**Assessment submission 1: Dissertation Proposal**

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| **Student name:** | Calum Lindsay |
| **Student number:** | 21010093 |
| **Project title:** | Where Have L-Systems Been Under-Utilized in 3D Games? |
| **Supervisor:** | Magnus Tullock |
| **Partner college:** | Shetland or Orkney? |

**Project summary/overview**

What is the product? What is your goal? What is the justification for your project? This should include a rough overview of the requirements, both functional and non-functional. There is no need for detailed scoping at this stage. [300 words]

Goal is to explore existing uses of L-Systems in games and pioneer new approaches and/or new avenues of exploration.

The goal of the project is to explore the existing usage of L-Systems to generate content for 3D video games, propose and create solutions using L-Systems in areas where other techniques are traditionally used, and pioneer solutions using L-Systems in areas where little to no research has taken place.

Functional requirements:

A comprehensive review of the current literature must be performed to identify areas of greater and lesser exploration. Solutions to relatively unexplored problems must be proposed and developed. Solutions to well-known problems using other techniques must be developed using L-Systems. Experimentation must be performed to produce performance metrics of both the new solutions and existing counterparts. Created solutions must be critically analysed against existing solutions where appropriate. A 3D application must be created to demonstrate the created solutions.

Non-functional requirements:

Existing solutions using other techniques must be acquired or developed to perform performance measurements upon. An interface must be created to allow the tweaking of solution inputs for demonstration purposes. The performance of the created solutions must be reasonable for their intended use-case which may be real-time or offline depending on the specific solution.

Justification:

Lindenmayer Systems are self-rewriting string generation algorithms at heart and were first proposed as a way of modelling the development of plant like structures by Aristid Lindenmayer (<https://www.sciencedirect.com/science/article/pii/0022519368900799>) with later work expanding on this and importantly introducing the concept of a turtle renderer to produce rasterized images, culminating in a fascinating book: The Algorithmic Beauty of Plants (<http://algorithmicbotany.org/papers/abop/abop.pdf>).

Procedural generation in video games allows the fast creation of large amounts of content with smaller development teams which is important as over time “The most popular commercial games get larger, prettier, more atmospheric, and more detailed.” (<https://dl.acm.org/doi/pdf/10.1145/2422956.2422957?casa_token=_uJTWI93H4QAAAAA:EV86R8uCLHtdWp8Te0I1We9TYMyGBx4jWuD3f-2Zteqz6DTaaaYhRFQWUY0x4NP2-5O5d0fJR1am3A> : pg2) thus requiring more and more high quality content which is a challenge when “manual content production is already expensive and unscalable” (“).

Lindenmayer systems have seen limited use in games, mostly being used “for botanic modeling and generation” (<https://www.diva-portal.org/smash/get/diva2:832913/FULLTEXT01.pdf> : pg8) with famous examples that use SpeedTree being Battlefield 3, The Witcher 2, Gears of War 3(“), Elden Ring and Ghostwire: Tokyo (<https://en.wikipedia.org/wiki/SpeedTree>), however, their usage has been fairly limited in other areas such as terrain and scenario generation, and finding solutions in these unexplored areas could prove valuable if they improve current methods in an established area or if they open up an area that hasn’t been extensively investigated.

**Previous work**

Short summary and discussion of previous work known (not a full literature review yet). [200 words]

* Extensive literature exists for solutions that use L-Systems to produce plants and trees beginning with the book: The Algorithmic Beauty of Plants (“). Further research has
* The original book <http://algorithmicbotany.org/papers/abop/abop.pdf>
* Combining genetic algorithms to evolve plants <https://link.springer.com/chapter/10.1007/978-3-319-90418-4_2>
* Dynamic Animation of L-System plant growth <https://nccastaff.bournemouth.ac.uk/jmacey/OldWeb/MastersProjects/MSc09/Hampshire/thesis.pdf>
* Generating 3D plants <https://www.scitepress.org/PublishedPapers/2009/17853/pdf/index.html>
* Plants that grow and then die <https://www.niclab.mx/portal/sites/default/files/SemanticDeathInPlantSimulationUsingLindenmayerSystems_0.pdf>
* Procedural cities <https://web.archive.org/web/20060114082225/http://www.vision.ee.ethz.ch/~pmueller/documents/procedural_modeling_of_cities__siggraph2001.pdf>
* Scenario Generation in U.S. Marines Fire Support Team Training games <https://dl.acm.org/doi/pdf/10.1145/1814256.1814262?casa_token=I6F3PwIIPH4AAAAA:Z2hq2C4LhggWv_tSDT-TcD9ETnl0m2HOJidyqCw-ocniSOFOo0O3noGsophBzSQk8f8WI2SszWAcxQ>
* Volumetric Spaceship generation <https://dl.acm.org/doi/pdf/10.1145/3520304.3528775?casa_token=7MOs98nNai0AAAAA:uSQgCc8x3ttin0TiPVI1fvd0pSMtNW2dfx58NTSt3GDJ9bWYb59Fse3slkaIeJgihCmeyD9tb-hsBQ>
* River delta generation <https://core.ac.uk/download/pdf/322445609.pdf#page=132>

**Technologies**

Proposed technologies to be used (with student’s level of experience/expertise with each) and justification (including brief discussion of alternatives). [100 words]

* Unreal Engine – No previous student experience. Extensively used in industry, Student is familiar with C++. Alternatives: Unity, Godot, Custom Engine. Justification: Provides performance and reduces time spent creating graphics code not directly applicable to the goals of the dissertation
* C++ - Student has 12 years of hobby-based experience. C++ is industry standard for high performance-oriented code and the student has a reasonable proficiency using it.

**Development methodology**

Proposed development methodology and justification (including brief discussion of alternatives). [200 words]

Kanban board combined with Scrum inspired sprints. Alternatives waterfall requires a specific final goal. Justification: Agile makes the most sense where the destination is not completely known, and the tasks’ timescales are difficult to predict.

Research Methodology: due to the nature of the research this will be mixed with a combination of observations, experiments and statistical analyses.

**Project plan/timeline**

Proposed timeline with major milestones. (No need for a formal Gantt chart, although that could be good. Whether it’s text or a diagram, this needs to be clear and reasonably detailed.) [100 words or equivalent in diagram]

**I feel like I probably need some more detail here but I’m unsure with the proposal being as open as it is?** Especially on the specific timing of anything! I will probably do this as a Gantt chart for clarity.

Sept – Oct - Literature review

Sept – Nov – Familiarization with Technologies to be used and initial development of demonstration application.

Nov – Dec – Exploration and prototyping phase.

Jan – Apr – Development of suite of final demonstration algorithms and integration with demonstration application.

Apr – May – Comparison of results to previous techniques, compilation of dissertation outcomes and final write up of dissertation.

**Supervisor meeting arrangements**

How often? When? How? (Phone? Skype? Face to face?) We need a commitment to a weekly meeting.

(Every / Every Second) (Wednesday / Thursday) Afternoon for (30 mins / 1 hour) using Microsoft Teams.

**Ethics**

Have you read the UHI Research Ethics Framework? Have you completed a REC1 or REC1-D Student Application for Ethical Approval form and submitted it along with this proposal? Are there any ethical risks in your project?

I haven’t looked at this yet but will do ASAP, **I don’t think I should have any ethical risks due to the fact that my proposed dissertation doesn’t require any volunteer participation?, unless it is required from a marking point of view in which case maybe I could get subjective opinions on the quality of the content generated?**

**Reference list**

List all references cited above, following the UHI Student Referencing Standard.