Towards Qualitative Procedural Generation

Mark R Johnson
Digital Creativity Labs / Science & Technology Studies Unit
Department of Sociology, University of York
York, YO10 5DD, United Kingdom
mark.johnson@york.ac.uk

Abstract

This "vision" paper explores the potential value of "qualitative procedural generation" (QPG) in games. Such procedural generation is not concerned with the traditional uses of PCG in games to date – maps, buildings, "dungeons", and so forth – but rather draws upon sociological, anthropological and literary theory to generate nonphysical sociocultural concepts such as religious beliefs, social norms, cultural practices, linguistic forms, and interpersonal behaviors. The paper first outlines the author's creation of such systems through the ongoing development of experimental roguelike game *Ultima Ratio Regum*, and how the game's philosophical inspirations informed its priorities in developing highly innovative QPG systems. It then examines several core components of the game's qualitative procedural generation: religious beliefs, practices, and heresies; linguistic dialects; political ideologies; and culturally-unique aesthetic styles. In each of these cases the paper also notes how these QPG concepts are visually represented in the game, experienced by the player, and their role in gameplay. The paper concludes by arguing that such forms of PCG have vast potential for enhancing the depth and believability of virtual worlds, for bringing a range of social scientific disciplines into the process of game design, and pushing procedural generation into previously untapped areas.

Introduction

Procedural generation in game design has, to date, been focused almost exclusively upon the generation of spaces. Common physical regions of gameplay created by procedural generation includes mazes and labyrinths (Ashlock *et al*, 2011), procedural cities (Parish and Müller, 2001; Greuter *et al*, 2003b; Kelly & McCabe, 2006; Groenewegen *et al*, 2009, etc), platformer levels (Smith *et al*, 2009; Cook & Colton, 2012; etc), roads (Galin *et al*, 2007), dungeons (van der Linden *et al*, 2014; Liapis *et al*, 2015, etc), the interiors of buildings (Martin, 2006; Tutenel *et al*, 2009), and the generation of entire worlds, and/or regions of terrain that respond to various geological, geographical, topographical or climatological models (Greuter *et al*, 2003a; Togelius *et* al, 2010, etc). In contrast, this paper defines and proposes the value of "qualitative procedural generation" (QPG). In contrast to these forms of procedural generation which focus on laying out the spaces of gameplay, qualitative procedural generation seeks to generate sociological and anthropological concepts and structures in order to develop deep, rich and believable game worlds. Such game worlds have the potential to be highly immersive through not just the physical layouts of their terrain, buildings and material culture, but through convincing, detailed and nuances portrayals of a number of sociocultural concepts.

This paper draws upon the author's five year exploration of QPG in the experimental roguelike *Ultima Ratio Regum* in order to examine the technical implementation, the potential thematic richness, and the gameplay repercussions, of the procedural generation of these concepts. The paper focuses upon four aspects. These are the generation of religions and heresies, the generation of languages and styles of speech, the generation of political and ideological beliefs, and the generation of aesthetic styles tethered to particular cultures and reproduced throughout their material cultural artefacts. It then considers the value of such procedural generation techniques to game design and computational creativity, especially within the realms of "simulation" games, and the potential future of the subfield. From a background as an academic sociologist, not a computer scientist, I argue that qualitative procedural generation is a potentially integral, and to-date overlooked, component of the creation of rich and believable virtual worlds, and one which opens up a potentially fascinating new field of PCG research and unusual possibilities for gameplay mechanics.

Ultima Ratio Regum Development and Inspirations

For the last five years the author has worked on the development of an experimental roguelike game, *Ultima Ratio Regum* ("the last argument of kings"). As a roguelike, the game builds upon traditional roguelike mechanics and expectations – using ASCII and ANSI characters (Johnson, 2015) to depict the in-game world, a high level of complexity and a correspondingly large possibility space for game mechanics, permadeath (dead characters cannot be

reloaded) and extensive procedural generation. However, whereas most roguelikes focus upon the use of procedural generation primary for the creation of dungeon spaces, and in rarer cases world maps and buildings, the focus in *URR* is instead on the procedural generation of sociological and anthropological concepts. The game does also generate world maps and buildings and interior layouts, but all spatial generation except for natural terrain is dependent upon cultural, social, political and religious elements, which are themselves generated. Buildings are generated according to their functions and needs, furniture according to cultural aesthetic styles and the wealth of the buildings they are found within, the layouts of towns, cities, settlements and monasteries according to a range of elements explored later in this paper, and so forth. Nevertheless, the focus of the game's designs and longer-term intentions lie in these forms of qualitative procedural generation, which this paper examines. First, however, it is worth acknowledging the particular influences which moved the game's design in this unusual and innovative direction, and how those inspirations have continued to affect the game's design.

The desire to create a game underpinned by qualitative procedural generation came from the inspirations behind the game's stories and objectives. These are primary from three literary authors – Umberto Eco, Jorge Borges, and Wu Ming / Luther Blissett – whose works share particular themes and orientations to both social and cultural life, and to the impact of ideas and beliefs on human political behaviour. Both of these elements are strongly reflected in the game's ongoing development. The works of Umberto Eco explore both the particular intellectual currents of distinct historical and cultural moments in European history, with an emphasis on how debates and trends in seemingly "academic" intellectual fields have profound impacts upon the everyday lives of citizens, whilst also examining the emergence of ideas themselves and human processes of ordering, pattern recognition, and in some cases apophenia. These themes are particularly apparent in *The Name of the Rose* (1980) and *Foucault's Pendulum* (1988), which explore the impact on Europe of a seemingly trivial Christian theological debate, and the inadvertent creation of a world-spanning conspiracy through miscommunication and academic inquiry, respectively. Similarly, Borges' work examines human perceptions of lived experience, challenges assumptions and expectations of the world we perceive, and serves to highlight both the arbitrariness, and yet immense social importance and impact, of human-made theological and philosophical systems. Particularly noteworthy is *Tlön, Uqbar, Orbis Tertius* (1940), in which an intellectual conspiracy threatens to rewrite history, and by doing so *become* accepted historical fact (the short story is an exploration of the concept of philosophical idealism), in the process literarily demonstrating the tremendous role of learning, historical records, and common knowledge and popular beliefs in the shaping of the perceived social world. Similar or related themes around questions of knowledge and belief are also found in *The Garden of Forking Paths* (1941), *The Library of Babel* (1941), *Funes the Memorious* (1942), *The House of Asterion* (1947) and *The Book of Sand* (1975). Equally, much of Borges' work has an inherent ludic quality, and examines themes – mazes, infinity, secrets – that will be familiar to any game player, but the thematic elements most often accompanying these in his works appear to have been generally overlooked by game developers. Lastly, the works of Italian literary collective Wu Ming / Luther Blissett, most noticeably *Q* (1999), *Manitauna* (2007) and *Altai* (2009), are heavily focused on themes of contact, communication and conflict between highly distinctive geographic and religious cultures, and the effects on everyday life of religious and political upheaval.

In these literary works I perceived immense potential for something untouched by procedural generation, and broadly untouched by games in general, irrespective of their use of PCG – the roles of politics, social life, and religion in simulated game worlds, as both setting and gameplay. Politics is most often depicted in strategy and city-building games, affecting gameplay at the highest level through systems of "policies" or "civics" – rarely if ever are political choices shown to have impact in games depicting individual characters. Social life is present in many modern role-playing games which contain characters moving around towns or cities on schedules, but these tend to be very static, limited in their engagement with the player, and broadly similar wherever in the virtual world the player travels. Many games contain religions, but these are most often background "lore" or narrative elements, or when they affect gameplay, are often a form of currency used to purchase religious buildings, influence followers, perform diplomacy, and so forth. By contrast, my intention in the creation and development of QPG is to show these elements having an effect on every part of the world the player explores, and making different locations within the in-game world highly socioculturally distinctive. To explore this further, the paper now recounts work in the game's development to date in generating religious beliefs, linguistic dialects, political beliefs, and aesthetic styles.

Religion

Procedurally generated religions in *Ultima Ratio Regum* consist of several components. Firstly – and this is broadly in common with other games that generate religions, such as *Dwarf Fortress* – the game decides whether a religion is monotheistic or polytheistic, and then names and describes each deity (human, animal, demonic, otherworldly, other) within that pantheon, and in some cases assigns particular meanings or "domains" to each deity, which is to say aspects of the real world that the deity is believed to have domain or influence over. Their names are drawn from the dialect of the culture that gave rise to this religion (see later in this paper). Secondly, and more distinctively, the game generates a range of other easily-identifiable factors which are then reflected in subsequent gameplay. It generates the

Figure 1: twelve of the approximately 50,000,000 possible religious altars that can generate in the game. These altars serve as iconographic representations of each religion and are designed to be highly distinctive, aid immediate recognition during gameplay, and also in many cases offer players some clues about the nature of the god(s) worshipped. As with almost all visible in-game items, these are tethered to the religious, cultural and social concepts that underpin them.

different worship practices which NPCs in-game then play out, around altars, reflecting pools, holy books, worshippers, and the generated geography of their religious buildings and cathedrals. As above, it generates holy books, which relate procedurally-generated beliefs that are in turn reflected in their practices, clothing, and other generated elements. It also generates sets of religious relics with connections to these holy books; religious festivals that take place at various points and can take a massive range of forms; religious garb unique to that religion, which spawns on priests, abbots, monks, and so forth; prayer mats for some religions, which share designs and colours with the religious altars, clothing, and holy books; a set of rules and laws about acceptable practices for worshipers, which affect the behaviour of NPCs worshiping that religion with regards to their clothing, their conversations with the player, their wealth, and many other factors; altars which share colours and shapes with these other elements, and are a highly visible component of the generated religions (Figure 1); and heresies that undermine components of the holy book and central tents of that religion, and set up in-game conflicts between opposing factions that share common iconography. Religions are also given a generated religious symbol which, like their preferred colours, are also reproduced throughout their physical items in the game world, allowing the player to ready identify religions through their shared aesthetics. Through these many components, the qualitative concepts of beliefs and acceptable practices are physically realized across a range of sites; in turn, the player should be able to immediately identify a holy book and a robe from the same religion, for example, through understanding them both with regards to the theological and philosophical beliefs and tenets of that religion.

Language

The second component of the game's QPG systems is the generation of linguistic dialects unique to each culture. The dialects are each designed to be highly distinct, and were implemented in order to challenge prevailing norms of conversation systems in open-world or simulation-driven games, i.e. AI actors who repeat set sentences, and behave in broadly comparable ways no matter where in the world they are located. Through implementing such a system whereby NPCs can be identified based on their speech patterns and attendant backgrounds – which is to say, a skilled player talking to an unknown character should be able to ascertain their cultural background merely from *observing how they speak* – a deep cultural richness not found in other games is offered, in addition to a gameplay mechanic in the identification of individuals the player identifies in the game world.

The language generation system consists of several components. Firstly, it generates a set of accepted syllables, vowels and consonants used for all names and titles within a language. This is simple to implement and is present in other games with comparable systems, but is an important foundation to the subsequent highly novel parts of the system. Secondly, dialects consist of references drawn from a range of sources, based upon the environment of their capital city, other settlements and any colonies, as well as local plants, animals, histories, political ideologies, and many other factors. Characters will often refer to these items during conversations, drawing upon the wealth of generated shared cultural references unique to each culture, ranging from metaphors to literary references and historical observations to religion-appropriate prayers, all procedurally-generated at world generation and stored as part of an overall cultural memory. Thirdly, each language has a procedurally-generated "archetype" for name generation, and the names of all individuals within that culture are subsequently generated within that archetype. Examples might include an archetype with a single name and a title which references local plants and animals, or three names of decreasing length, names with references to prophets or historical figures, names that expression family allegiance, names which reference the political ideologies of that person's culture, and so forth. Fourthly, the game generates a set of greetings, farewell, insults and compliments for each culture, drawing upon its full set of relevant references. For example, those from a deeply zealous nation might offer "greetings from the one true god" whilst people from a

nation with particular skill in mathematics and architecture might offer “greetings from the great architects who built our cities”. Fifthly, every sentence uttered by characters from a culture is affected by “sentence complexity”, which is the amount of detail that an NPC will give the player in any given sentence. It is selected for each culture at world generation and affects the length of each sentence in conversation. This comes with substantial gameplay importance due to the different amounts of information offered by different cultures – speaking to a more verbose culture will lend more information than a quieter one, whereas in the case of the latter, other methods might be preferable for discovering information about the culture in question.

As with many roguelike mechanics, this is intended to function as a strategic element: a verbose culture might have extremely high prices on their sold items, whilst a taciturn culture has cheap item prices, and the player has time to only visit one. This encourages players to make long-term gameplay decisions, as well as further populating the world with linguistic variation. As with the above religions, this demonstrates that qualitative procedural generation is not only valuable for worldbuilding, believability and immersion, but for creating unusual and intriguing strategic decisions of a sort not present in other contemporary games. The generation of dialects allows for game designers to distribute certain forms of competencies and possibilities across different in-game cultures, making them both distinctive to engage with, and placing certain gameplay options in regions of the map in a unique way. It also raises the possibility of storytelling through linguistic dialects even in a non-PCG game: different dialects might have connections to important historical events in a game’s narrative or to political feuds in the immediate game world. It also highlights potential connections to other areas of research and game design, such as natural language processing, which procedural generation would be well suited to explore.

Although all other systems described are finished, or at a state where their central functionality is implemented and they simply need to be added to further in the future, the language generation system is in-development, but a demonstration of the near-final version will be included with this paper at its presentation.

Politics

Each culture generated by the game is assigned a set of political beliefs; a small number of standardized beliefs are assigned at the moment of world generation based on their geographical and climatological location (a nation near ocean will be far more inclined towards exploration, for example), whilst other ideologies are produced as the game plays out 2000 years of history before the player enters the game. Broadly speaking, ideological beliefs fall into eight categories: leadership, religion, military, cultural, justice, trade, foreign affairs, and intellectual currents. These political beliefs, much like religions and dialects, are then physically represented within the game world. Nations with a penitentiary justice system will be replete with jails and prisons; nations with a hegemonic cultural outlook will have little from any other culture within their borders; imperialist nations will have colonies across the world and a large military presence wherever the player goes; isolationist nations have small territory and a heavily defended capital; nations with a state religion and a particular zealous outlook will be replete with places of worship; a nation that values gladiatorial combat will be full of arenas; and so forth. In turn, these values trickle down into the rest of the cultural practices of each nation, so gladiatorial nations will be replete with novels and poetry extolling the prowess of arena combatants; isolationist nations will tend to construct houses with high walls and guards as a reflection of their overall global outlook; nations whose cultures believe in barter rather than sale will be full of markets of varied items from around the world; and so forth (see Figure 2). In this regard, the game is able to generate an immense volume of cultures with unique sets of (never self-contradictory) ideological positions, and rather than these ideological positions being merely labels or definitions abstracted out from the world, they instead determine the texture of every part of the physical world the player explores, from the largest cities to the smallest pieces of furniture.

Figure 2: a district in a procedurally-generated city. This city is particular dense in roads and relatively sparse in housing; to the left (the partly revealed building with rows of plants) is a religious building, and the cross-shaped building on the right hand side is a prison. This is therefore a nation with a relatively small population, a state religion, a belief in prisons as a source of justice and appropriate punishment, and easy travel and trade for its citizens. Rather than ideological and demographic aspects being abstracted out, therefore, they are explicitly physically represented in the world explored by the player.

Aesthetics

Several of the above sections have hinted at the important role that shared aesthetics take in the qualitative procedural generation of *Ultima Ratio Regum*, and therefore in turn to

the development of qualitative procedural generation. All large-scale sociocultural structures in the game procedurally generate a set of aesthetic preferences which are then reproduced in all of their items. The design goal is that the player should be able to view two completely unrelated (in form and function) items, and without being told anything about the origin of either, be able to deduce that the two might hail from the same cultural origin, and make informed gameplay decisions on the back of this. For example, religions produce a commonality of both spatial and colour aesthetics. This can be seen in Figure 3, which shows a generated religious robe, altar, and prayer mat, which adhere to the same colour palette. As explored earlier in the paper, this is intended to have both worldbuilding impact by showing a consistency of aesthetic style through material artefacts of various sorts designed by one religion, whilst also allowing the player to come to recognize certain items according to their appearance. The game will never explicitly state "A Prayer Mat of [Religion]", but simply "A Prayer Mat" – the responsibility lies with the player to connect items they discover to other items they've seen before, and gradually build up a comprehensive picture of the world's generated cultures, and use this information to inform their decisions and actions within the game world. At time of writing, this system is the most well-developed in religions, although the concept also applies to a range of other domains. In Figure 4, for example, a floor tiling pattern, shop sign, table and chair are depicted, all sharing an octagonal aesthetic. This is a simpler example to the religious example outlined above, but the layering of complex and simple shared aesthetic throughout the world serves to make every part of the game world distinct, both in terms of unique and striking cultural practices, and the reproduction of mundane everyday aesthetics.

Figure 3: a religious garment, religious altar, and prayer mat, all shared by one generated religion. These share a colour palette and are never explicitly identified by in-game text as belonging to the same religion; the player is instead expected to draw these connections themselves. This means that the player is actively drawn into the process of uncovering and understanding the world, instead of simply having a completed world presented to them, and serves to give players a sense of ownership and understanding of the world they are currently exploring (as well as being essential to the game's core gameplay loop, which is focused on exploration, discovery, and the gathering of information).

Figure 4: an example of a simple low-level shared aesthetic of shape between various items – a tiled floor in an upper-class housing district, a shop sign for an auction house, a table, and a chair – that generate in one culture. Even the most basic of household goods are therefore procedurally generated according to aesthetic principles unique to each culture, with the goal of ensuring that every region of the game world has its own distinctive visual style.

Towards Qualitative Procedural Generation

I propose that the further development and implantation of the qualitative procedural generation techniques outlined here, as well as others I have no doubt failed to anticipate or consider, are integral to the creation of virtual worlds that are far more detailed, compelling, and "true to life" than those currently offered by large-scale simulation-focused or open-world computer games. By moving the discussion away from the standard procedural generation of space – which, although essential, has dominated game-related PCG research up to the present day – this paper has outlined a manifesto of sorts for the value of generating non-physical concepts, beliefs and practices, which are then reproduced and recreated throughout the physical world the player experiences. Doing so lends depth and, crucially, *meaning* to all of the forms of procedural generation a player encounters in a playthrough, tying them together to broader concepts which suffuse the game world and lend a cohesion, sense and shared internal logic that is rarely found in most game spaces.

Similarly, I have sought to outline how expending effort into such forms of procedural generation are not merely in service to the creation of compelling virtual worlds, but also open the possibility for intriguing new forms of gameplay. Creating a world with detailed procedural generation of religious beliefs, social norms and practices, dialects, and cultures and aesthetics, allows for a range of potential gameplay mechanics. These include: encouraging players

to identify useful information in statements and cultural artefacts instead of simply being "given" the information; a range of sites at which clues can be hidden towards secret or optional in-game content, designed so that the most observant players will be able to identify and locate them; and conversation and dialect systems which take account of the cultural and religious backgrounds of NPCs, in the process ensuring that they respond appropriately to the player's inquiries instead of reproducing "rote" responses. In these ways and others, qualitative procedural generation offers unusual and compelling gameplay mechanics that merit further exploration, research, and development.

Lastly, and in addition to game design as a practice, QPG also offers a range of new possibilities for scholarly enquiry into procedural generation, game design, and a range of associated fields such as graphical processing, natural language processing, and interactions between artificial intelligence actors. Although substantial work continues to be done on traditional predominantly "spatial" forms of procedural content generation, qualitative procedural generation is an almost entirely untapped field of potential research. Such a research direction is valuable not only to games, but to other related fields under the broader remit of "interactive media" – such as historical simulations or museum exhibits, interactive television, interactive storytelling, and many others – that would benefit from the ability to evoke sociocultural spaces and practices with a greater resolution and detail than is currently available.

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