‘EPHEMERALITY’ IN GAME DEVELOPMENT: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

Ephemeral Computation (Eph-C) is a newly created computation paradigm, the purpose of which is to take advantage of the ephemeral nature (limited lifetime) of computational resources. First we speak of this new paradigm in general terms, then more specifically in terms of videogame development. We present possible applications and benefits for the main research fields associated with videogame development. This is a preliminary work which aims to investigate the possibilities of applying ephemeral computation to the products of the videogame industry. Therefore, as a preliminary work, it attempts to serve as the inspiration for other researchers or videogame developers.

INTRODUCTION

Ephemeral Computation (Eph-C) (Cotta et al. (2015)) can be defined as the use and exploitation of computing devices of ephemeral (i.e., transitory and short-lived) nature in order to carry out complex computational tasks.. Eph-C is a concept proposed inside the frame of a project, coordinated between several research groups, from different universities, called “Bioinspired Algorithms in Complex Ephemeral Environments” (*Ephemech* project - https://ephemech.wordpress.com/) which has been funded by the Spanish Ministry of Economy and Competitiveness (Ministerio Español de Economía y Competitividad). This project aims to establish the theoretical basis and foundations to define the concept of ephemeral in computation. Its objective is to define the foundations of efficient (and scalable, in certain forms) systems design to provide services for managing ephemeral resources in complex systems. Specifically, it focuses on providing evolutionary computation capabilities to treat transitory behaviors. The definition of transitory behavior and the entities or resources it associates to, is something that is being studied within the project. The reality is that there are many problems associated with treating ephemeral resources, but we are convinced that there are great benefits also. Even though the mentioned project treats Eph-C from a general point of view, this paper focuses on analyzing the possibilities of Eph-C within the game development industry. The belief is that this industry can benefit greatly from this new paradigm, as it could be applied to most of the processes which are part of videogame development. One of the main objectives of ephemeral computation is to effectively use highly volatile resources whose computational power would be otherwise wasted or under-exploited. Think, for example, about the pervasive abundance of networked handheld devices and tablets not to mention more classical devices (such as desktop computers) whose computational capabilities are often not fully exploited. Hence, the concept of ephemeral computing partially overlaps with cloud computing, ubiquitous computing, volunteer computing and distributed computing. It exhibits, however, its own distinctive features, mainly in terms of the extreme dynamism of the underlying resources, and the ephemerality-aware nature of the computation. It therefore has to autonomously adapt to the ever-changing computational landscape, not just trying to adapt to the inherent volatility of this landscape but even trying to turn it into an advantage.

Figure 1 represents a conceptual map that relates Eph-C and other computation paradigms, as those mentioned previously, and provides some indications/ideas about possible practical applications/areas inside the industry of videogame development (more comments on it are given in Section).

This paper is therefore a preliminary work, with which we intend to initiate a discussion about the possibilities of Eph-C in the videogame development industry.

VIDEOGAMES AND ‘EPHEMERALITY’

The application of artificial/computational intelligence to games (game AI/CI) has seen major advances in the last decade and has now become a separate research field in itself (Lucas et al. (2013)). In general terms, it is about adding Artificial Intelligence techniques to videogame development which can result in areas of great interest, both for academic use (as it exploits a new practical field of research) and industry (which benefit from many of the research proposals which improve the development process reducing costs, providing sources of inspiration to industry professionals or extending

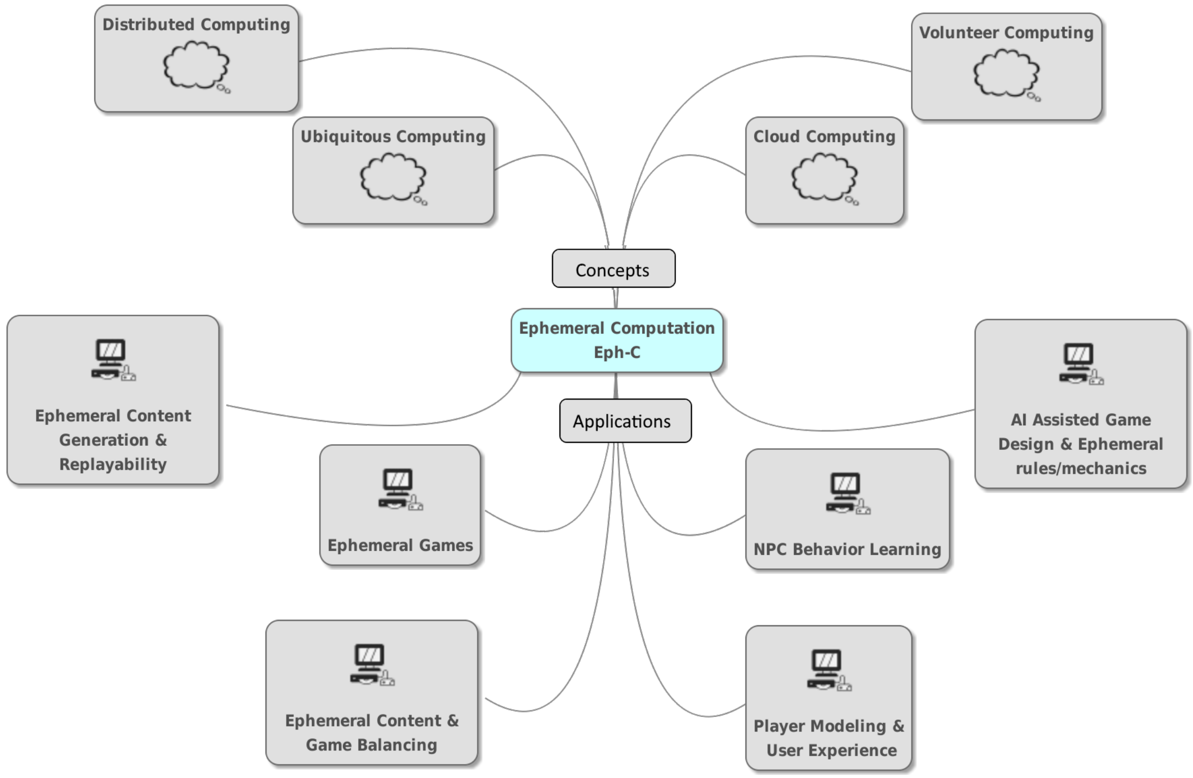

Figure 1: Related Concepts and Applications

the life of commercial games, to mention just a few). There are many lines of research that have arisen from the possibility of applying AI techniques to the videogame development process. (Yannakakis and Togelius (2015)) and (Lucas et al. (2015)) suggest some principal lines of research such as AI-assisted game design, computational narrative, procedural content generation, non-player-character (NPC) behavior learning, NPC affective computing, believable bots, social simulation, and player modeling, among others. Many of the problems that arise in these areas require creativity. It is not enough to just solve them competently but also to do so in the way a human would. Many interactions and relationships emerge naturally in games which creates a complex system that is usually not easy for a human to understand but can provide interesting results from a human perspective (Sweetser (2008)). Moreover, many games have an ephemeral nature, which is hard to manage computationally. Some game assets (i.e., game contents, NPC behavior/game AI, game goals and even game rules) can be seen as volatile in the sense that one cannot guarantee they will reoccur. Thus, it makes sense to consider creating them ephemerally.

The recent boom in casual games played on mobile devices means that both the design and gameplay of games demand resources that appear and disappear continuously while the game is being played (Lara-Cabrera et al. (2013)). This is precisely what occurs in the so-called pervasive games (i.e., games that have one or more salient features that expand the contractual magic circle of play spatially, temporally, or socially) where the gaming experience is extended out in the real world (Montola et al. (2009)). Playing games in the physical world requires computations that should be executed on the fly in the users mobile device and taking into account that players can decide to join in or drop out of the game at any moment. This is common in most multiplayer games.

We should, however, not just focus our attention on this specific genre of games as Eph-C can be applied in many areas of the gaming universe as shown in Figure 1 (note that this figure contains a preliminary schema that will be extended with more detailed information in the future although now it provides an overview of the underlying idea under the Eph-C paradigm). It is not unreasonable to think about the concept of *Ephemeral Games* as those games that can be only played once or that expire in some way; one can find many reasons for their creation such as: economic reasons (e.g., the player is expected to demand extensions of the game in the future) or creative aspects (e.g., provide unique game experiences by playing a game with irreversible actions). In addition, one can think about ephemeral goals/events that temporarily exist in games as these appear (and disappear) as consequences of the actions and preferences of the players. These goals/events are usually secondary (as the main goal is well-defined and related with the primary story of the game) but help to significantly improve the gaming experience and thus

they are critical in increasing user satisfaction (incidentally, the maximum objective of games). Another issue to consider is the reversibility of players actions. Many games give the player the option to save the current state of the game, so they can reload it later. This means that players do not have to face the consequences of their actions as they can always go back to a previous state. While this is useful (and desirable) in a number of games, it is also true that it poses a significant drawback in certain types of games like multiplayer online games (e.g., first-person-shooter, real-time strategy, or role-playing games, among others) where the actions of one player can affect the game's universe and thus affect other players. Goals, players' alliances, and even rewards have to be rearranged according to the game in progress which lends temporality to the nature of game. This transitory essence of games provokes important problems that are difficult to manage computationally, and where and how to create the volatile features of a game is a question that remains open and Eph-C can help to solve/mitigate.
We have then coined the term 'Ephemerality' to identify the ephemeral nature of a high number of entities in the real world, and more specifically in videogames.

CHALLENGES FOR EPHEMERAL COMPUTATION IN VIDEOGAMES

Although the objective of this paper is not to exhaustively cover all the possible challenges in the videogame context, it is possible to define possible applications or fields that could also benefit. The 10 key areas for the future of AI in videogames, according to a consensus of experts on Dagstuhl's seminar of AI in videogames (Yannakakis and Togelius (2015)), are: Non-player character (NPC) behavior learning, Search and planning, Player modeling, Games as AI benchmarks, Procedural content generation, Computational narrative, Believable agents, AI-assisted game design, General game AI, and AI in commercial games.
In the following sections, we make a preliminary approach to show how Eph-C can affect each of these different areas. As we have discussed, we believe that ephemeral computing has great potential to be applied on these areas.

Non-player character (NPC) behavior learning. The main objective in this area is to obtain AI controlled players capable of learning how to play the games as they play, a problem solved in different approaches (reinforced learning, artificial neural networks, decision trees, etc.) (Muñoz-Avila et al. (2013)). Although it is true that videogames have stable and well defined mechanics (although not necessarily easy to learn), it is also true that the appearance of secondary objectives or even the creation of new challenges (in the form of mini-games that have nothing to do with the main game) could negatively affect the learning process. In this context, ephemeral computation can help lower the negative impact.
Thus, Eph-C could improve the learning process of these agents by adding the perception of ephemeral events or game states, in such a way as to not affect the global learning or, conversely, exploit them to develop a better strategy.

Search and planning. Search and planning are common tasks to most for the *bots* or agents in videogames. These range from finding an optimal route to an objective, to planning a sequence of actions to achieve its objectives. Although the scientific literature is full of approaches to address this problem (Botea et al. (2013)), it is true that, in a context where planning can be done in the short or long term, the incorporation of measures that allow agents to adapt to the appearance or disappearance of obstacles, objectives, enemies, characters, or any other object that affects their actions is useful. Adapting search and planning algorithms to these new circumstances, allowing them to jump to new areas of the search space, could improve their results.

Player modeling. One of the greatest challenges in the videogames is to obtain models that represent a human player, whether they are behavior models, cognitive, emotional or based on other characteristics (Yannakakis et al. (2013)). A better understanding of players enables the development of dynamic games which adapt to each player, resulting in a unique experience for each player, even when playing the same game. The perceptions, emotions, or behaviors of a player can change over time, they can even suddenly change in a short space of time, resulting in ephemeral behaviors(or another aforementioned characteristic). The benefit of applying ephemeral computation to this area is twofold: adaptation of the models to these ephemeral behaviors, or ephemeral event (or any other content) generation to surprise the player and cause a previously anticipated reaction based on the model.

Games as AI benchmarks. Generally, videogames provide an excellent experimentation benchmark, as they permit modeling and simulating any kind of circumstance (real or hypothetical) where different agents can interact and modify their surroundings. For example, there have already been a great number of events where different AI methods have competed against each other within the framework of a videogame (Togelius (2016)). The results obtained in these competitions may allow designers to make some generalizations. Moreover, although AI techniques are developed and evaluated in videogame development, their results can be extrapolated to other fields, or they can inspire other researchers who apply these techniques to other contexts. One of the most recent and popular is the success of Google (actually, a company supported by Google) in the application of deep learning techniques in the videogame universe (David Silver et al. (2016);Mnih, Volodymyr et al. (2015)).
One of the possible problems is that these simulated environments are frequently deterministic (or partially, at least) and they behavior is known from their development. By adding ephemeral and spontaneous events, these environments can be brought closer to the real word, where it is not always possible to know what is going to happen. In this way,

by increasing the complexity of these environments, more robust AI can be achieved and their extensibility to other realistic environments can be increased

Procedural content generation. Procedural content generation (PCG) is an area in constant evolution and expansion, reaching any kind of videogame resource such as game maps, objects, missions, character behaviors or even sound or textures (Shaker et al. (2015)). To this end, different methods have been used, but evolutionary or genetic algorithms are one of the most used, because of their speed in generating and managing large quantities of possibilities. Thanks to the addition of PCG, development costs can be greatly reduced, or additional features can be added because a game whose contents have changed can be replayed. Usually, contents are generated to be stable and persistent, therefore, raising the possibility of including ephemeral content within procedural generation could open up a new range of possibilities to enrich the subsequent game experience. As ephemeral content, many different options can be considered, like emergent objectives, resources with limited lifetime, temporal abilities associated with players/enemies/NPCs, or even the game story itself (as described below).

Computational narrative. Automatic generation of rich and consistent narrative is one of the great challenges for AI in videogames (Horswill et al. (2014)). Even if first seems to be just another content type (and included in PCG) narrative has special attributes and constraints. Therefore, it deserves its own area of expertise, as an attractive and consistent narrative is more of an art form than a mere functionality. The fact of assessing the possibility of including narratives or just fragments with limited lifetime, which could appear and disappear spontaneously, would signify a new way of creating narrative for videogames.

Believable agents. Sometimes, it is not enough to create agents capable of fulfilling certain objectives or behaviors, but also their behavior needs to resemble human behavior closely enough to make their artificial nature unnoticeable (Philip Hingston (editor) (2012)). In a similar way as the Turing Test, there is a test that evaluates agents/bots/NPCs humanity in a videogame context (Hingston (2009);Polceanu et al. (2016)). Human nature is not always easy to simulate, as AI controlled agents always tend to find the optimum way to achieve their objectives, something that is not always true for humans. The emotional and instinctive nature of humans leads us to take unexpected and, occasionally, completely illogical actions from a computational point of view. The possibility of generating those emotions or behaviors in an ephemeral way for the agents could improve their ability to imitate the unpredictability of human behavior

AI-assisted game design. Another great challenge for AI is taking it to a higher level, not only using it for content generation or NPC behaviors, but for the game design itself.

Table 1: Relationships between Ephemeral Computation Applications (Adaptation vs. Generation) (Eph-C/A, Eph-C/G) and Key Research Areas of AI on Videogames

Research area	Eph-C/A	Eph-C/G
Non-player character (NPC) behavior learning	•	
Search and planning	•	
Player modeling	•	•
Games as AI benchmarks	•	•
Procedural content generation		•
Computational narrative		•
Believable agents		•
AI-assisted game design		•
General game AI	•	

Several approaches can be found in the literature which address this feature. Game rules or the definition of game mechanics can be automated (Togelius and Schmidhuber (2008)). These rules and mechanics could also be imagined as ephemeral, being transitory or permanently disappearing. As mentioned, it would be possible to think of completely ephemeral games, with limited life time or only being able to be executed once. This could bring us new and unique gaming experiences. This line of research can be complex but highly motivating.

General game AI. Usually, AI for games is developed under specific circumstances to meet certain objectives associated with specific games. This makes them very difficult to reuse in a different context other than the one they were developed for. A new recent research line proposes developing NPCs capable of learning and playing successfully, different games without being designed specifically for any of them (Liebana et al. (2016)). The main focus is on developing algorithms which allow optimizing the game strategy in different games without making any changes to the algorithms. The only source used is the information from the game rules and players' observation. We have already talked about the possibility of ephemeral events, resources or objectives. They would make this learning process much harder. The way of adapting these AI controlled algorithms to these new types of resources is an interesting but pending line of research. It remains one of the main issues due to the lack of proper ephemeral game definition.

SUMMARY

Based on the above, we can observe that ephemeral computation applications in the different key research areas of AI in videogames can be divided into two principal groups: *Adaptation* (modifying structures and algorithms to consider ephemeral nature of resources) and *Generation* (generating ephemeral contents to reach new objectives or improve the gaming experience). In Table 1 the relationships between these two types of applications (Adaptation and Generation) with different research areas are shown.

We would like to highlight that this work is a preliminary approximation. Therefore the table above is not meant to be definitive and will probably be updated and extended with results obtained from future research in these areas.

CONCLUSIONS AND FUTURE WORK

This paper has presented just some of the numerous possibilities to incorporate the new concept of ephemeral computation to key AI research areas in videogames. The work presented here represents our own starting point as ephemeral computation is an innovative paradigm in itself, and its application to the game development industry is a world only just being discovered and explored. This emergent paradigm opens up a new range of options, which can be interesting research focuses for new videogame (or any another area) research approaches.

Some of these new research lines have been presented in this paper, and we hope that this can serve as an inspiration to other researchers interested in this promising paradigm.

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