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Managing Massive Multiplayer Online Games

SS 2019

Exercise Sheet 3: Conflict Management and Dead Reckoning

The assignments are due May 22, 2019

Assignment 3-1 *Conflicts*

Consider an abstract game with three players in a two-dimensional world. Each player p has a health value $p.H \in \mathbb{N}$. The initial value is 50 for all players, $\forall 1 \leq i \leq 3 : p_i.H = 50$. A player p_i can perform the following actions:

- $Heal(p_j, n)$ increases the health points of player p_j by n points up to a maximum value of 100, i.e., $Heal(p_j, n) = min(p_j + n, 100)$.
- $Attack(p_j, n)$ reduces the health points of player p_j by n points. If $n > p_j.H$ player p_j is *dead* and cannot perform further actions.

The game uses a client-server architecture with the server handling the processing sequence, i.e. the order of execution is determined by the server. For the sake of simplicity you can assume that the latency is two time steps in both directions, i.e. for the transmission of an action to the server and for the transmission of an update from the server to the client.

Consider the following action requests:

Player	Action	Time(Client)
p_2	Attack(p_1,60)	1
p_1	Attack(p_2,30)	2
p_1	Heal(p_1, 80)	3
p_2	Heal(p_2, 60)	4
p_2	Attack(p_3,30)	5
p_3	Attack(p_2,50)	6
p_2	Attack(p_3,30)	7

How does the game proceed on the server, respectively on the clients? In case of conflicts, solve them by using the *reset local actions* approach.

(a) How does the game proceed on the side of the server?

(b) How does the game proceed on the side of the client of player p_1? What anomalies occur?

(c) How does the game proceed on the side of the client of player p_2? What anomalies occur?

(d) How does the game proceed on the side of the client of player p_3? What anomalies occur?

(e) Which anomalies would be prevented locally for player p_3 if the clients would communicate via peer2peer and used a lag-mechanism with four time steps delay to solve conflicts? Assume a latency of two time steps for the communication between two clients.

(f) Discuss the advantages and disadvantages of these solutions!

Assignment 3-2 *Dead Reckoning*

To save bandwidth positions of players are not transmitted every tick. Consider the client of player p_1 who perceives actions of another player p_2. The client of p_1 receives the following position updates of player p_2 from the server:

Player	x	y	Time
p_2	100	100	0
p_2	110	90	15
p_2	130	90	30
p_2	160	50	40

At which position is player p_2 displayed at time 45? Use the following prediction models:

(a) The last known position is used as prediction.

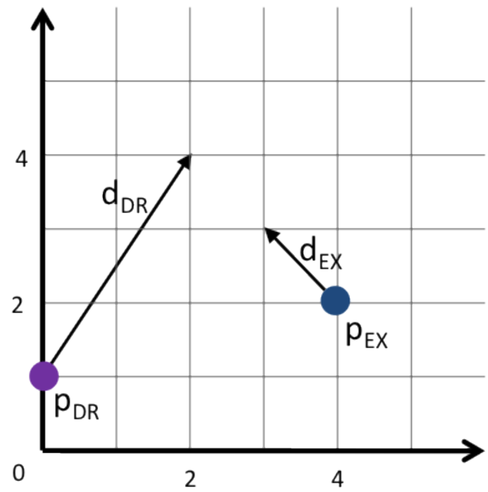
(b) The position is predicted by assuming a linear movement with constant velocity.

(c) The position is predicted by assuming a linear movement with constant acceleration.

Assignment 3-3 *Hermite-Interpolation*

Consider the following situation: The position of a player and his direction of movement at time t are given by dead reckoning with position vector p_{DR} and movement vector d_{DR}. At the same time an the client receives an update that consists of the actual position vector p_{EX} and movement vector d_{EX} from the server.

Now, the client has to transfer position and movement which were calculated with dead reckoning to the actual data within a time window δ. For the sake of simplicity you can assume that a player moves exactly the length of a movement vector within time window δ. In other words, at time $t + \delta t$ the player should be at position $p_{\text{EX}} + d_{\text{EX}}$.



The following vectors are given:

$$p_{\text{DR}} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad d_{\text{DR}} = \begin{pmatrix} 2 \\ 3 \end{pmatrix} \quad p_{\text{EX}} = \begin{pmatrix} 4 \\ 2 \end{pmatrix} \quad d_{\text{EX}} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$$

Illustrate the idea of position correction with linear combination of Hermite-functions as described in the script (chapter 3, page 20). Calculate the value of the linear combination function $\hat{p}(x)$ (see below) for $x \in \{\frac{1}{2}, \frac{7}{8}\}$. Mark these points in the plot and sketch your idea of the corresponding connecting curve based on these.

$$h_1(x) = 2x^3 - 3x^2 + 1 \qquad h_2(x) = -2x^3 + 3x^2$$
$$h_3(x) = x^3 - 2x^2 + x \qquad h_4(x) = x^3 - x^2$$

$$\hat{p}(x) = p_{\text{DR}} \cdot h_1(x) + (p_{\text{EX}} + d_{\text{EX}}) \cdot h_2(x) + d_{\text{DR}} \cdot h_3(x) + d_{\text{EX}} \cdot h_4(x)$$

where $x \in [0, 1]$ describes the progress of movement between time t and time $t + \Delta t$.