Diage: A Dialogue Generator

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Abstract

will come later[1] [3] [4] [8] [14] [11] [10] [12] [13]

Acknowledgements

Contents

Chapter 1

Introduction

1.1 Create-IT

Create-IT applied research is one of the research institutes hosted by the University of Applied Sciences of Amsterdam. In this lab students, teachers and researchers all preform applied studies in the different sections of the IT world. Their goal is to educate future professionals in the uses of applied research, so these professionals can anticipate the ever changing field that is Information Technology. In the newly created Game Research Lab students and researchers alike contribute to the growing community of game developers; making the development of games easier or trying to understand current problems within the industry[1].

1.2 Technology

This section covers the technologies used by me in developing and demonstrating the *Diage* system.

1.2.1 Diage

General Programming	C#.Net
Graphing	Gliffy
Prototyping	Ludoscope

1.2.2 Rouge

Programming	C#.Net
Game Engine	SilicaLib
Framework	XNA

And this thesis has been created in LaTeX.

1.3 Rough planning estimate

This project lasts for 20 weeks, and the following will indicate my initial planning.

- **Week 1-6** Literary study
- **Week 7-13** Creating a generative algorithm
- **Week 14-20** Proof of concept.

[1]How much can a few lines suck?

Chapter 2

Procedural Content Generation

In the world of game development we strive to create the best experiences for a wide and diverse audience. During the course of development there are a number of obstacles that can (and often will) hinder the progress of said game. Some of these hindrances come from processes that are essential to a game like; level- and world building, or story- and quest design. They take a proportionally large amount of development time and take a very specific mindset to create. A current development within the game development[1] community to tackle these issues is the use of *Procedural Content Generation* (PCG). This may be a confusing phrase for some, so let's dissect it.[2]

Content Generation When taken apart, this part of the phrase will probably become a lot clearer. It just really means what it says, we try to generate content, be that a quest for a Role-Playing game (like *World of Warcraft*) or a complete dungeon for a dungeon crawler (like *Rogue* or the *Diablo* series), content means anything within the context of a game. This generation can take place either on run-time (sometimes called `live` or `on-line` generation), making it possible for new generation for each time the game is run. Another possibility is to generate content prior to release. This has the benefit of being able to tweak the content to make it more satisfying or aesthetically pleasing, but removes the dynamic aspect that some games might strive for. Nobody will say that one of these methods is *better* than the other, but they are both tools to be used on the right moment.

Procedural This part of the phrase is the one that often causes the most confusion, but just means that we use a specific procedure to generate our content. In the world of programming, it usually comes down to one or multiple algorithms that work together to generate *predictable* content. A good example for a non-digital form of procedurally generated content is the card game *Klondike* (also called *Solitaire* or *Patience* in the US and the UK respectively). The procedure in this game is the shuffling of the deck. This "procedure" ensures a random order of the cards, and the resulting content is the layout of the game. While this might be a good example for content generation it is a poorly implemented one, for there exists multiple outcomes that the game can not be completed.

2.1 On "random" generation

In former years we always spoke of content that was generated *randomly*. The use of this adjective has since been frowned upon, because random insinuates a lack of control and predictability. We now favour the term procedural, as this covers the use of predictable algorithms and a structure that is mathematically justified. Generally speaking the two phrases are interchangeable, but their sentiment can cause confusion. For the sake of coherency I will continue using the term *procedural content generation*.

[1]twice development within the space of 3 words. NOT DONE

[2]Does this sound preachy?

2.2 A word on narration

I want to go as far as to say that narration defines what being humans means. We, as a society and as a species, have always used a storytelling context to receive and deliver information. Be that a story on the dangers of bears and lions to a more modern setting for the sake of leisure. But even then, for the sake of argument we need a proper definition of a narrative. Riedl and Young stated that a narrative is in it's simplest form a temporally ordered sequence of events [12]. This is the definition I will keep to throughout this document. One other thing of particular note; a narrative does not explicitly mean the usage of text or spoken word. This is an easy, and clear way to convey a story, but never the only ways to do so. Granted; it can certainly add to the experience, but in my own opinion a game should, first and foremost, try to convey a story through it's mechanics. To discard that rule is to introduce the expensively named *ludo-narrative dissonance*, or a discord between narrative and gameplay. There has been a vast discussion on the Internet about this phenomenon, on which I will not elaborate, but is worth of note to any aspiring game developer/designer. Games can be a powerful medium in which to explore the human condition, but for that we can really come to that point we need to start treating it with that same respect. And that's my preachy part.. which probably needs to be cut[3].

2.3 A word on static and dynamic generation

Throughout this document I reference to static and dynamic generation, or static and dynamic narratives. These terms refer to the point in time where the generation takes place. When we speak of a static generation, this happens during the development. A developer may choose to generate a game world and continue to populate that world with the rest of his content. In a dynamic setting, said world is generated at runtime, usually when a new game is started. This means that every time the player starts a new game he gets a new world to explore. In a narrative context that means that a static narrative has been generated, but will never change. Whereas a dynamic narrative will always try to be different from the former.

2.4 Problem definition

My main research question is *How can a roguelike game benefit from a procedurally generated narrative?*. The other questions I want to answer are: "How does a computer recognise a good narrative", and "How do you structured a procedurally generated narrative". In this section I will state my research questions, and try to dissect them so all readers of this document have the same definitions, and the same context.

How can a roguelike game benefit from a procedurally generated narrative?

Let me clarify the term *roguelike*. The genre started with the video game *Rogue* that was released in 1980, and was characterised by having "random" dungeons where the player has to navigate rooms and fight monsters. The ultimate goal of the game was to get to the highest level possible without dying once. The game never really "ended". The game was over when the player died, but after that the player got to start all over again on level 1 with a complete newly generated dungeon. As the game gets progressively harder when the player starts go get to other levels, the chances for the player to lose get higher. Now, back to the term "*roguelike* "; A game with no definitive end and *perma-death*[4]. The previous years has seen a rise in popular *roguelike* games, *FTL: Faster Than Light* by **Subset Games** (2012) and *The Binding of Isaac* by **Edmund McMillen and Floris Himsl** (2011) being just some examples.

[3]Which makes me sad

[4]Perma-death is a term used for the loss of progress that a player experiences when his/her character dies

I specifically target *roguelikes* for their inherent use of content generation. The need to have a different set of content throughout a play-session is the key selling point of a *roguelike* game. This makes it the right genre to experiment in with any new type of content generation.

In my question I speak of benefits to the game by the use of a procedurally generated narrative. This results in a few sub-questions that tackle these benefits. *What gameplay benefits can we introduce*, and *How does the development process benefit from a procedurally generated narrative.* These questions are measurable to a certain degree that give us a good view on the beneficial factor of a generated narrative.

2.4.1 Requirements and Constraints

Is this really necessary?

2.5 Research methods

In the previous section I have declared my research questions being

1. *How can a roguelike game benefit from a procedurally generated narrative?*
   - (a) *What gameplay benefits can we introduce?*
   - (b) *How does the development process benefit from a procedurally generated narrative?*

This section will cover the methods used to measure the benefits that adding a procedurally generated narrative has.

2.5.1 RQ 1a

What gameplay benefits can we introduce? If there ever was a noun which definition was disputed, it's probably *gameplay*. I'm not going to enter the discussion at this point, but just stick to the one I feel covers most facets: *"The experience of gameplay is one of interacting with a game design in the performance of cognitive tasks, with a variety of emotions arising from or associated with different elements of motivation, task performance and completion."*(Lindley, et al. 2008). [something about the quote]. I want the generated narrative to be part of a game, not just a additive thereon. With the close ties generated content has with emergent behaviour, I want to explore the changes that get introduced when adding a dynamic narrative to gameplay.

2.5.2 RQ 1b

How does the development process benefit from a procedurally generated narrative? This questions has some snags. What does it take to measure a process? Do we look at time spent writing a story and contrast that with the time spent building a story generator? What about the fact that we only have to build that generator once, whereas story crafting needs to be done for every single game.

2.6 Proof of concept

As a proof of concept I propose to build a game that incorporates the findings of this research. The game I will make will be a *roguelike* for their inherent use of PCG techniques. Due to the limited duration and scope of this project, the game will be restrained to the most basic elements of a *roguelike*. The only addition being a dynamically generated narrative. This game should pose as the proof of my research and be demonstrable to verify my answers to my research questions.

Chapter 3

The interactive story

Most of the research done on narrative generation is contained within the field of Interactive Storytelling (IS). The layman may not see the difference between a game with a story and a interactive story, and can be forgiven for this is still in open debate within their respective fields. However open the discussion may be there are, albeit subtle, differences. This chapter covers the work done in this field that relates to my own research, and discusses the contrast between the conception of interactive storytelling and video games.

3.1 Video Games and Interactive Stories

The notion that an interactive story is a distinctly different product than video games has been in open discussion ever since video games started having complex stories themselves. In the early years of video gaming (games like *Pong*, *Pac-Man* and *Tetris*) games usually didn't have a story[1], but then games like *The Legend of Zelda* by **Nintendo R&D4** became popular that did have a, albeit small, story. At this point in time the distinction, and especially the semantics, became open for debate.

In this day and age contemporary games often don't get shipped without an attempt at a story, with the exception being *social* games like *Candy Crush* by **King** and *Bejeweled* by **PopCap Games**, the lines between an interactive narrative and video games become blurry. As matter of fact; the term *video games* has recently been under fire. The questions; what makes something a game? What defines a game? The web show *Extra Credits*[2] has a nice answer to this:

> [...] We're asked this question all the time, but, you know; I think it's the wrong question. It's a distraction. It does nothing but limits us. It's as if we started to ask: "Well is this really poetry?" when poets moved away from rigid meter or rhyming couplets. [...]

The fact is, we are in the middle of a semantic war. My opinion is that in another ten years the industry will have a new term to call these works of interactive engagement. As we stand now games put more emphasis on doing and acting within a set of rules; the game mechanics. Whereas interactive stories revolve around the activity of acting out a story without the constriction of mechanics, usually because the only controls a user has are movement controls supplemented with a contextual button to interact with the environment.

3.2 IS

The early attempts to understand interactive storytelling came in the form of *Tale-Spin*[7]. Tale-Spin generated textual stories from data that a user created like; scenery, characters, and the problems that needed to be solved. Other work contains the *Oz Projects*[5] that used intelligent agent technology to

[1]That didn't stop people super imposing stories. See: `http://www.smbc-comics.com/?id=2736`

[2]See `http://extra-credits.net`

tackle the challenges in interactive storytelling. In 2006 came the award winning *Faade* by **Michael Mateas and Andrew Stern**[6]. This interactive story focusses on the player who is a close friend of two AI characters. During a cocktail party at the AI characters' home the player can support the characters or try to drive a wedge between them. We can't mention interactive storytelling without mentioning former game designer Chris Crawford, who left the world of video games to work on IS. He wrote *Chris Crawford on Interactive Storytelling*[2] which is a deconstruction of the entire field and compares that with traditional video games. This work is a must read for anyone considering in attempting anything with in the field of IS.

3.3 Dynamic plot generation

One of the most cited works when dealing with generating plots for interactive systems. Sgouros proposes a system that generates, manages, and resolves interactive plots[13]. The system dynamically moves the plot forward with the relations and interactions between actors serving as input. Figure 3.1 shows us the flow of Sgouros' *Plot Manager*; the central piece of his interactive story system. Sgouros shows us how we can abstract concepts like relations and events both causal and temporal and defines a syntax used to describe actions actors can make and goals they might have. His system generates so-called Aristotclian plots, where a conflict between antagonistic forces develops out of the initial situation. The plot will move through a sequence of conflicts and always terminates in a unambiguous solution.

3.4 Character-based storytelling

At the turn of the century we saw a shift from general story generation towards a more character driven approach. Researchers like Riedl and Mark[11][9] and Marc Cavazza[1] wanted to make characters within the story context be more outspoken and distinct and worked towards systems that made this possible. Both utilising the Mimesis system to generate character-centric plots.

3.5 Riedl and Young

Most of my work has been based on and influenced by Dr. Mark O. Riedl and Dr. R. Michael Young who contributed a lot of work to the computational planning of a story. With their papers[11][10][12] they tackle a multitude of challenges from story planners that use character intent to dealing with interactions between users and agents. They co-authored the IS system *Mimesis*[15], that allows storytellers to use a author-centric approach to generating different stories. My own planning system (further discussed in chapter 4) has taken a similar route as the systems proposed by Riedl and Young.

3.6 Generative narrative within games

I stated at the beginning of this chapter that most research on subject of narrative generation takes place within the field of interactive storytelling, but there are some commercial games that have used a form of generative narration. In *The Elder Scrolls V: Skyrim* by **Bethesda Game Studios** the developers implemented a system they called *Radiant A.I.* that tries to dynamically react to the player's actions. For example; players with a high *Pickpocket* skill would get told to "keep their hands to themselves" by certain guards. The *Radiant Quest* system expands on this, giving players quests that suit their skills and send them to places previously unvisited. This context is usually used within games; representing a 'fixed' story, but with subtle variance that lets each player have their own experience within a game world.

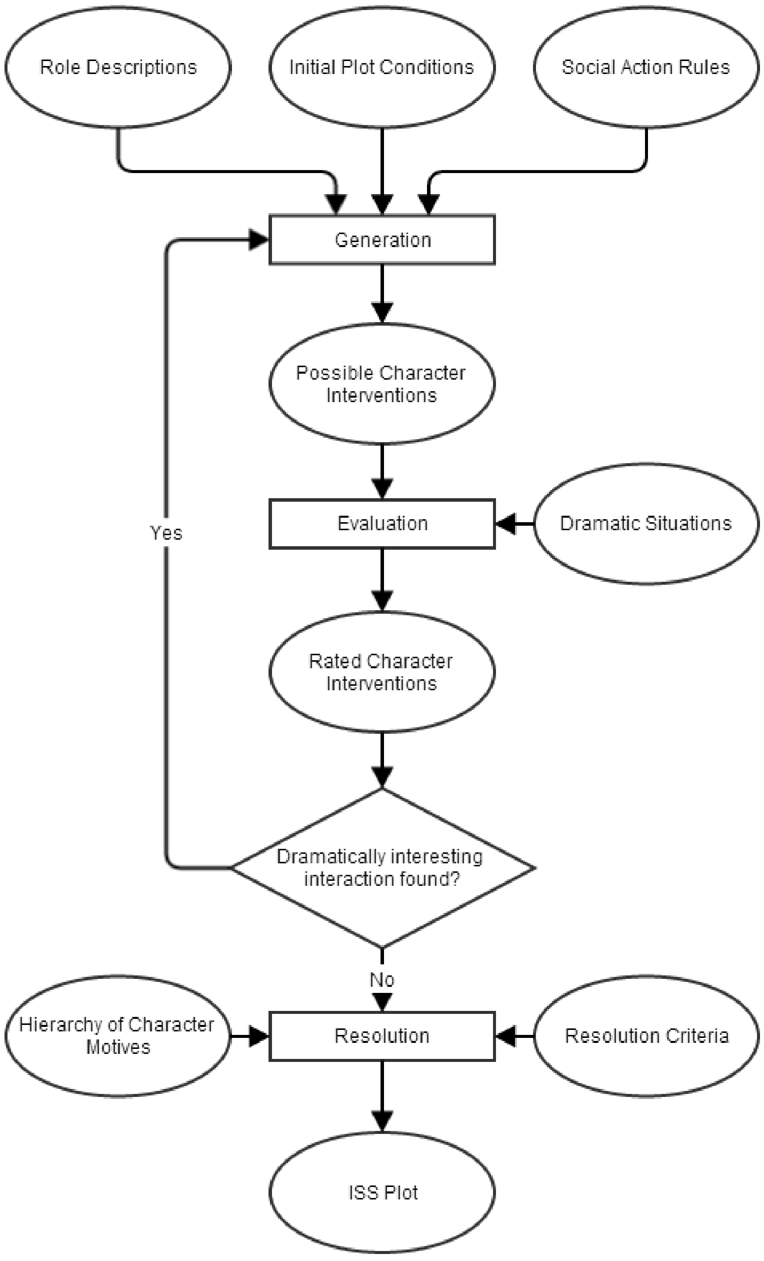


Figure 3.1: Flowchart of Sgouros' *Plot Manager*

3.7 Conclusions

The related work done within this field is vast. So vast perhaps, that to dissect it all greatly exceeds the scope wherein this thesis operates. But most of the research has been focussed on generating a narrative that is "fixed" from the beginning with some leeway towards actual context. The usage of a narrative planner is almost universal to ensure any kind of plot coherence, as is a form of author input to control the flow of a story. These basic elements create a interactive story system that can deliver powerful narratives with believable characters. My own concern is the involvement of the player. In most examples the player is merely an actor with a more volatile behaviour, instead of his own character. I strive for a system that really revolves around the player. The story made by the actions that the player did or did not do.

Chapter 4

Narrative planning

This chapter will discuss the use of a narrative planner as used by many of my sources. I want to incorporate a narrative planner that smartly uses Diage *to manipulate a narrative and conveys that in a way we petty humans can understand*

A lot of related work as gone into the use of a planning system that decides on the narrative structure. Researchers like Riedl and Young [11][10][12] and Cavazza [1] have been researching the use of artificial intelligence for years, and have made some interesting planning systems like *Memesis* [15]. To help me answer my questions, I have developed my own narrative planner that tracks and generates plot points that the player can resolve to further the characters story.

4.1 Events

Riedl and Young[12] and Julie Porteous and Marc Cavazza[8] have demonstrated that stories are perfectly suited to be represented as a sequence of temporal and causal events. Porteous and Cavazza suggest to use events as a constraint for partial temporal order. Defining operators as the following:

operator	meaning
sometime-before a b	*b* must be made true for the first time before *a*
sometime a	predicate *a* must be true at some stage of the narrative
at-end a	predicate *a* must be true at the end of the narrative

These operators ensure that we have some control and gives us a partial temporal order, partial because not all of the events are ordered with respect to each other. The table is further expanded upon in their paper *Controlling Narrative Generation with Planning Trajectories: the Role of Constraints* [8].

The *Diage* planner uses event constraints like this to layer plots and direct the player on what to do next. In the context of a *roguelike* we don't know when the story is going to stop, as it stops with the death of the player character. That could be within 2 minutes, but it could be several weeks. *Diage* takes this into account by keep adding segments onto a story, sometimes using information gained from previous plots and at other times creating entire new spaces and NPCs therein. So the operators that Porteous uses we use within these small story steps instead of the entire narrative. *Diage* tells us the story of the player character and how he/she influenced the world around him.

4.2 Initial Generation

Depending on the input given and the desires of the developer, *Diage* does the initial generation of the game world and plots in varying degrees, as seen in algorithm 1. If no input is given at all, *Diage* will just generate a random amount of entities to populate the world. Input can be given either within the game code, or with a DML file (further discussed in the next chapter). Whether specified or not, the player character needs a initial constraint. This constraint is his/her first 'objective'. This initial constraint can be given within the input, otherwise *Diage* will take an entity within the world and sets that as player constraint. With in the algorithm we see a section dedicated to custom rules. These rules can manipulate anything within the story setting. As an example I created a rule that randomly sets entities to a space. The given example is purely non-deterministic, but is a simple matter to populate the spaces more evenly with the entities. This rule system is used throughout *Diage* as a generalized form to give the developer more control on what a given entity can do.

```
Input: entities; customRules;
Output: Initial world state
let entities be all entities within current world state;
let customRules be the custom behaviour as specified by the developer;
foreach rule in customRules do
    rule.Invoke();
end
if entities.count ≤ 0 then
    entities = GenerateRandomEntities(max);
end
if player.constraint == null then
    select random e from entities;
    player.constraint = e;
end
```

Algorithm 1: Initial planning

```
/* Populates the spaces with the current entities within world state        */
Input: entities; spaces;
Output: All entities are randomly moved to a space
let entities be all objects within current world state, excluding spaces;
let spaces be all spaces within current world state;
while entities.count > 0 do
    select random s from spaces;
    entities.pop().MoveToSpace(s);
end
```

Procedure PopulateSpaces

4.3 Step Generation

When the initial generation is complete, the player should carry out his/her objective. When the objective has been completed, the planner will automatically start a step generation[1]. This generation is like the initial generation but uses the actor attribute system and the player as extra input. The attribute system will be covered in a later section. This step generation looks at all the given variables and generates a new constraint for the player(see procedure GenerateConstraint). The longer the character's life, the more exact this generation will be. For any action taken by the player can be used in the generation. It must be said that the actions that the planner can take needs to be specified by the author.

[1]in want of a better word. The term *step* comes from cellular automata, which I'm currently working on

```
Input: entities; actors; player; customRules;
Output: new world state
let entities be all entities, excluding actors and the player;
let actors be all actors, including the player;
foreach actor in actors do
    actor.rules.Invoke();
end
/* It's possible that one of the rules gave the player a constraint, so we'll
   check                                                                     */
if player.constraint == null then
    GenerateConstraint(player);
end
foreach rule in customRules do
    rule.Invoke();
end
```

Algorithm 2: Step planning

```
Input: player
Output: new constraint for the player
if rules.count $\geq$ 0 then
    foreach item in rules do
        rules.invoke(player);
    end
else
    select random e from entities;
    player.constraint = e;
end
```

Procedure GenerateConstraint(Player)

4.4 Planning flow

The previous sections described the processes that *Diage* goes through when generating a new world. The flowchart in figure 4.1 displays the steps taken by the planner. The initial generation influences the world by setting up spaces, actors, and objects and manipulating these entities by their specific rules. After this, the player can, and will, influence the world by acting in it. The planner keeps track of his/her actions and saves this for future story generation [2]. The step generation gets activated automatically when the player's constraint is removed, i.e. a plot is resolved. This can also be manually activated by the author on whatever occasion or event he/she wishes. After the step generation the player gets his/her new constraint and, depending on the generative rules used, the world can be manipulated too. Be that actors that move, or new spaces that are generated. The step generation is highly dependant upon the player's attributes, as everything can react to the gain or loss between story steps[3]. The actor attributes are a powerful tool in the *Diage* arsenal, and the (game)world literary revolves around them. It has to be noted, that the design of *Diage* works with semi-persistent worlds too. The world data can be saved to be used in a later play-through, giving the world a whole epic of one player, and starting the next.

4.5 Actor attributes

All actor entities have a attribute system in place that give them unique skills or personalities. These attributes can interact with the planner to create different outcomes of the step generation. The attributes can also communicate directly with a player. For example; the player could have a attribute *Archery* where an actor in the role of shop keeper might offer the player a exceptional bow if said attribute is above a value of 50. Even if we put it less 'gamey' and more in a narrative setting, we could add personality archetypes (sometimes called alignments in RPGs) as a attribute. For example; the *Lawful Good* archetype will be friendly to all other on the *Good* axis, but completely antagonistic towards any on the *Chaos* side (see figure 4.2 for reference). The attribute system can create a wide variety of emergent behaviour and will be expanded upon in a following chapter [*citation needed*]

[2] For example; a foe thought defeated returns for a rematch.

[3] Mental note: one of the papers referenced this as a beat, might be a good idea!

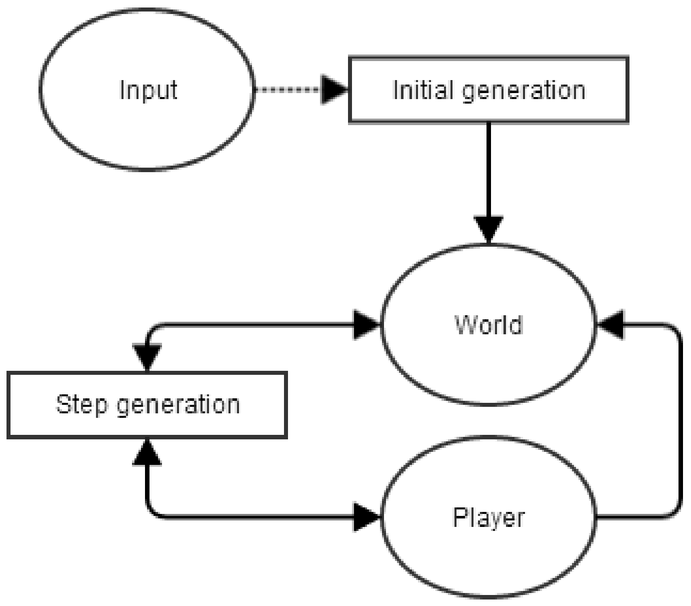
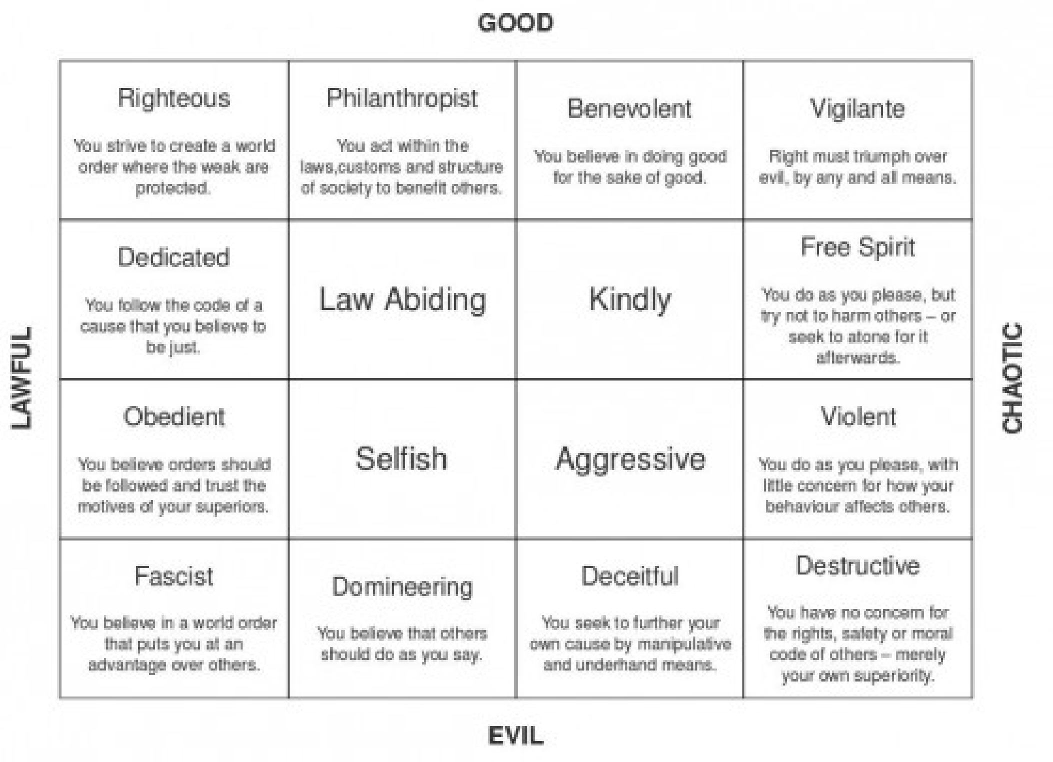


Figure 4.1: Diage Planner flowchart


GOOD

LAWFUL

CHAOTIC

Righteous You strive to create a world order where the weak are protected.	Philanthropist You act within the laws,customs and structure of society to benefit others.	Benevolent You believe in doing good for the sake of good.	Vigilante Right must triumph over evil, by any and all means.
Dedicated You follow the code of a cause that you believe to be just.	Law Abiding	Kindly	Free Spirit You do as you please, but try not to harm others – or seek to atone for it afterwards.
Obedient You believe orders should be followed and trust the motives of your superiors.	Selfish	Aggressive	Violent You do as you please, with little concern for how your behaviour affects others.
Fascist You believe in a world order that puts you at an advantage over others.	Domineering You believe that others should do as you say.	Deceitful You seek to further your own cause by manipulative and underhand means.	Destructive You have no concern for the rights, safety or moral code of others – merely your own superiority.

EVIL

Figure 4.2: *Dungeons & Dragons* alignment sheet

Chapter 5

Diage Modelling Language

In this chapter I will cover the Diage Modelling Language (DML) that is used to visualize the flow of information, some are static and others will wait for the interaction of the player to release this information and ensuring plot progression. *Diage* uses the symbols to represent the *Diage* entities as seen in figure 5.1.

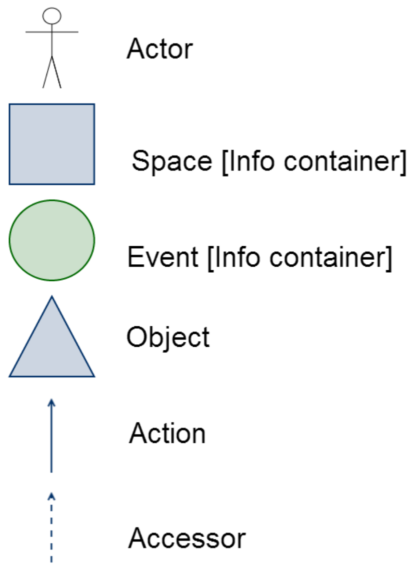


Figure 5.1: DML Symbols

5.1 Entities

Diage entities come in four forms; `Actors`, `Objects`, `Spaces` and `Events`. The latter two are also information containers which I will discuss in section 5.2. The following section will only cover the pure entities; the objects and actors. In conjunction with `actions` and `accessors` these entities convey story information and plot progression.

5.1.1 Objects

Diage objects form the basis of all entities. They represent the props and items that we find in the world that have narrative importance. For example; if the Player walks in to a shop *Diage* does not specify all items that one could buy in the shop, but only those that have plot importance. In terms, these objects should adhere to the *Checkhov's Gun* principle. This dramatic principle states that all objects used in a narrative should eventually be used. I quote: "*One must never place a loaded rifle* *on the stage if it isn't going to go off. It's wrong to make promises you don't mean to keep.*[1]" Objects have three properties; a `name`, a `ID` and a `type` The ID is a unique identifier dependant on the type. And the type is used with actions/accessors as seen in figure 5.2 (Futher discussed in section 5.1.2). The name is the noun given to an object within the story context. For example; The player receives the *Skeleton Key of Awesomeness*, but the type is just `key` giving it no special properties than any other key. It might make sense to name an object something else than it's type, but a name is not given it defaults to it's type. Objects form the world, and all other entities derive from the *Diage* object. This means that all entities have the same properties as the object, but can extend upon it.

5.1.2 Actors

An actor is the representation of any one object that can, as the noun implies, act. Examples are the store-clerk, a wandering adventurer or the player. The actor is the only entity that can physically interact with the world, and by doing so the only that can change the world's state. By being able to change the world, the actors are the only entities that can ensure plot progression. Just like the object, an actor has three properties; a `name`, a `ID` and a `type`. The type property is used in predefined actions as seen in figure 5.2a. This figure defines that the `Player` can **`speak`** to all actors of type `NPC`. A further glance at figure 5.2 shows some more actions that could be defined for the player actor. These predefined actions tell us that the player can trigger all events and enter all spaces. I will expand upon these actions in section 5.3.

5.2 Information Containers

Information containers are entities that hold story information. A space holds information about it's spacial children, and events release information into spaces when they are resolved. Information containers have the unique property that they are nestable. For example; a space that represents a city can hold several spaces that represents housing.

5.2.1 Spaces

A space is the representation of any segment of the world or the world itself. As spaces are info containers they are nestable, as mentioned before, but they differ in the fact that they can hold every entity as a child. These children make up the spacial awareness of the space and tells us what information it can pas on to actors. Usually an actor gains all the information a space can give upon the moment it enters the space; when the actor becomes a child object to the space. This can be modified, and some parts of information maybe withheld from the actor, but this is where the events come in.

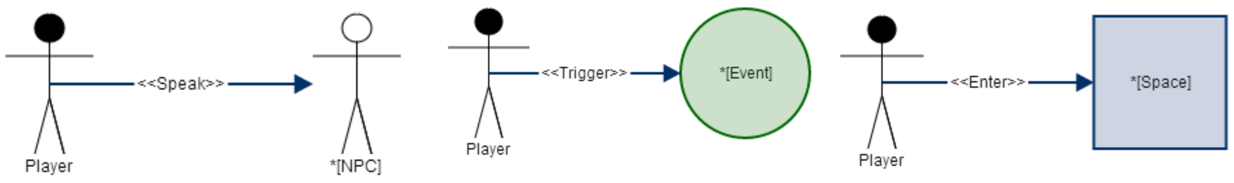
5.2.2 Events

A event is the odd one out as an entity, as it is the only one that does not represent something within the narrative. A event is the abstraction of information that is released into the story when an actor - usually the player - interacts with it, thus events are used for story pacing and narrative convenience. When we need the state of a space to change we use a event to initiate that change. This only applies on the narrative context of the world, because *Diage* does not specify everything that happens with in the interactive context. For example; if the player went to a store to buy some cheese to eat. *Diage* only specifies the store's loss of the cheese, if said food item is a special narrative item. Like a poisonous piece of cheese that the villain left there as a cunning trap for our hero. Events make the world go round and are the dynamic forces in *Diage*.

[1]`http://berlin.wolf.ox.ac.uk/lists/quotations/quotations_by_ib.html`

5.3 Actions and Accessors

Actions and accessors are the abstract connectors in *Diage*. They convey what actors can do (actions) and what knowledge they possess (accessors). Some accessors are implied, due to the fact that an actor might be the child of a space, in other cases these connections are explicitly added to a *Diage* model. If we review the diagram in figure 5.3 we see that the mayor has no connections whatsoever. This would imply that the Mayor has no knowledge about what's or who's in the store. If we compare that figure to figure 5.5, we see that the Mayor now has a connection to the Shop, thus we can be sure that the Mayor has the knowledge it would have, if it had been in the shop space itself.



(a) A standard action for NPC interaction (b) A standard action for event interaction (c) A standard action for space interaction

Figure 5.2: Predefined actions

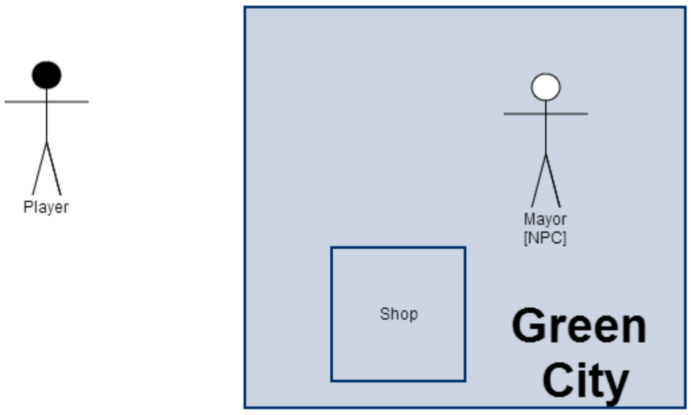


Figure 5.3: An example of a Diage diagram using predefined actions

5.4 Diage as a graph

Diage can be defined by DML, but also as a graph. This form of representation allows us to use graph theory to manipulate and transform the diagram, which we'll cover in the next chapter[2]

[2]SHOULD BE LEFT FOR FINAL!

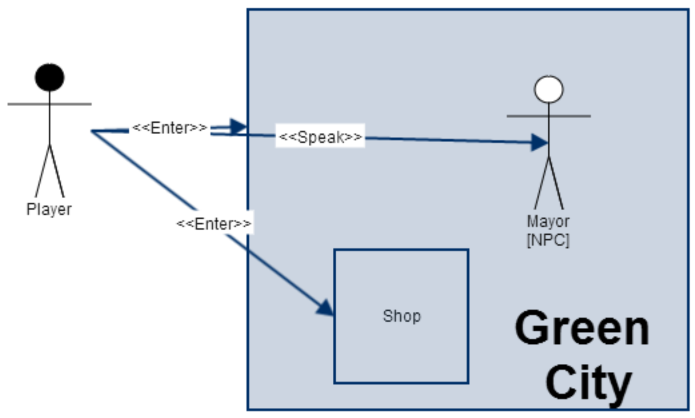


Figure 5.4: An example of a Diage diagram without using predefined actions

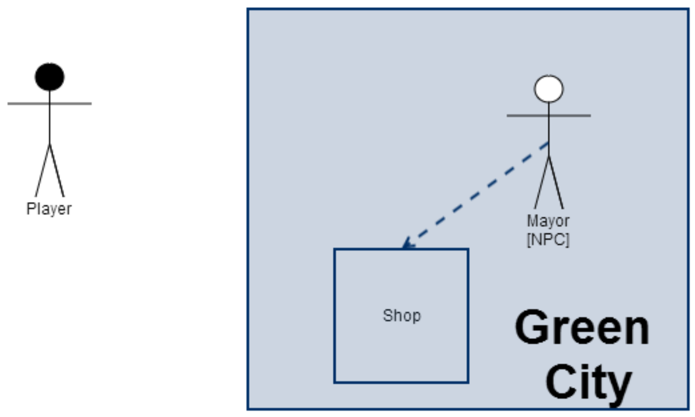


Figure 5.5: A *Diage* diagram showing a explicit connection between the Mayor and the Shop

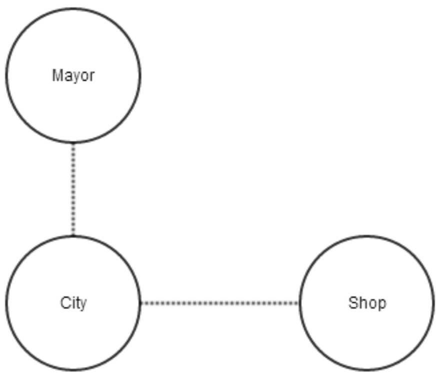


Figure 5.6: Figure 5.3 as a graph

Chapter 6

Rouge

You are a nameless traveller that has been compelled to search for something. An object, a person, or just a place. You don't know yet, but it's up to you to find out. You will travel through various caves, forests and towns to pursue the whims of your heart. Every time you seem to solve a problem, another one turns up. Always moving you towards some inevitable doom. Are you born for heroism, or will you die unloved and unknown?

Choose your path, and see where the voices in your head take you.

Rouge is a *roguelike* tile-based game that is created specifically for the demonstration of the *Diage* narrative generation system. Created within my own framework *SilicaLib* created on top of the XNA game-framework created by Microsoft. Rouge is characterised by the fact that the world and the narrative is generated by the direct influence of the player.

6.1 Mechanics

In Rouge, the player moves through the world one tile at a time.

6.2 World generation

The world within Rouge is procedurally generated by a cellular automaton. During a step of this automaton, the algorithm walks through the game world and checks each tile for certain conditions pertaining to their neighbours. If these conditions are met, his state will be changed accordingly. The states a tile has in Rouge are a simple *alive* or *dead* state. When a tile has 5 or more live neighbours, the tile becomes alive themselves. However, when a tile has less than 2 live neighbours, the tile dies. The first rule ensures that tiles group together, and the other rule destroys any singular 'island' tiles.

```
Input: tilemap
Output: new tilemap
let deadCells and liveCells be an empty collection of tiles;
foreach tile in tilemap do
    if tile.neighbours $\geq$ 5 then
        liveCells.push(tile);
    else if tile.neighbours $\leq$ 1 then
        deadCells.push(tile);
end
foreach tile in deadCells do
    tile.alive = false;
end
foreach tile in liveCells do
    tile.alive = true;
end
```

Algorithm 3: Cellular Automation algorithm as used in Rouge

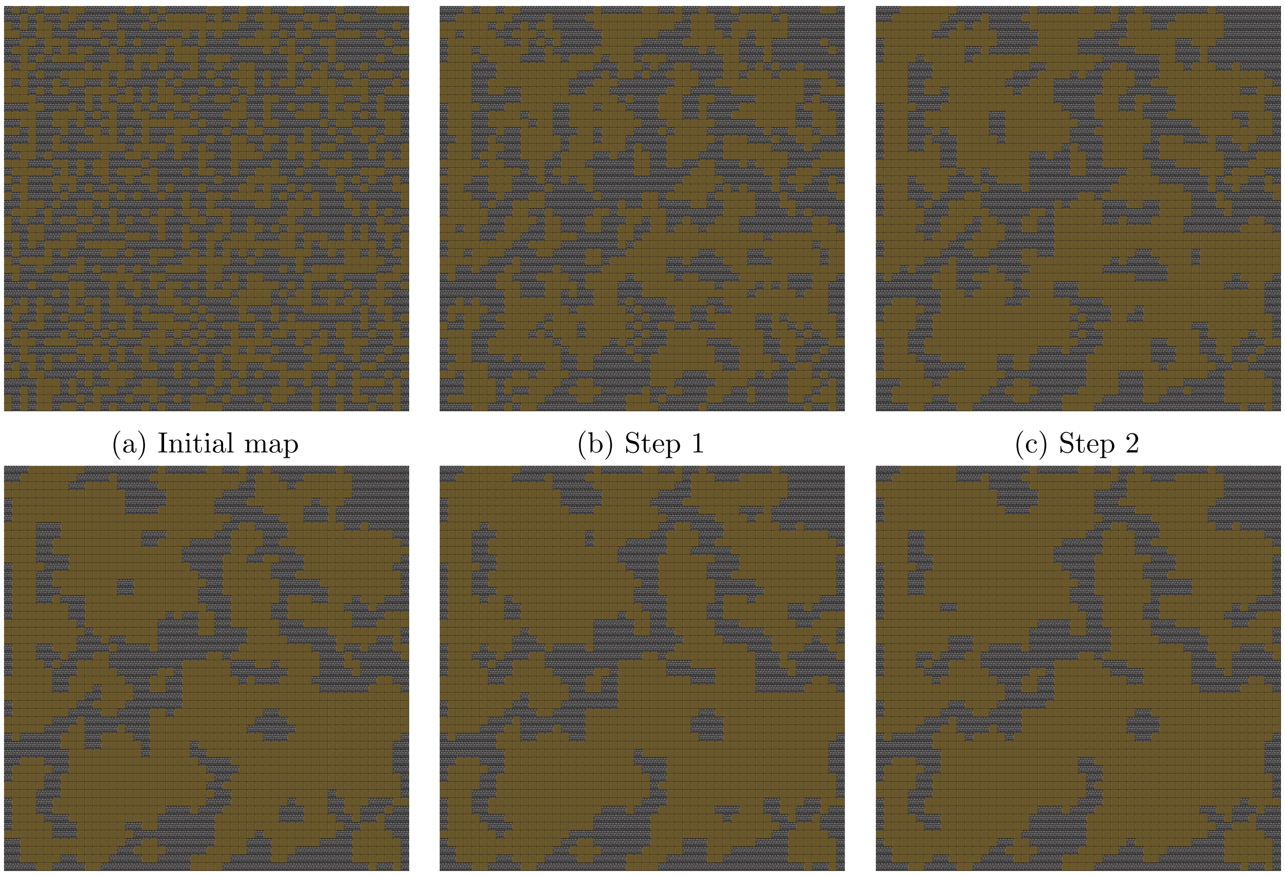

(a) Initial map (b) Step 1 (c) Step 2
(d) Step 3 (e) Step 4 (f) Step 5

Figure 6.1: The generation of a 50 x 50 tilemap with 20 x 20 (pixels) tiles

Chapter 7

Usage in Ludoscope

This chapter will discuss the usage of Ludoscope for the procedural generation of plots and the diage knowledge model for a hypothetical quest generator.

Chapter 8

Further study

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