

Simulating Personality for First Person Shooter Non-player Characters

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April 22, 2008

Note

The work presented here represents the summary for the directed study COMP 4905 during the winter term of 2008 at Carleton University.

Keywords

Artificial Intelligence, Game, Player Experience, Fuzzy Logic, Combat, First Person Shooter, Personality, Stress Factors, Moral, Characteristics, Personality, Hierarchical State Machines

1 Introduction

1.1 Context/Background

First person shooter games are plagued with the problem of players losing interest once they have learned the patterns that the Artificial Intelligence(AI) follows. Although the same player do not tire from playing these games online against other players. The idea of this project is to study how AI with random personality boundaries affects the player performance, experience and desire to continue playing.

1.2 Definition of the problem

The purpose of this project is to develop a universal combat artificial intelligence (CAI) that can mimic human behaviour in a combat situation. This AI can be applied to any shooting combat game and it should change the performance of the offline play to the performance of the online play. This means that the performance of the player might vary but should average to a constant time over a length of time. The performance is measured by the values shown in the Data column in Figure 10.

The resources that have been helpful in formulating the AI solution have been covered in the references section of this report. The input from all of these sources was crucial in formulating this work.

1.3 Summary of the result

CAI works of a simple filtering concept described as follows. As a behaviour is selected at a certain time t , the observed results could modify a positive filter and a negative filter. These filters alter the probability of option selection during the next decision making interval $t+1$. A proof of concept (POC) was developed to test a few concepts from CAI. Results were obtained from people playing both the control POC (AI dormant) and the AI active POC. On average, the performance of the people playing the AI POC got the same score, in twice the amount of time, and with one quarter of the health in relation to the results of the same PC's playing the control POC.

1.4 Outline of the report

Studies conducted in developing CAI is reported in Section 2. CAI and its filters are described in Section 3. Testing using the control POC and the AI POC is described in Section 4. The results obtained from the POC testing is analyzed in Section 5. Conclusions and future work are reviewed in Section 6.

2 Studies conducted

We review in this section the focus group that was conducted for this study.

The invited guests for this focus group were retired and currently serving military war veterans in the Canadian army. The veterans had all experienced combat in Iraq, Afghanistan and Kosovo. The focus on this group was to discuss reaction of humans under different stressful combat situations and also moral boosting situations. The veterans were asked to write responses to a set of questions and scenarios that were obtained from different scenarios found in combat based games. The group later looked at their own responses and discussed the causes and main factors for each set of questions and comments. The comments they discussed here were used to develop the reactions that an AI character should show and have as options. (reactions section in filter 1 CAI). At this point a set of reactions had been developed that is based on a hierarchical state machine. The idea developing this structure is stress factors that affect the mental capabilities and performance of people which can be mimicked by AI. The less stress present, the more stable and capable will a reaction be.

At a later date, the group was asked to work backwards and discuss different personalities that would best encapsulate the reactions that were previously determined. The effects of the stress on the individual AI character is dependent on the personality they have. The personalities also dictated what reactions an AI character would be allowed to make within normal situations.

The group was then asked to agree on a set of characteristics that would be the most influential during a combat situation. The effects of each characteristic is different based on the personality that an AI character would have. The group was asked to look at this structure again at a later date and to modify any parts as they saw fit.

The resulting structure was CAI.

3 Combat Artificial Intelligence, CAI's filtering system

CAI responds to environmental events obtained from the player interacting with the game environment. As events are observed, they are processed through different filters. The term "filters" is metaphorically used to represent how these layers act. As a layer obtains data, the outcome from the conditions effects the possible

reactions. Each NPC that is generated has a personality that can be described as "untrained", "trained and unexperience" or "trained and experienced".

As these NPC are generated, their personality is generated and stored. The personalities vary through a set of bounded multipliers that are randomly generated for every characteristic for every NPC. Figure 1 shows the relative effects of observable data on the characteristics based on personalities. This concept requires further study to provide the optimal boundaries, as well as the effects of "low", "normal", "high" and "very high" as seen in the same figure.

Data	corresponds to	Trained and Exp.	Trained and UnExp	Untrained
Leader Alive?	Leadership/moral	low	normal	high
%age of team surviving	moral/suival	low	low	high
Length of Fight (t)	fatigue	low	normal	high
Another NPC damaged?	moral	normal	high	high
Distance from Fire?	proximity of stressor	low	normal	high
This AI took damage?	moral/suival/fatigue	normal	high	very high
Overall team health	leadership/moral/suival	normal	high	low
AI Remaining health	moral/prox2strs/fatigue	normal	high	very high
PC took damage?	Moral/training	high	normal	low
Duration under fire	prox2strs/fatigue	low	normal	high

Figure 1: Data effects on characteristics, based on personalities.

CAI has a simple concept of using three basic filters that apply to a group responses. Further filters can be applied to customize CAI for any gaming environment. Filter 1 in the CAI model represents reaction selection based on currently observed data (as defined by Figure 1). Data observed at time t is sent to Filter 1 and the effect of this filter is observed at time $t+1$; the effect of the other filters is observed at time $t+2$. Filters 2 and 3 are representative of memory. Multiple filters can be added after the third filter, Filter 4 is an extra filter given as a sample. All these filters are discussed in further details in the following four subsections. A sample set of filters being applied at specific events is shown in Figure 2.

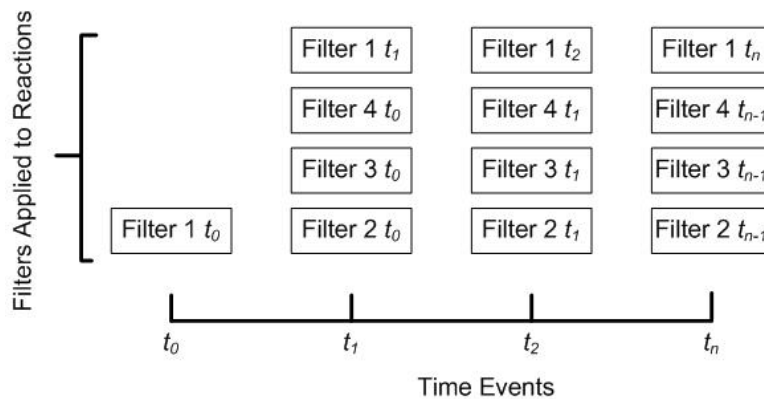


Figure 2: Sample filters applied at different time intervals.

The implementation of CAI is one layered. The data that is collected during an event is combined with the randomly generated personality factor for each character. These conditions are directly affect the reactions that result to the most current events. This can be seen in Figure 3.

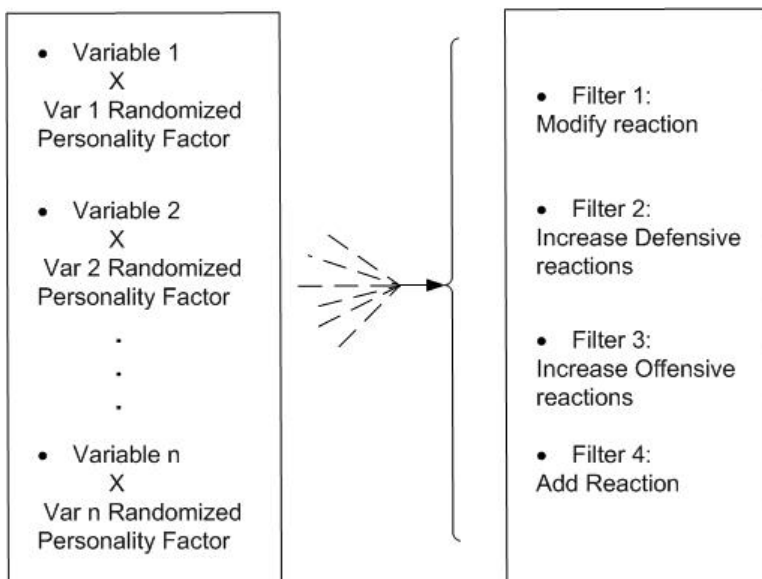


Figure 3: Implementation of CAI.

3.1 Filter 1

Filter 1 is shown in Figure 4. The progression of development with the focus group went from right to left, however the filter is only one layered when implemented. The data collected (Data column in Figure 4) is combined with the randomly generated bounded personality multipliers for each NPC based on that NPC personality (Figure 1). The reaction column in Figure 4 is hierarchial. At the top of the column are the most complex and mentally stable reactions (due to moral boosting factors), while at the bottom are the less stable reactions (due to a higher amount of stress). The possible movement up or down the column from the reaction at time t is bounded (according to the focus group, a next normal response is very close to their most current response). Although it is possible to have a drop or increase equal to the length of the list, these dramatic changes are left to other filters (representing special situations).

3.2 Filter 2

Filter 2 is shown in Figure 5. This filter represents the stress increasing and moral decreasing events through memory. These events are observed by Filter 2 (based on the consensus of the focus group) at time t . The effect of this filter is to remove a reaction or a category of reactions from the available options from Filter 1 at time $t+1$. Recouperating these disabled events are based on time and/or Filters 3.

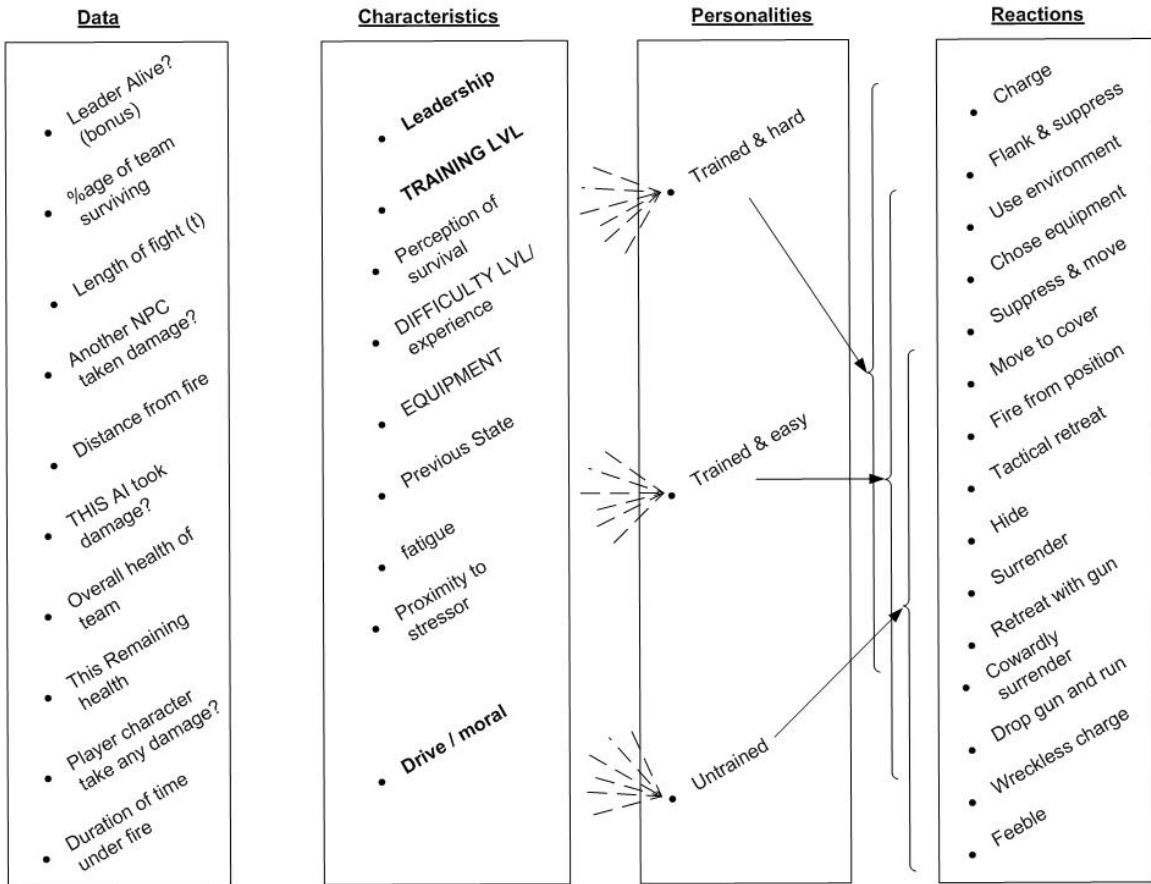


Figure 4: Filter 1.

This filter adds fear to the personality of the NPC's. Memory of locations of deaths, and deaths due to a specific PC action are recorded and avoided until time or other filters take effect.

3.3 Filter 3

Filter 3 is shown in Figure 6. This filter represents the stress decreasing and moral increasing events through memory. These events are observed by Filter 3 (based on the consensus of the focus group) at time t . The effect of this filter is to increase the probability of an NPC of becoming more capable. This effect on Filter 1 is observed at time $t+1$. The effects of Filter 3 are removed over time and also due to the effects of Filter 2.

This filter introduces the effects of moral and a team presence on an NPC. As either of these factors decrease so will the relative mental capabilities of the NPC's.

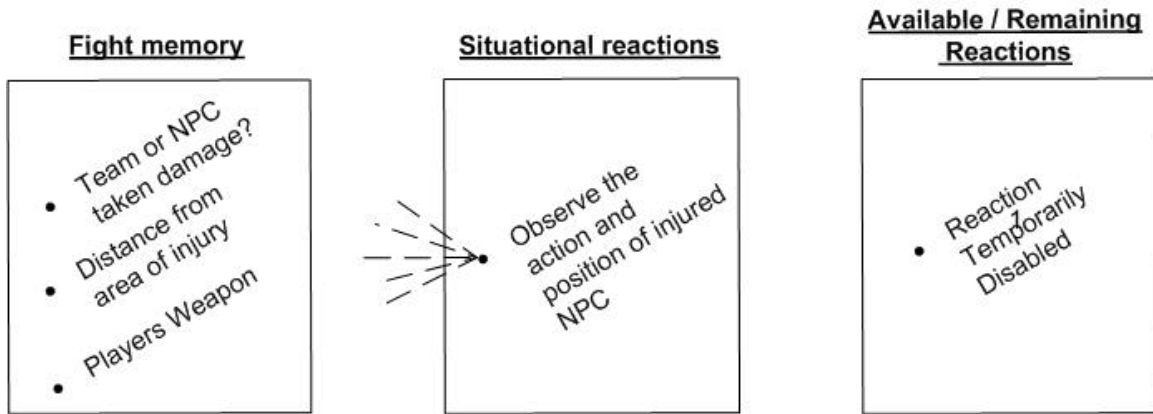


Figure 5: Filter 2.

3.4 Filter 4

Filter 4 is shown in Figure 7. This filter and others can be added by the game developers to customize the reactions of the NPC in a game. These filters can be used to represent environmental situations not accounted for by Filter 1. Certain responses due to environment/weapon/powers are possible by activating extra filters. Fine tuning the responses can be done by separating these filters, however increasing the complexity of CAI requires study.

4 Testing using Control POC and AI POC

A proof of concept (POC) was built to test the effects of CAI in a combat scenario. The POC had two games built using Game Maker, see Figures 6 and 7. Both games are exactly the same except for the implementation of a few concepts from CAI that modifies the regular behaviour. Green character represents the player and is controlled by moving up, down and can shoot to its right. Red characters represent the NPC and they can move in all two-dimensional directions, they can only shoot to their left. The objective for the player character is to stay alive while the objective of an NPC is to cross the green line on the left. The player character loses health if it collides with a bullet or an NPC. This also happens if an NPC crosses the green line.

The control POC game has regular behaviour, this is defined as randomly selecting one of the reactions over a random period of time (reaction is selected every 1.5 seconds or when a flagged event is observed). The control POC does not respond to the flagged events that alter its reaction selection.

The set of reactions that are available to the NPC is "charge", "suppress & move", "hide" and "wreckless charge". Charge is moving left when the player character is not threatening the NPC. "Suppress and move" is the NPC attempt to avoid damage if a threat is present in the vicinity. This reaction causes the red player to shoot and move to cover. "Hide" occurs when the NPC is behind cover and a threat is present. The effect of this reaction is for the red player to stay in position. "Wreckless charge" is charging to the left disregarding the presence of danger. Sample screen shots of the control POC NPC in combat are show and described in Figure 8. The first Frame shows the injury. The remaining frames show movement of the NPCs

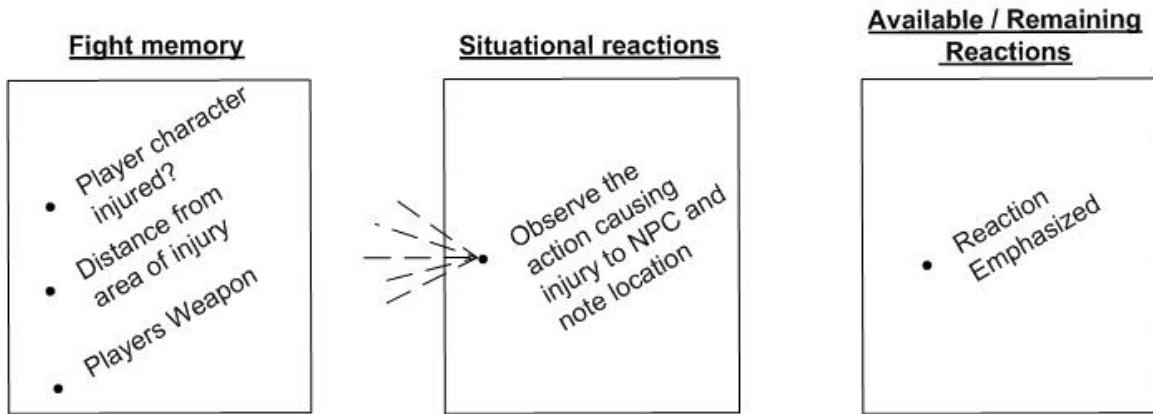


Figure 6: Filter 3.

and presence of the NPCs based on the injury location.

The AI POC game is responsive to the flagged events. The flagged events are the following; stressful events and moral boosting events. The stressful events occur where either the NPC or a teammate in the vicinity receives an injury. The moral boosting events are when the player character receives an injury. As the data is collected, a script containing fuzzy logic checks the values. If certain boundaries are crossed, then influences on reactions and behaviours of that specific NPC are enforced. Sample screen shots of the AI POC NPC in combat are shown and described in Figure 9. The first frame shows the injury. The remaining frames show movement of the NPCs and the lack of presence of the NPCs based on the injury location.

The pseudocode that was implemented for the AI POC is given below. The variable *AvoidY* is used to know if an injury was made. The value given to *AvoidY* is the Y coordinate in the POC where the injury was made. If this value is *zero*, then there has been no recent injury. *Proximity* is a value that dictates whether an NPC is affected or not by an injury of their team; *Proximity* is a randomly generated bounded variable for each NPC. The effect of an injury on an NPC in the *Proximity* lasts for a bounded period of time, within this time limit the NPC has attempts (random) of recovering. *CurrentCoordinate* is used to retrieve the current coordinates of the NPCs running the AI.

- 1: **if** *AvoidY* is not *zero* **then**
- 2: **if** distance between *CurrentCoordinate* and *AvoidY* is smaller than *Proximity* **then**
- 3: Check for direction of injury. Randomly select between one of the appropriate movements of hide, suppress & move, or wreckless charge.
- 4: **end if**
- 5: **else**
- 6: Randomly select between Wreckless charge, suppress & move, hide, and charge.
- 7: **end if**

Below is the AI script used in Game Maker that was implemented in the AI POC. Comments inserted into the code describe the logic used to simulate CAI.

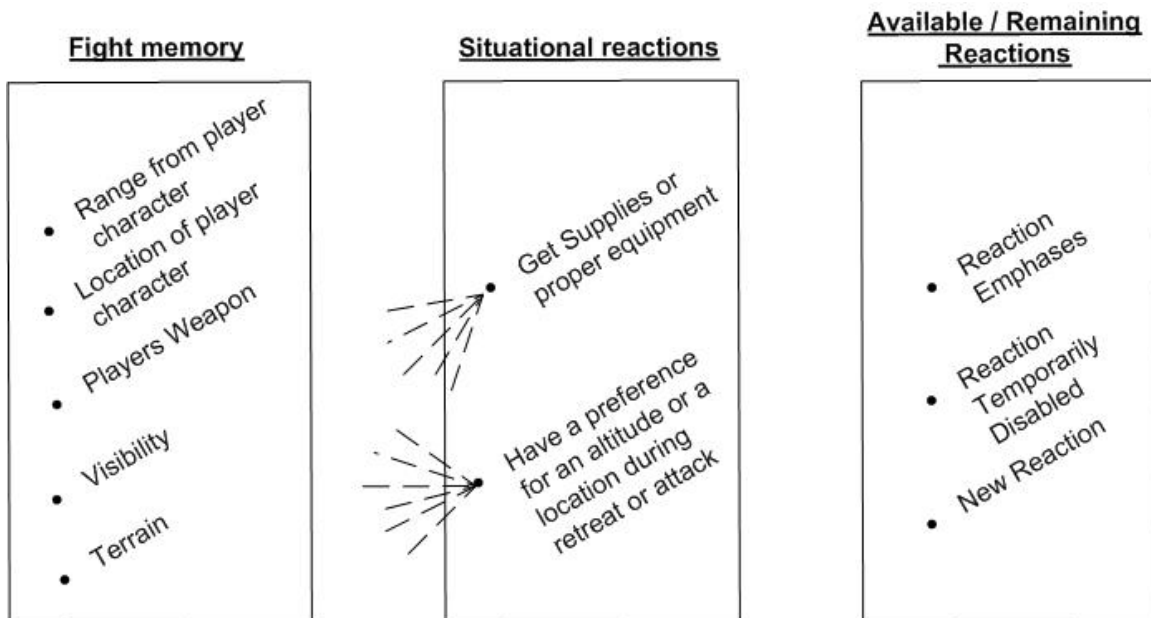


Figure 7: Filter 4.

```

{
  distance = 100;
  var currenty ; currenty = argument0;
  var avoidy; avoidy =a argument1;
  f = round(random(3));
  if (f == 0)
  {
    if ((avoidy!=0) || (abs(abs(currenty) - abs(avoidy))<distance)){
      else{// this command attacks and moves forward
        event_perform_object(options, ev_other, ev_user0);
      }
    }
  }
}

```

The above script segment checks for an injury and for the distance between the NPC and the location of an injury. The following statements check for the direction of an injury in relation to the green line. These statements tell the NPC the direction to travel and the reaction to do. These specified reactions in Game Maker represent "charge", "suppress & move", "hide" and "wreckless charge" reactions.

```

else if (f == 1)
{
  if ((currenty>=avoidy)&&(avoidy!=0) && (abs(abs(currenty) - abs(avoidy))<distance))
  {
    event_perform_object(options, ev_other, ev_user1);
  }
  else{
    event_perform_object(options, ev_other, ev_user2);
  }
}

```

```

}
else if (f == 2)
{
    if ((avoidy >=currenty)&&(avoidy!=0)&& (abs(abs(currenty) - abs(avoidy))<distance))
    {
        event_perform_object(options, ev_other, ev_user2);
    }
    else{
        event_perform_object(options, ev_other, ev_user1);
    }
}
else
{
    if (avoidy==0){}
    else{
        event_perform_object(options, ev_other, ev_user3);
    }
}
}
}

```

A comparison of the reaction selection for each game is shown in Figure 10 along with the data that represents events that are flagged for reaction/behaviour modification.

5 Results

The experimentation using the POC was done in the following way. Half of the PC's began testing on the control POC while the other half began testing on the AI POC, then they switched to the other game. The results obtained were compiled from the averages of all the PC's and over the different trials. 16 players played 12 games.

The data that was collected from the game engine was "Score" (representing the number of injuries received by the red team), "Red Killed", "Green Health" and "duration of match" (match ends when either the player or all NPC are dead).

The "Score" is initialized to *zero* and is incremented by *one* for every bullet fired by the player that strikes an NPC. The average score obtained by the PC's was *10.06* for the control POC game, and *10.60* for the AI POC game. The difference is negligible since it is less than one. The player finishes the stage with same number of points in both POC games.

The "Red Killed" average value represents the number of killed NPC via green bullets or direct contact with player character. The average of control and AI "Red Killed" is *1.89* and *2.02* respectively. Again the difference is negligible because it is less than *one*. The PC finishes the stage with the same number of red kills in both games.

The average "Green Health" for control and AI was *23.38* and *6.26* respectively, which was *26.78%* of control. The health for the player character is initialized to 160, the percentage of remaining health for the control game was *14.61%* while the percentage of remaining health for the AI game was *3.91%*. The player character in the control POC game finishes the stage with four times more health than in the AI POC.

The average "Duration of match" for control and AI was *12.38 seconds* and *26.58 seconds* respectively. As more matches were played the "duration of match" for control showed a steady decrease, while the "duration of match" for AI was relatively consistent. Figure 11 shows this difference in performance. The player character in the control POC game finishes the stage with four times more health than in the AI POC.

Testers were also asked to comment on both the game play and game experience. This was important to separate how players felt about the game from how they felt about playing against the AI. The following

comments were given by the testers on the game. "The game was difficult, but fun". "It was easy to figure out how to beat this one". "It was fun and engaging, very fast pace". "Was kind of difficult because they charged and i did not have time to shoot them all". "They were fairly predictable, they mostly charged". It is clear to see that the players were able to figure how to modify their own behaviour in order to survive.

The comments on the playing experience against the AI are given bellow. "These guys were more challenging". "I could not find a quick way to kill them, they kept changing up". "Difficult trying to kill them, they didn't like to get shot". "Seemed to know what it was doing, annoyed me". "They seemed more confident when they were clumped together". "I found them more difficult than the other guys". "I could not find any pattern to their behaviour, they would change one tactic to the next, and not all of them either". "More defensive, like they wanted to live". "Not suicidal, avoided my shots, they were tough but manageable". The comments for the AI NPC's shows that the players perceived that they were playing against a relatively more intelligent set of enemies.

6 Conclusions and future work

The AI POC game implemented a few concepts of CAI in one filter; the implementation and testing of the POC brought desired results.

The performance of PC's as they played the AI POC game did not change, however the PC's took a longer period of time to complete a level (that did not decrease over time) and they lost more health to achieve the same score.

Implementing the entire concept of CAI by extrapolation will give us better results. This means that the NPC's would seem to be very human in their responses during combat. The boundaries of the random variables affecting personalities and situations require further testing in a complete CAI implementation. Memory can be tested to let CAI learn and pass knowledge of PC strategy through weapon use and techniques can be used to be passed on from one combat encounter to the next. This can be used to adjust the level of play of the game for the player. If PC performance as measured in the report increases during game play then CAI could implement more memorization to keep the player at a more challenged level.

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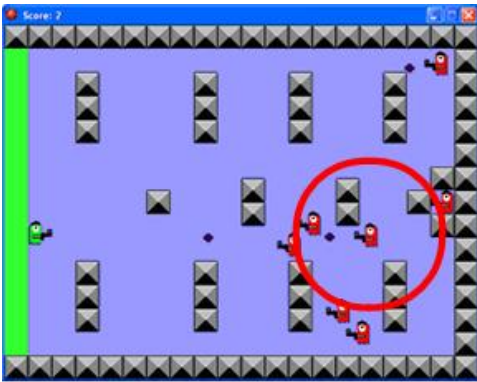
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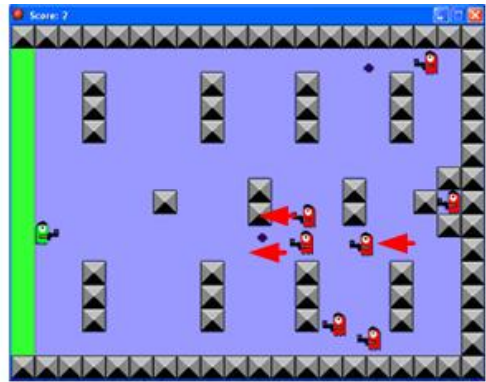
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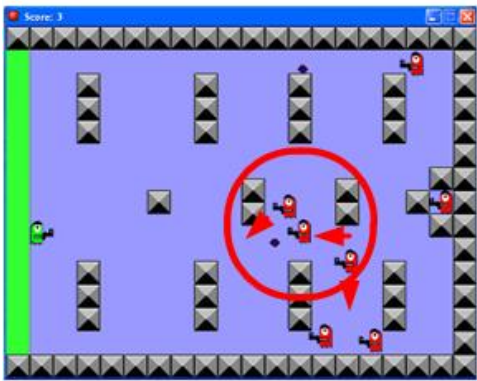
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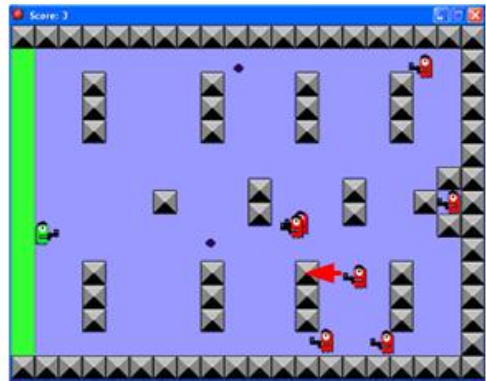
Frame 1. Red Circle indicates location of injured NPCs.



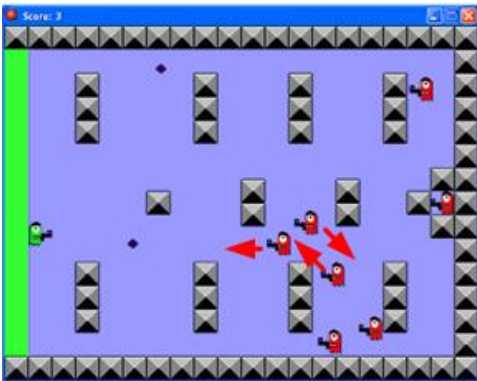
Frame 2. Red arrows indicating the directions of movement of NPCs in the vicinity. Reaction chosen ignores stress factors.



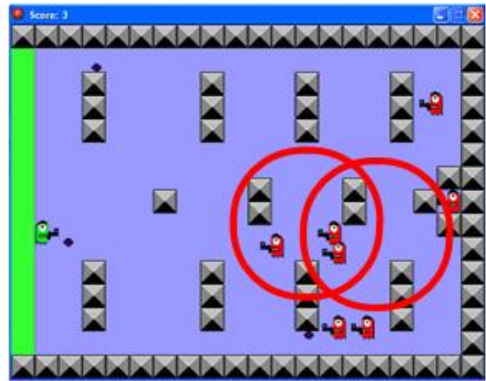
Frame 3. The second shot fired player character is not avoided and a second injury is obtained.



Frame 4. The NPCs continue to attack ignoring the most recent encounter.

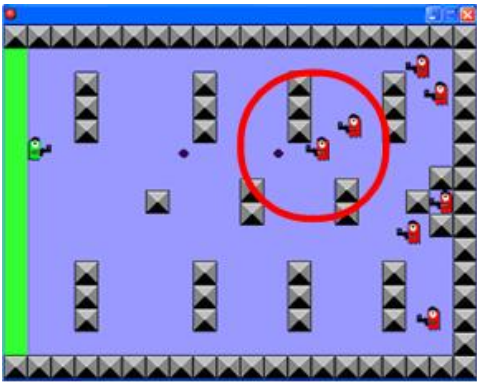


Frame 5. NPCs are moving in area of danger.

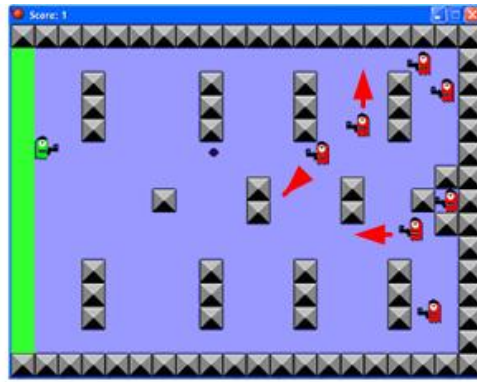


Frame 6. Areas of encounter still contain active NPCs.

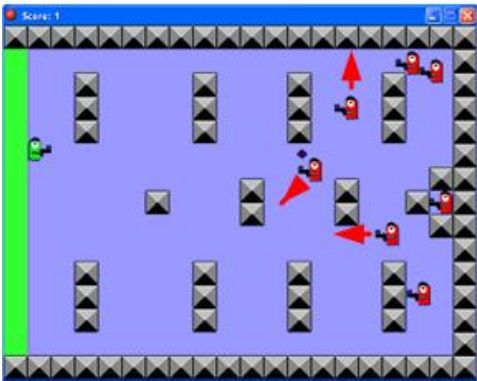
Figure 8: Game play for the control POC showing behaviour of NPC's during combat.



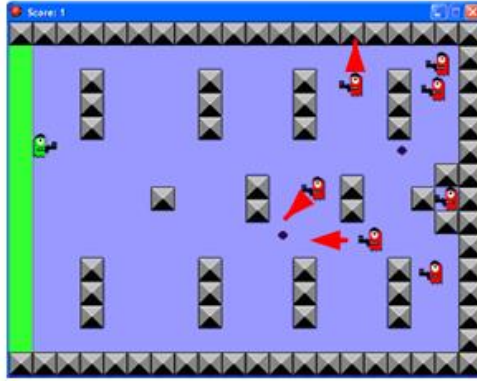
Frame 1. Red Circle indicates location of injured NPCs.



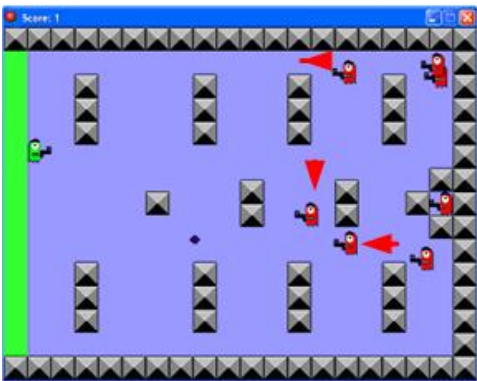
Frame 2. Red arrows indicating the directions of movement of NPCs in the vicinity of encounter. AI avoids the area based on proximity.



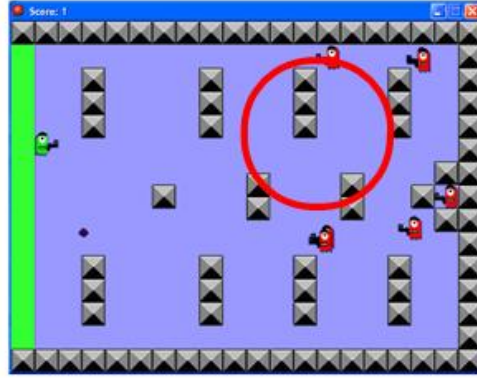
Frame 3. The second shot fired by green player (PC) is avoided due to the movements of NPCs. NPCs not in vicinity of initial encounter continue their low stress reaction.



Frame 4. The NPCs decide on the area to avoid, seeking a less stressful approach.



Frame 5. NPCs continue to attack from a different direction.



Frame 6. Area of original encounter is avoided by red NPCs.

Figure 9: Game play for the AI POC showing modified behaviour of NPC's during combat.

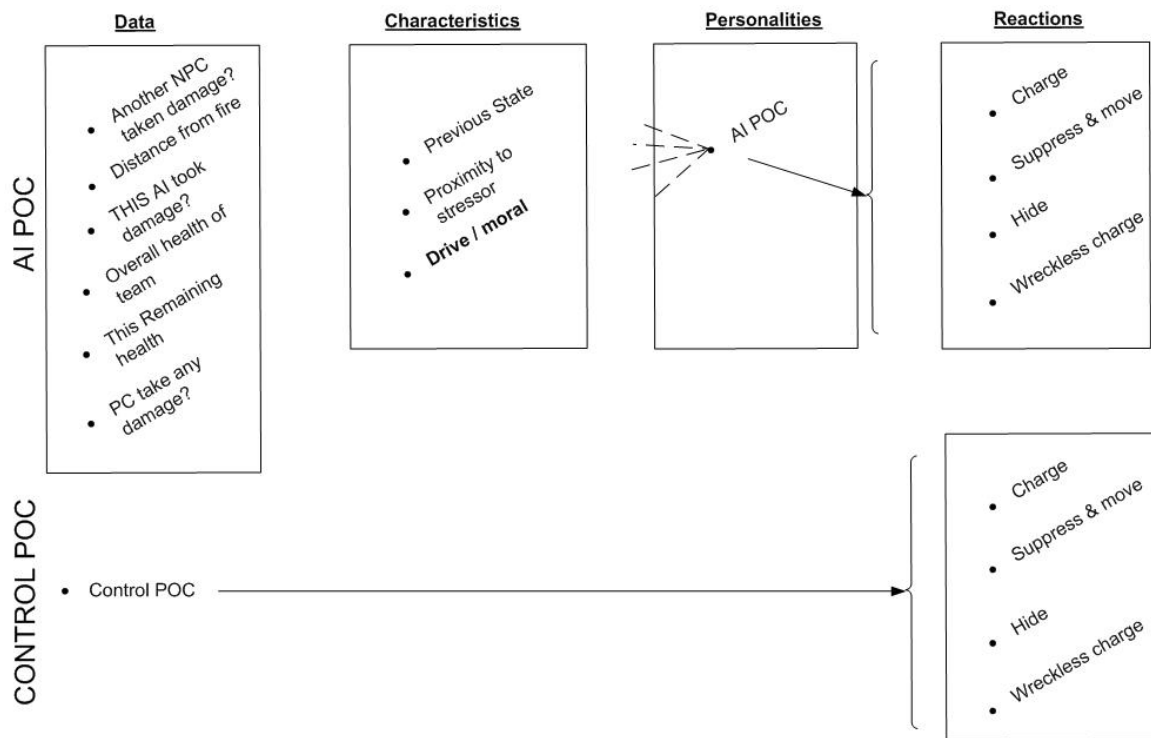


Figure 10: Logic for control POC and AI POC.

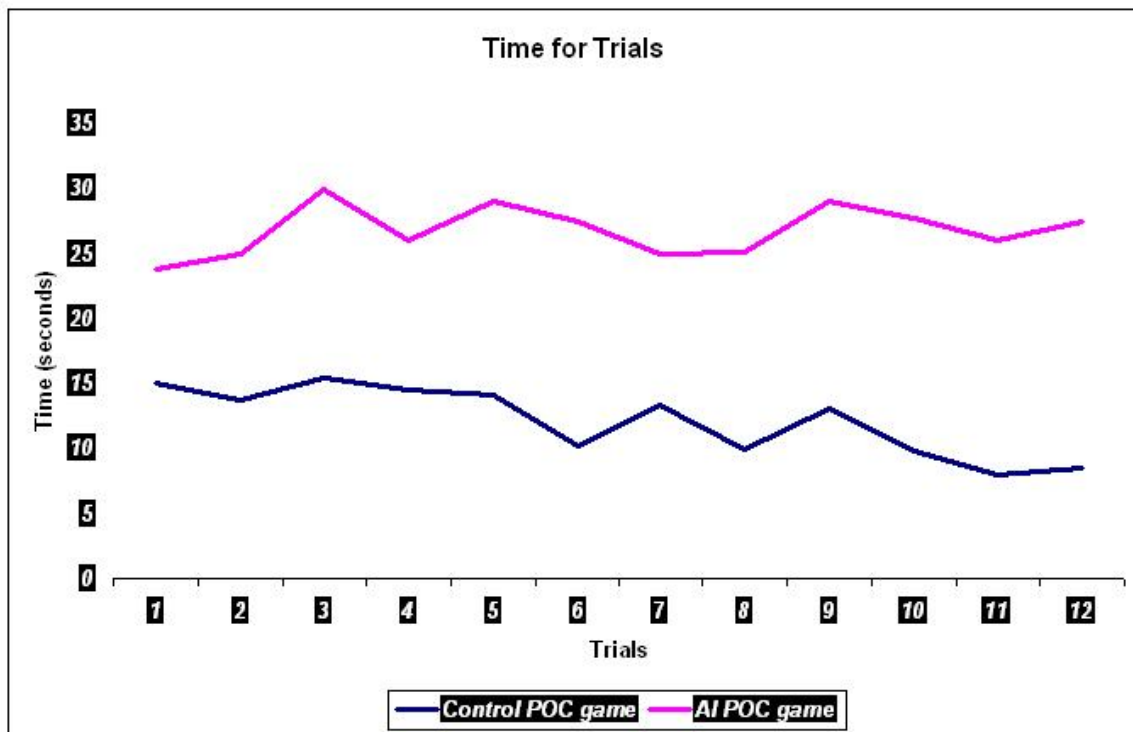


Figure 11: Time per match for consecutive trials.