Research Paper Comp3190

Title of research: Enhancing intelligence in believable agents.

Name: Khaled Hamdy Elgohary

Student Number:7924188

Educational establishment: University of Manitoba

Submission date: 7th of December 2022

Abstract

We are exploring how to make believable agents more realistic, and perform actions that are Based on their emotions / actions of people they interact with, in other words we're looking To make believable agents more intelligent in the aspect of being realistic.

In the world of believable agents there are various aspects to look at when we think about enhancing the intelligence of a believable agent, for example (natural language in interactive, the ability to display emotions, the intelligence of the actions done by the agent caused by a certain action of another agent/people or action that is triggered by a certain emotion).

In this research we will describe the approaches taken, and show how it leads to believable agents that have properties that we makes us think they're realistic or in other words worth of believing, such as; using language processing and emotions displayed by other agent or people to execute a certain action, making actions that will affect other people's emotions and be able to identify that emotion and act upon it.

Introduction

Over the last several years believable agents have been gaining a lot of attention in several Fields, most commonly in robotics, things we simply interact with rather than being in a virtual world. The roles of believable agents became quite beneficial for today's society which always drives people to further enhance them to be able to serve us more in various fields for example entertainment industry, medical fields, and ... etc.

One of the first steps to be taken into making the believable agent intelligent is the ability of it to display emotions, with a response from the agent indicating that what kind of emotion it's displaying. We first need to pick a model to display emotions for us, and then finding a way to implement it in our agent.

For the second step we need to figure out a way for the agent to make a feedback based on his emotions or the emotions of others, the action can be a physical or it can simply be a reply from the agent in a sort of statement, or it can be the mix of which will prove to be more difficult approach.

Final step to take is, the ability of the agent to control its emotions and actions, and it's motives, we don't want the agent to overdo something or under do something, and therefore we want the agent to be able to pick it's action carefully.

Fetching emotional states

We will be using the model proposed in the research paper [Magy Seif, El-nasr Thomas, R. Ioerger, John Yen ,1998] "Learning and Emotional Intelligence in Agents".1998. to be able to produce an emotional state for an event that occurred to the agent. A Diagram of the system architecture of the model will be found below.

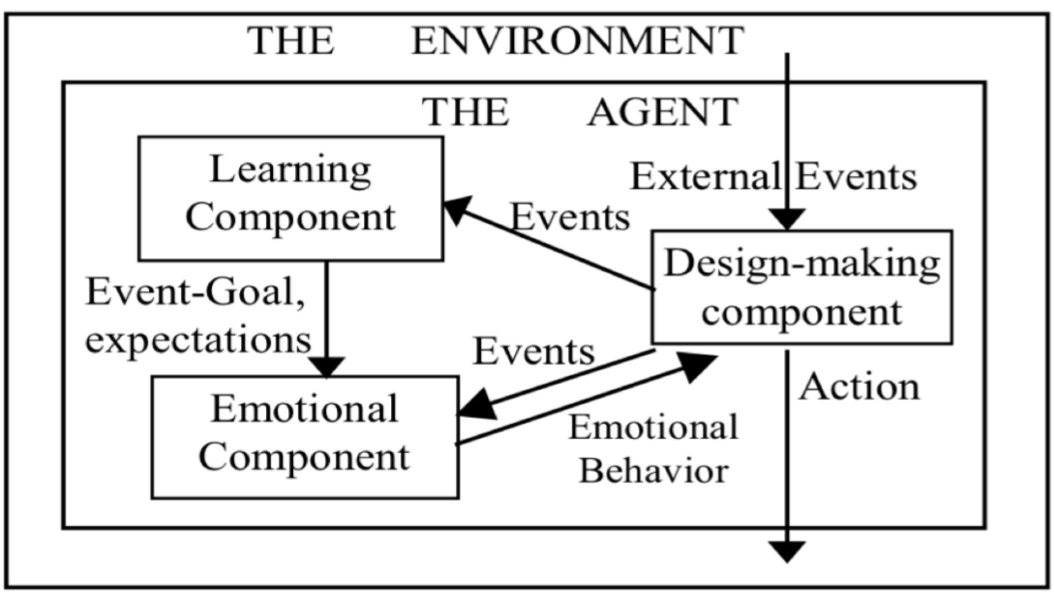

Figure 1. System's Architecture

We first must briefly explain every part of the system architecture to use. Starting with emotional component. When an agent experiences any event, it's passed to the learning component and the emotional component. The responsibilities of the learning component are to keep track of the history of events that has occurred to the agent, and the emotional component is responsible for producing an emotional state, which then can be described as an action made by the believable agent or much more complicated a facial expression. After that the emotional state is passed onto the decision-making component which then executes an action.

Although the model does exactly what we want, there is only 1 draw back from it. "Most of the actions are very small, quick and specific, such as Throwball, and thus, an action or two consecutive actions by themselves are not meaningful." [Magy Seif, El-nasr Thomas, R. Ioerger, John Yen ,1998] "Learning and Emotional Intelligence in Agents" p4.1998. What if we want the agent to do more than just a very small action, what if we want the agent to pick up a glass of water from the table, that involves series of steps including moving from the initial position to the table, leaning, holding the glass, leaning up again, and going back to the goal which is the person who expressed the feeling, and that is more than a small action, hence we need to further extend the model to do more complicated actions, which will be discussed further on.

Extending actions made by believable agents

If we're talking about believable agents in a virtual setting, then the actions made by them are simply a response, and an action made in that virtual world. On the other hand, if we're talking about an agent in the real world for ex a robot, the actions made will have to be somehow connected to the sensory-motor system of that agent, which is however not our concern, our concern is the action itself that is made by the agent.

As we've seen in the model, we picked for providing us with an emotional state for the believable agents, the actions executed by it is very simple and minimalistic. We want to do more than that, we want the actions made by the agent to be more complex and meaningful, and hence we have to extend the domain of the actions done by the agent and its complexity.

Introduction to HAP

Hap is a behaviour-based architecture that was used for building believable agents, it's originally written in lisp and was designed to execute actions linearly. Hap was Developed originally by A.Bryan Loyall , and after that several extensions of hap were created in order to support different areas in ai for example Tok which was proposed in [Loyall and Bates, 1995] Loyall, A. , and Bates, J.,"Behaviour-based Language Generation for Believable Agents" .1995.

Hap was created to satisfy three goals, first one is that it was designed to expressing behaviour which is in that case the actions made by the agent. Secondly, it was designed to be an agent architecture that addresses some of the requirements for believable agents in real-time, visual worlds. Thirdly, it’s an architecture that can be used to express all the processing aspects of a believable agent [Mateas and Stern ,2002].

Before jumping into the conclusion of using hap we first need to look at how hap’s work. Hap programs are written as a series of behaviours, with each behaviour executed sequentially, each step involved in the execution of the behaviour has a fail/success possibility, if the step is executed successfully then the program can move into the next step of executing the behaviour, if not then the whole behaviour fails [Mateas and Stern ,2002].

Introduction to ABL

ABL (A behaviour Language) is based on the oz project (bates 1992) believable agents language Hap developed by A. B. Loyall(Loyall 1997 , Bates, Loyall, and Reilly 1992. While ABL is an extension of how, which means it did add significant modifications to it which are listed Below [Mateas and Stern ,2002]: -

1. The syntax is more java like, which makes it easier for people to read and interpret.
2. Generalized the mechanism by which an ABL agent connects to the sensory-motor system.
3. Added new constructs to the language.

ABL was proposed in the research paper [Mateas and Stern ,2002] Mateas, M., and Stern,A. ,"A Behaviour Language for Story-based Believable Agents".2002. The main reason of using ABL is that its syntax is similar to java, and hence it's easier for developers to read and interpret. Below is an example of sequential behaviour written in ABL which was added in the research paper: -

```
sequential behavior AnswerTheDoor() {
  WME w;
  with success_test { w = (KnockWME) } wait;
  act sigh();
  subgoal OpenDoor();
  subgoal GreetGuest();
  mental_act { deleteWME(w); }
}
```

The above example is of a sequential behaviour for the agent to answer a door, whenever some knocks on the door, the agent sigh and then opens the door and greet the guests. In the above behaviour there are 4 step types, wait, act, subgoal, and mental act. Success tests are conditions, whenever they become true, they cause the step associated with it to be executed, it can be associated with any step type. Subgoals are steps that are executed by the agent, whenever the success test is passed [Mateas and Stern ,2002].

Personal theory, and the connection between ABL and emotional state model.

Our model in section 1, provides us with an emotional state from which is generated whenever our agent encounters an event, emotions can be combined, but they all break down into a basic list of emotions (sadness, happiness, fear, anger, surprise, disgust), and from each of these emotions, are other emotions that comes under it, for example anxiety can be broken down from fear.

The model provided in section 1, is capable of interpreting actions in which they are simple, but as mentioned we want more than that, and that's why we're using ABL in executing the actions. A program can be written in ABL such that for every emotion there are specific actions to do, and each of these actions concerns a certain of steps to make, of course the domain of the actions done by an agent will be limited, but as expected the actions executed will be complicated the way we wanted it to be.

For example, if the agent encountered an event where a person is crying, that emotional state will be fed into ABL, in which there is a certain action corresponding to it such that: -

```
Sequential behaviour ComfortThePerson () {
        WME w;
        with success_test {w= (P cries)} wait;
        act sad;
        subgoal moveTowardPerson ();
        subgoal patThePersonOnTheBack ();
        mental_act{deleteWME(w)};
}
```

The above example show’s a series of steps taken to pat a person on their back if their sad, in which the emotion state is retrieved from the model in section 1. The agent waits for a person to start crying, and then if it’s a success, then the agent will act sad, and then move toward the person, and then the agent will pat the person on his back, after that the mental act will be deleted and the action will be a success. The whole action will depend on whether a person is crying, and the emotional state we get. Sadness is not just expressed by crying, but all the actions executed toward sadness, will come under the emotional state of being sad received by the model.

Action selection

As discussed in section 2.3, we we're able to write our own actions into ABL and execute them based on the emotional state fed into ABL from our model in section 1. There is time we may have 1 action toward a certain emotion, and we will have to carefully select one of them depending on the event and the intensity of the emotion state.

For that part, we need a model that will be able to make the action selection for us. We will use the model proposed in the paper [Burghouts and Heylen and Poel and Akker and Nijholt ,2003] Burghouts,G. , Heylen,D. , Poel,M. , Akker,R. , and Nijholt,A. , "An Action Selection Architecture for an Emotional Agent",2003. A diagram of the agent selection architecture will be found below: -

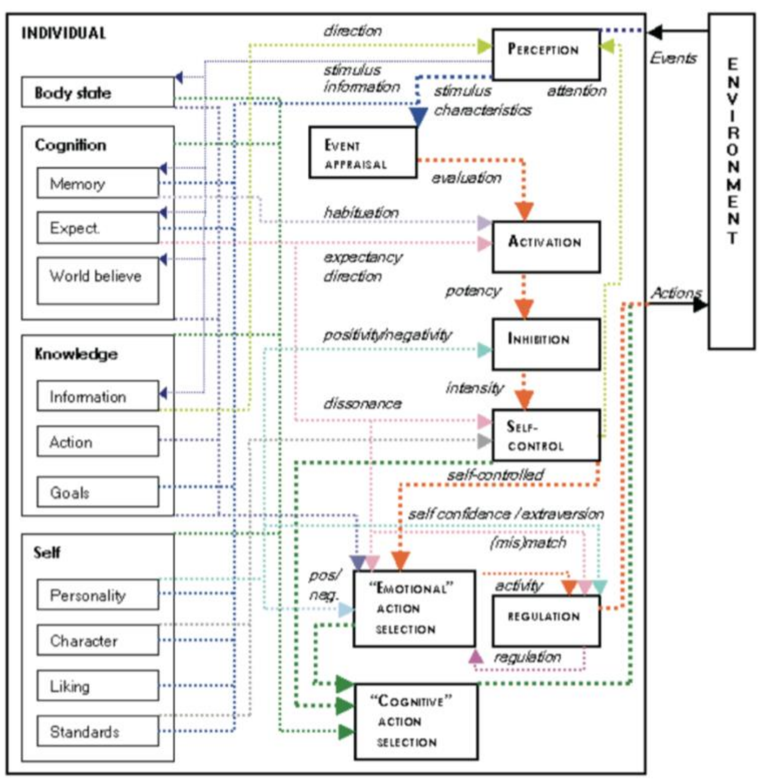

Figure 1: Action selection architecture

The boxes on the right decompose the emotion process. The emotion process is several modules that manipulates the intensity of the emotions. Each module will involve different contributing factors, starting with the event appraisal. The explanation of each module will be on an abstract level, since we're only interested in what that module is going to produce for us [Burghouts and Heylen and Poel and Akker and Nijholt ,2003].

The event appraisal module is similar to the module we selected for producing an emotional state, the only difference is that the event appraisal produces intensity of the emotional state. Activation is the second step after generating an emotional state, during the activation stage, our generated emotional state is transformed into potency values that is for triggered emotions, depending on habituation, expectancy, and discrepancy [Burghouts and Heylen and Poel and Akker and Nijholt ,2003].

```
emotionActivation ::
[(Emotion,Intensity)]->
(ElapsedTime,PreviousIntensity)->
Expectancy->Discrepancy->
[(Emotion,Potency)]
```

Second step after the activation stage is, Inhibition. Inhibition occurs due to the quelling of emotions, and it usually occur when subjected to negative emotions, which then is reduced by transforming these negative emotions into positive emotions. The importance of this modules is to pick the emotion that inhibits the other emotions [Burghouts and Heylen and Poel and Akker and Nijholt ,2003].

```
emotionsInhibition::
[(Emotion,Potency)]->
[(Emotion,EmotionImpact)]->
[(Emotion,Intensity)].
```

Self-control of emotional behaviour is the next step after inhibition. What this module does is the reduction or removal of dissonances between expected behaviour and the standards one upholds, and the final step that occur after this is the action selection [Burghouts and Heylen and Poel and Akker and Nijholt ,2003].

```
selfControlExpectedBehaviour::
[(Emotion,Intensity)]
Expectancy->Strategies->
[(Action,PraiseWorthinessOfAction)]->
[(Emotion,Intensity)]
```

All the components mention operate together to be able to select the action that best matches the emotional state and its intensity, which in that case, the list of actions to be selected from will be provided from ABL, and the model will determine the action to be selected for us.

Modifications

The model we picked for producing an emotional state is similar to the event appraisal module in the previous model, only difference Is the event appraisal module is capable of producing intensity of the emotion along with the emotional state, in which the selection of the action will be dependent on. Modifications can be done to our model for producing the emotional state so that it can be provide us with the intensity of the emotion, or the event appraisal module can be used, since it already provides us with what we need.

Conclusion

Finally, we were able to create a linkage between all the models proposed in this paper, although further modifications have been done/proposed along the way, but they all come down to the same goal of this research. Firstly, we were able to get a model able of producing an emotional state from an event that has occurred to a believable agent, and then we introduced ABL language, that helped us to further extend the domain of the actions that could be done by the agent. Finally, we were able to link everything together, and find a model that was able of selecting the most suitable action an agent can executed, depending on the emotional state fetched from the agent, and its intensity. Although this paragraph marks the end of our research paper, there is still a lot left to be covered in the future, we only covered my own personal theory of how the theory part of how the theoretical part of the goal of this research can be implemented, but there is still a practical part that needs to be created, which also comes with its own challenges and further modifications on the theoretical part .

References

- [Magy Seif, El-nasr Thomas, R. Ioerger, John Yen ,1998] “Learning and Emotional Intelligence in Agents”.1998.
- [Loyall and Bates, 1995] Loyall, A., and Bates, J.,”Behaviour-based Language Generation for Believable Agents” .1995.
- [Mateas and Stern ,2002] Mateas, M., and Stern,A. ,”A Behaviour Language for Story-based Believable Agents”.2002.
- [Burghouts and Heylen and Poel and Akker and Nijholt ,2003] Burghouts,G. , Heylen,D. , Poel,M. , Akker,R. , and Nijholt,A. , “An Action Selection Architecture for an Emotional Agent”,2003.