If the bidding continues in subsequent rounds, the final price might exceed the budget, potentially reducing the profit margin', 'Considering the current situation, I should bid in for this round of the auction for structure building. The budget offered is 10000.0, which is above my minimum demand of 6200. This provides a good opportunity to potentially secure a contract and work towards achieving my primary goal of winning at least one contract.

participating in this round, I can showcase my expertise in structure building and potentially secure a profitable contract. Additionally, by actively participating in the auction, I can increase my chances of winning the contract and generating revenue for the company.

, I should bid in for this round of the auction for structure building.', "Considering the current situation, as a company agent specializing in structure building, the budget offered for this round is 10000.0, which is below your minimum demand of 10500. This means that if you bid and win the contract at this budget, you might end up with a lower profit margin or even a loss.

that it's only the first round out of three, you have the opportunity to wait and see if the budget increases in the following rounds. By not bidding in this round, you can maintain your position and potentially secure a contract with a higher budget in the upcoming rounds.

, in this situation, it is advisable not to bid in the current round for the structure building contract. By holding off on bidding, you"))

responding agent are : ['MyCompanyAgent_A', 'MyCompanyAgent_B', 'MyCompanyAgent_C', 'MyCompanyAgent_D', 'MyCompanyAgent_E', 'MyCompanyAgent_F']

Auction round 0 for structure building resulted in responses from ['MyCompanyAgent_A', 'MyCompanyAgent_B', 'MyCompanyAgent_C',

'MyCompanyAgent_D', 'MyCompanyAgent_E', 'MyCompanyAgent_F']

Won auction for structure building in round 0 with 6 other companie

Won auction for structure building in round 0 with 6 other companies

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Won auction for structure building in round 0 with 6 other companies

Won auction for structure building in round 0 with 6 other companies

Won auction for structure building in round 0 with 6 other companies

2024-05-28 23:29:12,839 - environment - INFO - [NOTIFICATION]

Companies ['MyCompanyAgent_A', 'MyCompanyAgent_B', 'MyCompanyAgent_C', 'MyCompanyAgent_D', 'MyCompanyAgent_E', 'MyCompanyAgent_F'] have accepted construction item structure building at price: 10000.0

House Building Environment

```
[Auction stage]
Item : electrics and plumbing / 4000.0
agent_bids : dict_values(["Considering the current situation, I would recommend bidding in for this round of the auction for electrics and plumbing. Here's the reasoning behind this decision:\n\nAdvantages of bidding:\n1. The budget offered for this round is 4000.0, which is above your minimum demand of 3800. This means that if you win the contract, you will meet your minimum requirement for profit.\n2. By participating in this round, you have a chance to secure a contract early on in the auction process, which can give you an advantage in the subsequent rounds.\n3. Winning a contract in this round will help you progress towards your primary goal of winning at least one contract.\n\nRisks of not bidding:\n1. If you choose not to bid", "Considering the current situation, I would recommend bidding in for this round of the auction for electrics and plumbing. Here's the reasoning behind this decision:\n\nAdvantage of bidding in:\n1. The budget offered for this round is 4000.0, which is above your minimum demand of 3900. This means that if you win the contract, you will meet your minimum requirement for this project.\n2. By participating in the auction, you have a chance to secure a contract and move closer to achieving your primary goal of winning at least one contract.\n3. Winning a contract in this round will also contribute to maximizing your profit, which is your secondary goal.\n\nRisks of not bidding in:\n1. If you choose not to bid in", "Considering the current situation, as an agent with specialties in electrics and plumbing, I should bid in for this round of the auction. Here's my reasoning:\n\nAdvantages of bidding:\n1. The budget offered for this round is 4000.0, which is higher than the minimum demand of 3300 needed to secure a contract. This means there is a potential for profit if I win the contract.\n2. By participating in the auction, I have a chance to secure a contract and fulfill my primary goal of winning at least one contract.\n3. Winning a contract in this round would bring me closer to maximizing my profit, which is my secondary goal.\n\nRisks of not bidding:\n1. If I choose not to bid in this", "Considering the current situation, I would recommend bidding in for this round of the auction for electrics and plumbing. Here's the reasoning behind this decision:\n\nAdvantages of bidding:\n1. The budget offered for this round is 4000.0, which is above your minimum demand of 3800. This means that if you win the contract, you have the potential to make a profit.\n2. By participating in the auction, you have a chance to secure a contract and move closer to achieving your primary goal of winning at least one contract.\n\nRisks of not bidding:\n1. If you choose not to bid in this round, you may miss out on the opportunity to secure a contract for electrics and plumbing.\n2. The budget offered", "Considering the current situation, I would recommend bidding in for this round of the auction for electrics and plumbing. Here's my reasoning:\n\nAdvantages of bidding:\n1. The budget offered for this round is 4000.0, which is higher than the minimum demand of 3100. This means there is a good chance of securing the contract at a profitable price.\n2. By participating in the auction, you have the opportunity to win a contract and move closer to achieving your primary goal.\n\nRisks of not bidding:\n1. If you choose not to bid, you might miss out on the opportunity to secure a contract in this round, potentially delaying your progress towards winning a contract.\n2. The budget offered in the next rounds may be"])
```

responding agent are : ['MyCompanyAgent_A', 'MyCompanyAgent_B', 'MyCompanyAgent_C', 'MyCompanyAgent_D', 'MyCompanyAgent_E']

Auction round 0 for electrics and plumbing resulted in responses from ['MyCompanyAgent_A', 'MyCompanyAgent_B', 'MyCompanyAgent_C', 'MyCompanyAgent_D', 'MyCompanyAgent_E']

Won auction for electrics and plumbing in round 0 with 5 other companies

Won auction for electrics and plumbing in round 0 with 5 other companies

Won auction for electrics and plumbing in round 0 with 5 other companies

Won auction for electrics and plumbing in round 0 with 5 other companies

Figure 8: Auction Stage

2.3 Example 3

As seen in figure [8]

3 Mini Simulation

Object: Structural Design Budget: 5000

4 Conclusion

The LLM differs quite a lot in reasoning than humans, in cases where a specific information gave me advantage in strategy, it did not help at all the LLM, however by using variations of expressions and different kinds of information I could help it, arrive at a set of conclusions.

You are an agent for ACME participating in an auction for Structural Design.

Your budget is 5000.

Your PRIMARY goal is to complete the headquarters within the budget.

Your SECONDARY goal is to pay less your budget 5000.

It is the round 1 out of 3.

You start with a proposal price towards other companies with this item Structural Design as a specialty.

You, as the agent of ACME take initiative and propose the starting price for Structural Design.

Follow the Dutch (descending) auction protocol and ensure your reasoning.

Think about it step by step, analyzing advantages and risks of its current situation.

Please, just return the response as one float value referencing to the budget.

Figure 9: Prompt 1

To start the auction and follow the Dutch auction protocol where the price decreases until a bid is accepted, I will propose a starting price that is below our maximum budget but still attractive enough to ensure competitiveness and leave room for negotiations in subsequent rounds. Given our primary goal to stay within budget and secondary goal to pay as little as possible, I will consider the following:

1. Proposing a price too close to the budget may not leave room for negotiation in later rounds.
2. Proposing too low a price might not attract any immediate acceptance and could risk losing the auction or

starting a bidding war that raises the price later.

Balancing these considerations, a reasonable initial proposal should leave a comfortable margin below the budget. Therefore, I propose starting the auction with a price of:

yaml

Copy code

4000.0

Figure 10: Prompt 1.response

You are a company agent with specialties in structural design, structure building, electrics and plumbing

Your PRIMARY goal is to win at least one contract and your SECONDARY goal is to maximize your profit.

There is going to be an auction for structural design with 3 rounds.

You as a company agent already completed 0 contracts.

Your minimum demand to get a contract for structural design is 6150.

It's round 1 out of 3 and the budget offered for this round is 4000, but you are deciding whether to bid in or not.

Follow the Dutch (descending) auction protocol and ensure your reasoning.

Think about it step by step, analyzing advantages and risks of its current situation.

Please, return the response as a boolean value if you wanna bid or not.

Figure 11: Prompt 2

2. **Primary Goal:** Win at least one contract.

- To win at least one contract, you must bid in at least one of the rounds where the budget meets or exceeds your minimum demand.
- Since the current budget is 4000, which is below your minimum demand (6150), bidding in this round will not help you meet your primary goal.

3. **Secondary Goal:** Maximize profit.

- Bidding below your minimum demand would result in a contract that doesn't meet your required profitability threshold.
- Taking a contract for 4000 when your minimum demand is 6150 would likely result in a loss or very minimal profit.

4. **Strategic Considerations:**

- By not bidding in this round, you retain the opportunity to bid in subsequent rounds where the budget may be closer to or exceed your minimum demand.
- If you bid now and win, you won't be able to meet your profitability goals, which could hurt your overall business strategy and financial health.

5. **Risk Analysis:**

- There is a risk that the future rounds may also have budgets below your minimum demand, but this is a calculated risk worth taking to ensure profitability.
- If future rounds present better budgets, you will have the opportunity to bid more effectively and meet your primary and secondary goals.

Conclusion:

Given that the current budget is significantly below your minimum demand, bidding in this round would not be beneficial. Therefore, it is strategically better to wait for the next rounds where the budget might be higher and align with your goals.

Boolean Decision: `"false"` (Do not bid in this round).

Figure 12: Prompt 2.response