Uses of Empirical Modelling in a dart game simulation

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Abstract

There are numerous of dart tournaments which are famous around the whole world, especially in United Kingdom. This paper discusses the application of Empirical Modelling (EM) in constructing a small simulation of a dart game, focused on the principle, mechanism and rules, especially the players' motility. Through EM, the dart, as a real-world game, can be created in a quite different way from other forms of software development. EM has its own special features, ways and means on model implementations. Through the model of dart simulation, the paper will illustrated what are the differences of EM, give the reasons why use the EM and show the shortages of EM. At last, some suggestions to improve the EM will be given.

1 Introduction

This paper is aiming to present the author's own understanding of Empirical Modelling itself and analyse a real simulation using it. For this purpose, a common dart game was developed for illustrating and explaining this particular modelling system.

1.1 Overview of EM

Empirical Modelling, as comprehended from the denotation, is based on experiment and observation, which is about making real-world artefacts to support people thinking.

Compared with conventional programs, EM is more personal and cognitive. It does not pay too much attention on how to promote the functionality and efficiency, but the experienced and observational aspects.

As a matter of fact, EM contains two key features which are agent-oriented and definitive. That is to say, EM makes use of a fundamentally agent-based approach in programming related the notation of LSD, and also a definition-based script. Furthermore, three main concepts are involved in EM: observable, agent, and dependency. Observable means the models can be perceived and identified, and agent should be reckon as a real-world similarity in structure of model and data, finally the dependency is trying to show the relationships between different observables in the same artefact.

1.1 Brief description of dart model

The dart game simulation involves the whole real game processes, about player choosing, aiming, darting, score getting and results showing. All of them are based on the real dart rule. And except those apparent actions, some physical and psychical connections are considered behind the mechanism, which even makes it not only a simulation but also a research experiment for human's initiative.

Additionally, this model extremely benefits from EM, especially the feature "dependency" and "agency" which simplify the implementation of relationships and influences a lot.

2 Dart model design

2.1 Original idea

The primarily idea of dart game model came from the 2011 Professional Darts Corporation (PDC) World Darts Championship[1], which began from 16 December 2010. When seeing the competitors playing dart, an inspiration came out since the author has realized that every time the result was different influenced by numerous external factors.

After decided to model the dart game, a series of external effects had been thought of. At the beginning, several forces were considered as factors such as gravitational force, spin damping force and wind force. And meanwhile, there were also some individual impacts imaged in time of darting like accuracy, ability and stability.

2.2 Current idea

As mentioned above, the model, with all the aspects, would totally simulate the realistic dart game. Nevertheless, there was a problem experienced, which was if put all those types of effects into the same model, it would be extremely difficult to tell which one exactly influenced result. For example, whenever the deflection turns out, it can result from either external forces or man's initiative.

As a matter of fact, to all the participants, in the real darts competition, the external condition was supposed to be indiscriminate. The results were only depending on the participants themselves.

Taking the fact into account, the author decided to use the man's initiative as the main factor. And two major effects, which were accuracy and stability, of this were picked to better showing the connection.

2.3 Factors analysis

As discussed above, a simulated dart game should consider two major types of factors, external force and human initiative.

In this model, external force, such as gravitational force, spin damping force and wind force, was slightly considered. All the aerodynamic resistances were ignored due to their little influence, since the game areas are always indoors. By comparison, although the gravity is most significant aspect of all vertical force, the players use darts with same weight, hence gravitational force was also calculated in a quite simply way.

While participant is playing a vital role in the dart game. Normally, different individuals have different capacity levels which are related to their abilities and qualities. Ability refers to the targeting ability of player which is the core factor of causing different results. Additionally quality is reckoned as personal condition during the dart competition, especially in psychology, like resistance of nervous, fear and gutless. Those, so-called human initiative, will cause different accuracy and stability throughout the entire dart game, and become the crucial reasons of win or lose the game.

2.4 Model design

This model is aiming at simulating a real dart game by using EDEN, DoNaLD, and SCOUT. Through analysed the mechanism of the game, it can be divided into five main aspects in order to simplify the model design.

2.4.1 Dart board

Dart board is one of the most significant parts of dart game simulation. In this model, the board is designed according to the real dart board with twenty radial sections and five scoring areas which include normal area, Bull's eye, Bull, Double ring, Triple ring. The completed dart board can be seen from the Figure 1.

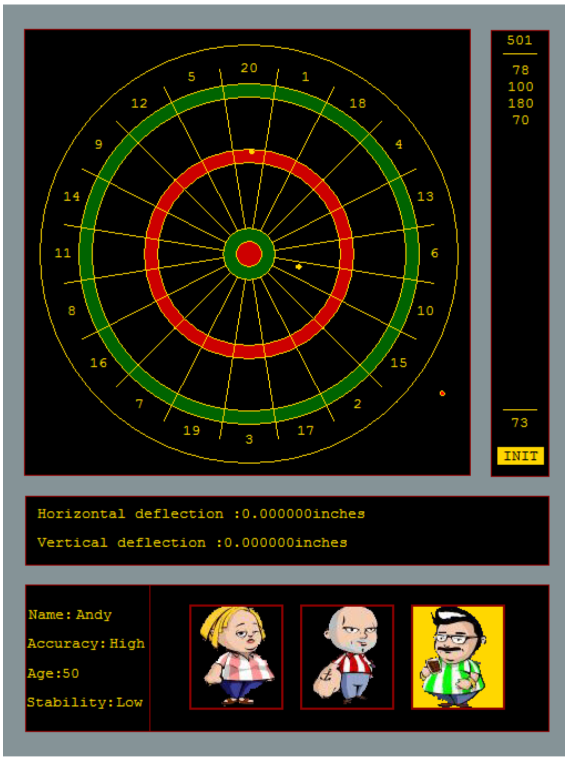

Figure 1: A screenshot of the graphical interface to the dart game model

2.4.2 Aiming control

Aiming control is the core section of this model which is showed in the Figure 2. The circle with a changing radius presented the current status and ability of the player. There are two attributes considered in aiming simulation, accuracy and stability. The maximum radius of the aiming circle is linked with accuracy attribute. Homogonously stability attribute determines the rate of radius transformation. (Accuracy and stability will be illustrated in next section)

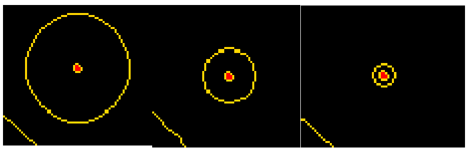

Figure 2: Aiming circle with changing radius

2.4.3 Score board & score rule

A score board is put beside the main dart board in order to record scores. To understand how it works, a brief dart rule is supposed to be introduced. Every round player has to reduce the total point 501 by his dart score, and each round player throws three times. Before the total point is decreased to zero (win condition), it must make sure that the last dart is inside the double-ring (the green ring in the Figure 1) and just reduce the total point to zero not negative. Otherwise, all the scores got from this round should be cancelled and then re-play this round. In that case, the command window will output the notice text like Figure 3.

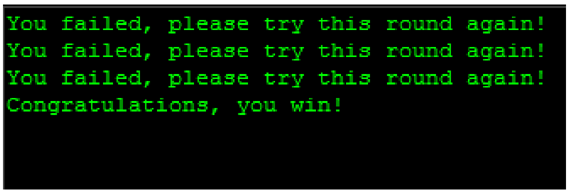

Figure 3: Output text in command window

Throughout the whole game, score board will display the results and record the points according to the mentioned dart rule. And each element under the total point is the record of different rounds, which is the sum of all three darts per round.

2.4.4 Player selection

At the bottom of Figure 1, a selection part is set for users to choose different characters. With different characters, there are four different features called “Name”, ”Accuracy”, ”Age” and ”Stability”, which connect with the aiming system.

2.4.5 Deflection display

This part is used to show the exact deflection affected by different effects in each throw time. It contains both horizontal and vertical directions deflection.

3 Accuracy & Stability

In this section, two major factors, accuracy and stability, of this dart model will be clarified explicitly.

Accuracy is used in order to measure the capacity of a particular player, which means given an expected score how accurate that he can get it exactly. That depends on the technical level of the player himself. In this model, a circle with different maximum radius stands for the whole accuracy thing. Radiuses differ from high to low accuracy, higher accuracy has shorter radius which can be regarded as inside the shorter radius circle the random point is closer to expected point. Additionally, shorter radius circle also can be considered as having higher possibility of getting desired score.

By contrast, stability is related to personal initiative, which means facing different competitors and situations, player will perform differently due to the emotional effects. For instance, when a player feels nervous, it will cause a shaking arm or unstable pant which would influent his performance. Consequently, this erratic factor, in this model, is presented by rate of radius transformation. In other words, the radius will change as time changes from zero to the maximum, and the speed of that changing is rely on the stability characteristic. Moreover, more stable player will generate slower changing speed of radius.

4 Empirical features utility

From numerous achievements by EM group in University of Warwick, Empirical Modelling is able to be regard as an extremely outstanding modelling tool. [2] The main features which are observable, dependency and agency contributed to its success. Apparently it is absolutely different from other conventional programming or modelling approaches. The following paragraphs will illustrate how those three features worked in this dart game modelling.

4.1 Observable

Observable is one of the most significant features in EM. It was defined that “An observable is a feature of the situation or domain that we are modelling to which we can attach an identity.” [3] In other words, as an observable, it should contain a current value or status which will be helpful to the update process. For example, create a table object for a 3D movement model, a current position and status like static or dynamic are supposed to be involved.

In this model, the character or player is just like an observable. It has a fixed value of accuracy capacity, stability and a current accuracy status as well. In most cases, this particular feature is reckoned as the foundation of all empirical features, and it should work with dependency and agency together.

4.2 Dependency

Dependency is the most special one of all three features, which was regarded as “A dependency is a relationship amongst observables that expresses how they are indivisibly linked in change.” [3] Combined with observable, dependency is used to create a series of permanent relationships between one observable to another. Unlike other program approaches, these relationships are working automatically. It is not to make complicated connections of all variables, and also not to calculate every updated value in some particular functions or procedures, but use triggered actions in all observables to keep updating the values whenever it is necessary. This feature is beneficial to both system and programmer. It can synchronise the update processes of the whole system and save programmers' extra work on figuring out the relations and computing the values, especially in a large number of observables with a complex reticular connections.

This model was fully used dependency feature during the dart game simulation. After user selecting the character, the radius and changing rate will update along with the alterative accuracy and stability features dependently. Additionally, when finishing dart throwing, the position of result and score list will update automatically as well as the deflection variables. The principle is to make all observables in SCOUT or DoNaLD equal to the certain EDEN variables persistently. Hence those observables current values and status will keep pace with the alterative variables.

4.3 Agency

Furthermore, EM is also an agent-based modelling tool. "An agent is an entity in the domain being modelled that is perceived as capable of initiating state-change." [3] It can be considered that all the observables in EM are real world simulation, which means the observables themselves are able to perceive the state-change in a closed world. It will affect and also be affected by the particular structure of observables and procedures. There are no existed simulation doing any better than agency, it is entirely the same as real objects.

Agency was utilised in order to improve this model. The system will perceive the movement of mouse from the user. If user presses the left key, system would deem that the user is ready to throw dart at that point. And then, if user move up the mouse and release the key, system would regard this action as throwing dart. While, when user move down and release the mouse, system would allow user to re-aim. Additionally, not only the system is perceptive, but also the course of scoring. All the external forces and personal characteristics will influence the dart results. Besides, there is no need to calculate all the impact factors into the scoring function. It will benefit from the perceptive agent.

In a nutshell, without those three empirical features, the simulation would not be easily constructed or even hardly achieved.

5 Shortages & Suggestions

There is no double that EM is a quite helpful tool for modelling. Nevertheless, it still contains some shortages in a sense. Main problem is that it is not a perfect language.

To SCOUT, it is extremely complex to locate the windows, especially the type of windows within several sub-boxes. And the attributions from some types of boxes are not enough for description. For example, if a round or ellipse box is required, it cannot be satisfied by using SCOUT to change the shapes. Moreover, a complete description for text boxes is unnecessary in some cases, which means sometimes it will generate quite a lot redundancy by defining a whole box for just one or two characters. The situation can be improved if SCOUT gives more types of boxes or windows with more attributions, and an override function is suggested to design for SCOUT.

Besides, notation of DoNaLD is also not powerful enough. Loops and lists are not allow to be used, for instance, in order to create twenty lines or labels in DoNaLD, it is almost a disaster to define and evaluate them twenty times. Furthermore, some functions are not usable to openshapes, which limit this data type a lot. More data types and loop statements are advised to be added.

Additionally, combination of SCOUT and DoNaLD has constricts to construct a user-oriented interface. A direct and visual method will make the design and code more efficient and effective.

Finally, a strong recommendation is given to promote the EDEN, which is to create a function for a string type in order to get same named variables in SCOUT or DoNaLD. That will build a more convenient access between those three notations.

In a word, more powerful and functional language and platform of EM are required to further develop this modelling tool.

6 Achievement

This model focuses on the whole personal impacts. Both physical and psychological aspects of dart player are completely considered. To simulate the action of dart, the author used restricted mouse movements to imitate the aiming and throwing procedures by press, release, and drag up and down. To imitate variety of human mental activities, a dynamic aiming system was designed in order to simulate the unstable emotion.

An experiment is expected to be carried out by this model, if a complete and accurate data for competitors can be collected. After that, a comparison between ability and initiative related factors is supposed to be obtained.

7 Further work

This dart game simulation can be extended by using Cadence, which contains more powerful graphical functions and explicit variables observation. By Cadence, this model can be designed as a 3D game, putting more factors like distance and angles into consideration. And also users will be able to see the current status and values for every observable.

Moreover, a remote controller is advised to replace the mouse such as Wiimote referred by Dr Meurig, in which way it will be extremely enhance the manoeuvrability for this game.

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