Procedural content generation in education

Orchestration of content using PCG

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Background Information

- **What:** PCG is an automated content generation technique in which a "content" (a common example would be exercises for a math quiz/game) is created by a computer.
- **Why:** PCG is able to produce content with limited-to-none human interaction which makes it a useful technique for education that is worth exploring.
- **Which (sub-topic/area):** This research focuses on how PCG is used to "orchestrate" the simultaneous generation of content of various types and what has been achieved so far.

Research Question

What has been achieved so far orchestrating the simultaneous generation of content of various types?

- Which methods are used in the industry when implementing PCG that orchestrate the simultaneous generation of content?
- How or why is PCG used to orchestrate the generation of multiple types of content? Is it preferred over other alternatives?
- What are the similarities/differences between applications of PCG that orchestrate the generation of a game? Based on these, are there implementations of PCG that are better/worse?

Methodology

The main method of research of this project is **literature review**. Recent literature related to PCG orchestration in the **education** and **game** *domains* have been analyzed. Only the papers that are promising from an educational standpoint (and apply orchestration) have been selected for discussion.

Results & Discussion

Author	V	A	N	G	R	L	E
Xu et al. (2021)	X	-	X	-	-	-	X
Lifindra et al. (2023)	-	-	-	-	P	X	X
Game-O-Matic, Treanor et al. (2012)	X	-	P	-	X	P	P
Data Adventures, Green et al. (2018)	X	-	X	-	-	P	P
AudioInSpace, Hoover et al. (2015)	X	X	-	-	P	-	-
Mechanic Miner, Cook et al. (2013)	-	-	-	P	X	X	P
Dormans (2010)	-	-	X	-	-	X	-
Karavolos, Bouwer and Bidarra (2015)	-	-	X	-	-	X	P
Valls-Vargas et al. (2017)	P	-	-	-	-	X	X
Smith, Padget and Vidler (2018)	-	-	X	-	-	X	P
Prager et al. (2019)	X	X	-	-	-	-	P
Karavolos, Liapis and Yannakakis (2019)	-	-	-	X	X	X	-
Migkotzidis and Liapis (2021)	-	-	-	X	X	X	-

- Generating basic math exercises with support material like a suitable text or a related visual [1]
  - Orchestrating the generation of a simulation together with a math/science question [2]
- Generating a simple maze game that features algebra questions between rooms [3]
- Controllable generation of programming exercises for an educational game utilizing generative grammars [4]
- Experiment on which orchestration approach is more "fun" for the players [5]

Future Work

- Generating exercises for other subjects
- Generative grammars are mostly only used for generating better levels [6]
- ML techniques could be useful

References

[1] Yi Xu, Roger Smeets, and Rafael Bidarra. "Procedural generation of problems for elementary math education". en. In: International Journal of Serious Games 8.2 (June 2021), pp. 49–66. issn: 2384-8766. doi: 10.17083/ijsg.v8i2.396. url: http://journal.seriousgamessociety.org/index.php/IJSG/article/view/396 (visited on 03/26/2024).
[2] Mike Treanor et al. "The micro-rhetorics of Game-o-Matic". In: Proceedings of the International Conference on the Foundations of Digital Games. FDG '12. New York, NY, USA: Association for Computing Machinery, May 2012, pp. 18–25. isbn: 978-1-4503-1333-9. doi: 10.1145/2282338.2282347. url: https://doi.org/10.1145/2282338.2282347 (visited on 06/11/2024).
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