Project Proposal CSCE 875
Team: Reagent October 15, 2011

Problem Statement:

To design a multi-agent system that simulates a very simple commodities exchange where agents buy and sell oil. The exchange is made up of buyers, sellers, and speculators that employ value functions and auction strategies in order to achieve their goals (Local Decisions) while minimizing the impact on the stability of the price of oil (Global Coherence).

Agent Design:

The system will contain three primary agents: 1) oil producers, 2) oil consumers, and 3) speculators. Oil producers will begin the simulation with P_i barrels of oil with the goal of selling it at the highest price that can be obtained. Oil consumers will start the simulation with C_i dollars with the goal of obtaining ~~a~~ N barrels of oil. Speculators will begin the simulation with S_i dollars with the goal of buying as much oil as they can and then selling it in order to realize a profit. The simulation will function as a turn based trading exchange where, for each turn in the trading day, an agent may execute a single action. The following actions will be available to agents:

- Offer *k* barrels of oil for sale at a price per barrel,
- Decrease the offering price per barrel of the *k* offered barrels,
- Make an offer in an auction for *n* barrels of oil at the offer price,
- Make a counter offer on an auction for *n* barrels of oil above the most recently offered price.

The agent will also consider the following variables in its valuation function:

- Trading price of oil. Based on the current winning prices per auction per term, the exchange will set a trading price per barrel of oil. The trading price will be a base line for buying and selling agents when considering a trade.
- Number of remaining turns in the trading simulation. If an agent needs to dump oil - or conversely buy it - and there are few remaining turns, the agent will be more likely to offer at a lower price or purchase at a higher price.
- Scarcity of oil. If it is difficult to purchase oil (i.e. few agents are offering sale), then agents will place a higher value on oil and offer it at a higher price, or be willing to pay a higher price. Conversely, if there is an abundance of oil being traded, the agents will place a lower value on oil.
- Availability of capital. Agents will place a higher value on oil if they have increased resources with which to purchase barrels.

Commented [LS1]: Not quite sure how the agents make their decisions – need perhaps equations or at least some clearer description/specifics.

I also don't quite understand how you are going to use auction in the environment.

Further, for the experiments, I am not sure whether your experiment design would give you the data that you need in order to do a good POJI for your hypotheses as the parameter values are not listed.

Finally, I am not sure what you mean by "stability of the price of oil" and what you mean or how you can evaluate whether your system "minimizes the impact on the stability of the price of oil."

Please track all your changes and keep my comments in your next version of proposal.

Commented [LS2]: But what is the problem? Simulation alone might not give you enough design rationales. Is it an optimization problem? A constraint satisfaction problem? A machine learning problem for convergence? Please clarify.

Commented [LS3]: Ah … this has potential. But who is minimizing this? Each individual agent? Or the system? Not clear. Why would an individual agent want to minimize the impact on the stability of the price of oil, for example?

If this indeed is what you want to do, then this becomes an optimization problem.

Commented [LS4]: So, the consumers can also do this?

Commented [LS5]: Are these actions available to each type of agents? If no, then please be more specific. If yes, then what's the difference between these three types of agents? The difference must be then within the decision making process – then I would like to have more specifics on that in order to better understand the differences.

Commented [LS6]: Who runs the auction.? Who sets the trading price of oil?

Commented [LS7]: Good one.

Commented [LS8]: But how does a local agent assess this value?

Commented [LS9]: That means your agent types will different capitals to begin with as well?

While trading, all agents will have access to view oil offerings. If no price is offered after the first 3 turns, the seller will begin lowering the price at each turn until they sell the *k* barrels originally offered (a Dutch auction). If offers are made within the first 3 turns, agents may counter offer (increase the price) once per turn until no more offers are made. Offerings made per turn will cause the global price of oil to fluctuate thereby impacting the value each agent places on a barrel of oil. After *t* turns, the trading simulation will end. The overall goal of the exchange (global goal to which the agents are individually striving) is to ensure that producers are able to meet the demand of consumers.

An agent will no longer participate in the exchange if the following conditions are met:

- an agent sells P_i barrels of oil,
- an agent purchases N_i barrels of oil,
- an agent spends S_i or C_i dollars and has no oil to sell or has < N_i barrels.

Commented [LS10]: Hmm … in your beginning paragraph, you have something like "buying as many as possible". Then in your second paragraph, you have "availability of capital". But here, it seems that you are imposing a blanket rule over all agents. This is thus actually a set of global restrictions. And thus this makes your agents less autonomous, and so weakens your proposed project.

Please integrate the conditions needed to decide whether an agent should sell or buy better.

Conceptually, I don't see why an agent cannot KEEP selling or buying as long as it has the money or oil to do so …

Desired Emergent Behavior:

The desired emergent behavior is that the producers and consumers will execute trades to move barrels of oil to cover demand at a stable price (i.e. the agents will work to minimize the role of speculators).

Hypothesis:

Hypothesis 1: The trading price of oil is inversely proportional to $sum(P_i)$. If oil is a scarce commodity, producers will command a high price for offered barrels as a result of the consumer need to purchase some number of barrels before the simulation ends. For small values of *P* trading price will be large and for large values of $sum(P_i)$, the trading price will be low.

Commented [LS11]: Okay.

Hypothesis 2: The trading price of oil is proportional to $sum(S_i + C_i)$. Because agents are limited in their ability to value oil greater than the resources with which they have to purchase it, the increased availability of resources (money) will allow auction prices to rise and increase the trading price of oil. For large values of $sum(S_i + C_i)$, the trading price will quickly converge $sum(S_i + C_i)/P$.

Commented [LS12]: I cannot judge the feasibility or the relevance of this hypothesis as I don't know how the "auction" process is going to be simulated in your environment.

Hypothesis 3: Convergence on a trading price of $sum(S_i + C_i)/P$, will have the same effect as an abundance of availability of oil. Once the trading price of oil hits a maximum value, agents will no longer be able to highly value it, due to their inability to buy at that price (i.e. the limiting factor of the value function is *S* or *C*) and trading prices will fall. As a result of the lowering price, agents will decreasingly value oil, causing prices to "bottom out" at $sum(P_i)/sum(N_i)$.

Commented [LS13]: Okay.

Hypothesis 4: The number of speculators participating in the exchange will decrease the stability of the trading price. Large numbers of speculators buying oil needed by consumers will result in rapid trading price increases until convergence is met and prices fall. As prices fall, speculators will continue to compete with consumers to purchase oil to drive the price back up in an effort to "sell high". This will results in pricing increasing and decreasing regularly; thereby decreasing stability in trading price.

Commented [LS14]: If the prices increase and decrease – is that stable? I ask because I don't really know how you will measure "stability". IF the system takes time to converge, does that mean that if the "time" taken to converge is very small, then the system is stable? Please be clearer in your problem statement about stability and also in your design the environment.

Experiments:

In order to test our hypothesis we will run the simulation varying parameters: *sum*(P_i), *sum*(C_i+S_i), and the number of speculators. Our experiments will not consider ratios greater than 2:1 in order to validate our hypothesis within a "reasonable" range. During each experiment we will tracking the trading price of oil at each turn and examine the price fluctuation over the entire experiment for differing values of our variable parameters. There will be 4 experiments, one for each hypothesis.

Commented [LS15]: What will these values be?

- Run 500 simulations 100 times each for *a,b,c,d* values of the total number of barrels in the system. Test hypothesis 1.
- Run 500 simulations 100 times each for *e,f,g,h* values of the total number of dollars in the system. Test hypotheses 2 and 3.
- Run 300 simulations 100 times each for *i,j,k* numbers of speculators. *i* will be fewer speculators than consumers, *j* will be and equal number of speculators to consumers, and *k* will be more speculators than consumers. Test hypothesis 4.

Commented [LS16]: What are a, b, c, d, e, f, g, h, I, j , and k?