Alphabet Soup: Design and Development of a Short Form Game

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ABSTRACT
In this paper, we describe the design and development of a short form game, Alphabet Soup. Alphabet Soup is designed to use Bayesian networks in conjunction with data from UNESCO, UNICEF, and WHO to create realistic results within gameplay about social issues around the world. This paper illustrates our attempts to implement an artificial intelligence system in short form game design. Using Bayesian networks we attempt to control simple behaviors for game agents that direct gameplay in social awareness games designed to be consumable.

Categories and Subject Descriptors
K.8.0 [Personal Computing]: General – Games. I.2.4 [Artificial Intelligence]: Knowledge Representation Formalism and Methods – Representations (procedural and rule-based).

General Terms
Design

Keywords
Game design, short form, social issues

1. INTRODUCTION
In this paper, we present *Alphabet Soup,* a short form game about the range of social, emotional, and physical diseases that run rampant in the world today. Players of *Alphabet Soup* fashion the landscape of their gameplay by making choices based off of statistics from the World Health Organization (WHO), United Nations Children's Fund (UNICEF), and the United Nations Educational Scientific and Cultural Organization (UNESCO). The results of these choices are many and varied- involving variables associated with health, wealth, and happiness- and are informed by a series of Bayesian network models integrated within a database. This framework, called *Bane,* allows the creation of many stories within one game as the player shifts from one character to another such as a small girl in rural Bhutan, or an obese man in urban Mexico.

Bane, unlike more sophisticated systems such as *Comme il Faut* [1], is a basic intelligence system that assumes missing information and makes best guesses about the probability of a chosen action as the player completes the action. In order to make this work we had to find a solution to handling these uncertain situations. The use of Bayesian networks allows for rational decisions to be made without knowing all of the information and thus gives the illusion of an approximate human intelligence in computer-controlled situations.

By creating a generic infrastructure that can be used repeatedly we have made progress towards a system that uses networks to handle multiple behaviors such as path finding. This in itself is not a new discovery, what makes *Bane* engaging in gameplay is the simplicity and relative speed at which it can be adapted to create a variety of stories. This paper describes the design and development of one such game, *Alphabet Soup: Bhutan* using *Bane* to achieve a varied and intelligent experience of social issues while maintaining a dynamic narrative space.

Figure 1. Alphabet Soup opening screen

2. *BANE* AND GAMEPLAY
Gameplay in *Alphabet Soup* involves playing as a specific character- such as nine-year-old girl Dorji Wangmo in rural Bhutan- to survive for a certain period of time in an untenable situation.

Short form games [2] are created to be played in a brief amount of time. *Alphabet Soup* was specifically designed as a short form game to take advantage of the limited power of *Bane.* There are a limited amount of choices that can be controlled within the system and choices available and how each changes the player's wellbeing are managed by the game's AI system, *Bane.* The player is presented with a dilemma, sourced from WHO. UNICEF, or UNESCO, and makes a choice from AI generated results.

Each of these dilemmas is stand-alone but the results will be chained, enabled by the Bayesian network embedded in *Bane.* For example, the player could have Dorji Wangmo choose to stay inside during cold weather or to go outside to gather firewood.

Each choice the player makes is not entirely based on free will however, *Bane* will determine the historical likelihood of each decision and the cultural context in which it occurs. Additionally, how each player responds to the dilemma is also determined in this way. An example is a dilemma where Dorji Wangmo gets tuberculosis. As elaborated in the Bayesian network below (figure 2), while the likelihood for developing tuberculosis is lower in people under the age of twenty [3] she is more likely to develop it given her level of poverty, crowded housing, and a history of influenza (figure 3).

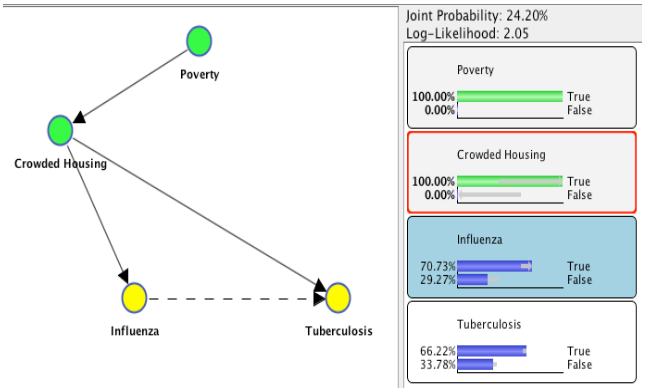

Figure 2. Bayesian joint probability (24.2%) of developing Tuberculosis after Influenza in Bhutan

While the goals of each story in *Alphabet Soup* are to survive each story has a specific set of dilemmas and statistics that control which actions the player can take. Dorji Wangmo can try to avoid influenza by not living in crowded housing but her level of poverty makes that choice almost impossible to achieve as you can see below where *Bane* draws from WHO, UNESCO, and UNICEF statistics about rural life in Bhutan.

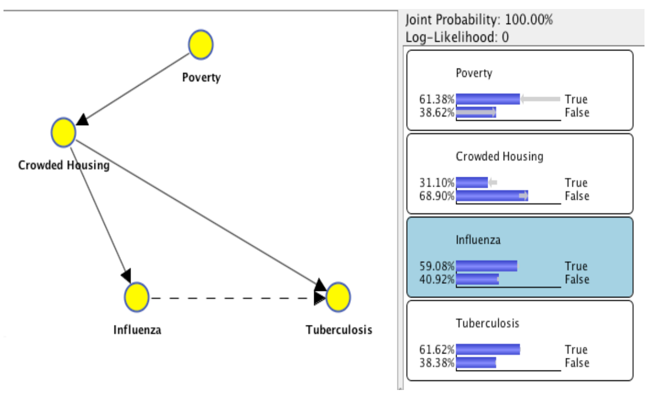

Figure 3. Bayesian joint probability (100%) of developing Tuberculosis after Influenza in Bhutan

Because the gameplay of *Alphabet Soup* involves being manipulated by the AI system, the focus of most narratives, the gameplay is an unhappy story. And this story is authored equally by the designers and *Bane*, where the designers create the initial situation and define the goals yet *Bane* crafts the outcomes of possible interactions. In fact, *Bane* enables the emergent solutions to each dilemma and the resulting narrative is affected in terms of the players' wellbeing score, a responsive metric that increases and decreases with each dilemma.

2.1 Bayesian Networks

Bayesian networks are based on the mathematical theory known as Bayes' Theorem, which is used to calculate the probability of an event occurring given a known event. Bayes' theorem states

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}.$$

This theorem allows us to calculate the statistical probability of events occurring even if we know very little about the world. We can determine a more realistic and probable assumption about A if we know that B has occurred. An example from games and learning is Val Shute from Florida State University and her work on stealth assessment in physics games [4]. Bayes supports "what-if" scenarios by activating and observing evidence that describes a particular case or situation and then propagating that information through the network using the internal probability distributions that govern that behavior on the Bayesian network.

2.2 The Data Behind *Bane*

Bane derives all of the results to proposed dilemmas in *Alphabet Soup* from an intersection of current data in WHO, UNICEF, and UNESCO. This data consists of freely available databanks with thousands of variables ranging from maternal health to average wage of child workers in countries around the world. The latest data is from the 2010 census conducted by UNICEF and is available with first person accounts of daily social situations.

Social awareness video games have achieved a high level of ethos and playability in the Games for Change movement [5]. Many of these games are both conceptually and physically well made with a high level of detail and artwork involved. Additionally the data behind these games are well researched and fit seamlessly into the narrative of the game. All of this takes money, in time and people, as well as physical resources. The development of *Bane* has focused on modeling a quick and dirty system that can access targeted statistics to create Bayesian networks linked to country specific narratives. *Alphabet Soup* set out to make short form game development sustainable by limiting the amount of time and resources needed to produce a single story within the game.

Without a system like *Bane*, representing the daily dilemmas and results of the game would be too costly to produce as a short form experience. *Alphabet Soup's* AI system is comprised of thousands of results from each story, all based on Bayesian networks of 10 or less nodes since each dilemma is not chained to the following. This allows the game to be flexible within each story but also introduces a level of complexity in the decision matrix. For example the player is unlikely to die of hypothermia in summer and *Bane* has seasonal variables to control for these events. These rules encode a notion of truth and structure, which the player will use to psychologically place him or herself during the game while striving to meet the goals of each story all being measured by a variable we named wellbeing.

2.3 Wellbeing as a Measure of Success

The following will provide a high level description of the components of *Alphabet Soup's* measurement of success state, which were arrived at after four iterations. Wellbeing (see figure 4) is measured with additive, non-reciporcal, non-chaining variables: health, wealth, and happiness.

Health: ordinal scale, starts with a number dependent on national statistics such as average age of death and childhood mortality rates. The three elements are: dead, sick and well.

Wealth: ordinal scale, game begins with a wage dependent on national wage, age, and gender. The three elements are: below living wage, living wage, and wealthy.

Happiness: binary scale, measured on the WHO gross national happiness scale. The two elements are: unhappy and happy.

Each dilemma and result is linked to at least one of the variables and effect wellbeing in different amounts dependent on the country. See below for three examples of the wellbeing success measure (figures 4, 5, and 6).

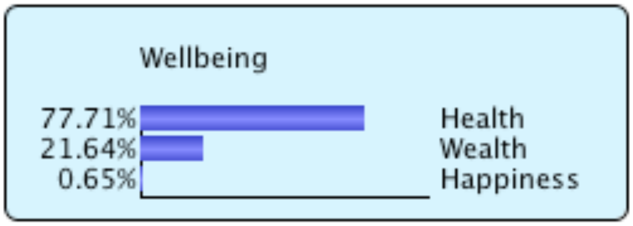

Figure 4. Initial wellbeing based on playing as a nine-year-old girl in rural Bhutan

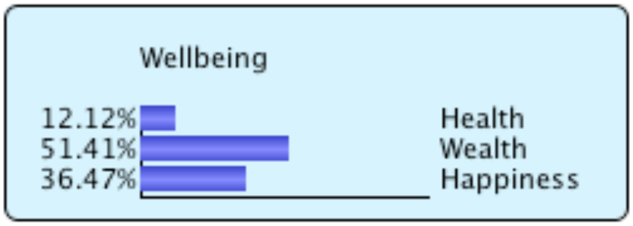

Figure 5. Initial wellbeing based on playing as an obese, asthmatic middle-aged man in Mexico City

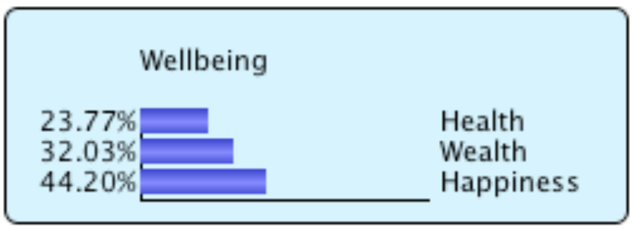

Figure 6. Wellbeing of man in Mexico after quitting a job at the factory that had negatively impacted his asthma

The following example illustrates the structures described above, and will be used again to demonstrate the processes.

Dorji Wangmo is a nine-year-old girl in a rural Bhutan, where 70.8% of the population lives. Her growth is moderately stunted (33.5% of children) and she survived past the age of five (under-five mortality rate = 69 per thousand nationally). Each of these statistics including her age and gender are used to calculate the health probabilities of wellbeing. Dorji Wangmo comes from a subsistence farming background where 44.5% of the women are literate and the net intake for primary education is 68.1% of the population. Her father supports her need for education, as 51.3% of fathers in Bhutan do. Her farm is too far from school to make the journey daily and she lives with her sister in a small mud hut 6 hours walk from her family. The average wage of a subsistence farmer in Bhutan is measured in terms of product and this puts her in the second poorest wealth index in which 18.1% of Bhutan's population subsists. Each of these statistics is used to calculate the wealth probabilities of wellbeing. Happiness is measured using the World Health Organizations' measure of national happiness. Bhutan has a rating of 5.3 out of 10 and on our binary scale is rated as happy [6]. This example illustrates the starting point for the gameplay, however each dilemma has it's own effects on these variables as well as possible confounding variables such as luck (i.e. finding money on the ground).

2.4 *Bane's* Processes

In the initial work toward creating a playable Bayesian model, we utilized the program *BayesiaLab* [7] to encode probabilities of each dilemma within the statistical data from WHO, UNICEF, and UNESCO. In order to grow each dilemma into a storyline the linked statistic (see figure 7 result below) is the starting point for each network model. One example of a process in *Bane* is how Dorji Wangmo develops tuberculosis. This result is derived by linking each of the actions in the storyline (e.g., sleeping, studying, cooking food) to a central dilemma. In this case the dilemma is the weather yet the result, no matter if she stays inside or not is getting sick. The dotted line in figure 7 represents where *Bane* accesses the probability network to decide if the player will develop tuberculosis or not. Essentially, *Bane* is a system that determines the outcome of each action based on probability and player action.

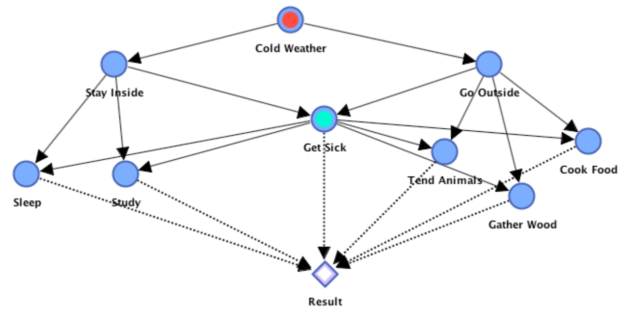

Figure 7. Bayesia Lab mock up of statistical result and storyline

Bayesian networks comprised of situational state encoded into *Bane* determine all of Dorji Wangmo's responses to dilemmas. As an example, using the network in figure 7, if it is winter she will be more likely to need firewood more often and will have different weighting for the results of choosing to stay inside versus going outside. *Bane* operates by a set of simple loops, stepping from process to process as the dilemmas are randomly selected. The first process is always the player's choice to engage in the game. Based on the statistical data from the region and the season in which the play is engaged (e.g. winter, fall, summer, spring) a starting wellbeing scored is computed (see figure 4).

Next, a dilemma is presented for the player to consider. Every time a dilemma is presented the player has to weigh their wellbeing against the possible results. Wellbeing is scored by counting the weight of health, wealth, and happiness and computing based on each dilemma (figures 5 and 6). Each dilemma has at least two ways it can play out that depend on the wellbeing and whether *Bane* deems it probabilistic for a certain choice to be made. Each of these *nodes* is connected by *edges* and drives the AI within the game. For example, if Dorji Wangmo chooses to go to school over caring for her sick sister *Bane* does not punish her by decreasing her happiness but overall her wellbeing score will decrease because she will have to work twice as hard to gather firewood, tend the animals, and collect clean water and that will impact her health score. If the sum is zero for health at any point the player is dead, however if the sum for wealth reaches zero the rules that pertain to the game structure will present a zero sum equation. For example, Dorji Wangmo is sick and cannot gather firewood, nor is her sister recovered to collect firewood. With the health score decreasing and wealth at zero (as measured by supplies over money) the player will be given the option to return home to the farmhouse and quit school. Choosing to stay results in death and returning home results in the game ending but without wellbeing reaching zero.

Bane's processing loop concludes in an end state along with a report of side effects of social awareness gameplay. Each effect is associated with a key statistic from WHO, UNICEF, or UNESCO that links the sets of template-based dilemmas and results with real world associations. At the end state a report of wellbeing is produced and logged in *Bane* to create new learning parameters for future play.

2.5 Story Progression and Short Form Play

Designing *Alphabet Soup* around *Bane* has resulted in both opportunities and limitations for story progression and short form play. At the root of it, the game is puzzle based but inherently limited in directions that the player can act upon. The structure of the dilemmas and results were designed to address social awareness within a specific timeframe of gameplay.

Using a short form game template to create story progression in *Alphabet Soup* was a deliberate choice by the creators. We simply did not have the budget or time to invest in creating more sophisticated system and aimed to produce something that could grow out of storyline rather than programming, thus *Bane* was born. A player starts *Alphabet Soup* by selecting a story, in this instance a player selects *Bhutan* and is entered into the world of Dorji Wangmo. Each story is comprised of a randomized set of dilemmas forming the storyline. The goal in all of the stories is to stay alive and keep a wellbeing score that allows the player to achieve the everyday goals of their particular storyline. The distinct settings of each of the stories do not permit for cross overs in storylines, such as Bhutan or Mexico.

There is a given number of turns within each story, between 12 and 17 dilemmas are presented and results given between the beginning of gameplay and the end state. The completed dilemmas do not inform the upcoming dilemmas and chaining of wellbeing is done through a simple additive algorithm within *Bane*. The objective of every game in *Alphabet Soup* is to beat the odds and survive without succumbing one of the social issues prevalent in the storylines. We specifically designed each story to be short form to not overwhelm gameplay with a series of unfortunate events that eventually lead to the demise of each player. The short form game design [2] allows quick gameplay and produces specific experiences for each player, while a bank of over 100 dilemmas ensures that there are multiple storylines to play.

3. CONCLUSION

In this paper we have described how *Alphabet Soup* creates multiple opportunities to experience awareness of social issues while maintaining a dynamic and statistically accurate space through its artificial intelligence system *Bane*. *Alphabet Soup* is an example of how playable Bayesian models can be embedded into short form games and enable authoring of stories through template based Bayesian networks.

4. ACKNOWLEDGMENTS

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