Intelligent Fridge Poetry Magnets

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ABSTRACT

Exemplifying the aims of the ECAgents project, this paper presents a community of communicating embodied agents which learn an adjacency-based grammar from user interactions. The agents act as intelligent fridge magnets, each printing a word on their respective displays. The user places agents next to other agents on the fridge, removing and replacing them if the word they display is ungrammatical given the current context, thereby indicating grammatical acceptability. We present these agents both as a test bed for exploring research into ECAgents and as a means of investigating how users respond to expressive devices like fridge poetry magnets which learn from user interaction.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *natural language, input devices and strategies.*

General Terms

Algorithms, Design, Experimentation, Languages.

Keywords

embodied communicating agents, interaction-based grammar-learning, expressive user-interfaces, intelligent agents, user interaction.

1. INTRODUCTION

This project was designed in accordance with the principles of the ECAgents project (see http://ecagents.istc.cnr.it for more information), in which emergent grammar among communities of autonomous embodied communicating agents characterises emergent behaviour. The ECAgents project focuses on a plurality of embodied agents with emergent communication systems and conventions and underlying ontologies which self-organise and evolve as the population of agents and their environment changes [2], [3]. We choose to investigate ECAgents which interact with the user [1] and in which the user contributes entirely to environmental change in order to provide a test bed for the coupling of (1) user-interaction and (2) autonomous agents which evolve their own sense of grammar. To this end, we present our intelligent fridge poetry magnets as both ECAgents exemplars and as a test bed for further investigation into learning within the ECAgents scope. We describe interactions and the agents' functionality, and then discuss how they learn and communicate. Finally we address how they are physically implemented and ideas for further development and research.

Fridge poetry magnets unite the benefits of the fridge as an interactive surface and space for creative expression with the novel aspect of intelligence, that is, fridge poetry magnets which learn a sense of basic adjacency-based grammar. As discussed in [4], the fridge itself can be seen as a central interactive surface in the home, supplying a highly utilised (and therefore data-rich) source for user-studies into both the scope of intelligent and adaptive fridge poetry magnets and the ways in which users interact with them and adapt standard poetry magnets' expressive capabilities. However we leave user-studies into the nature of interactions with intelligent poetry magnets for future work and now turn our attention to the nature of interactions with these poetry agents.

2. INTERACTION

Poetry magnets are generally seen as static expressive devices. Here we explore how intelligent poetry magnets which produce words automatically and not selected by the user can be interacted with. As discussed below, if the user dislikes the word chosen by the agent, she can request another word. However the magnets do not provide the direct vehicle for user expression that standard poetry magnets do, and are meant to be interacted with as autonomous agents that can be taught a basic sense of grammar, and produce random (independent of the user) collocations of concepts which make sense grammatically and introduce unpredictability and novelty in fridge poetry.

Interactions are user-initiated; the user picks up an agent and places it on the fridge. It then displays a word randomly selected from its lexicon. The user then picks up another agent and places it next to the one already on the fridge. Agents need to be placed next to each other in order to communicate, as will be discussed in the section below on hardware. The agent discovers it has a neighbour and learns its neighbour's part of speech. Based on the likelihood of being adjacent to (either to the left or right of) its neighbour, it probabilistically selects a part of speech and then chooses a word at random from its lexicon which has this part of speech and displays this word. If the user dislikes the word chosen, she lifts the agent off and replaces it on the fridge. The agent again chooses based on the same probability distribution, i.e., it does not take into account the user's correction (this is discussed more in the next section). The probabilistic selection of a new part of speech (and word) means that the agent can choose a different part of speech this time, hopefully resulting in something acceptable. If the user leaves the agent on the fridge, it assumes its neighbours' parts of speech are acceptable and updates the likelihood of having them as left and right neighbours in its likelihood tables.

3. LEARNING AND COMMUNICATION

Agents only communicate with and learn from immediately adjacent neighbours, not from more distant neighbours in our current implementation. This means that they learn a local sense of grammar. This was done to ensure that agents do not learn a global (sentential) grammar while the sentence is being created, which would erroneously result in initial phrases becoming more likely than a whole sentence. Of course this could be avoided if agents simply learn sentential grammar once the sentence has been completed, which is easily added to our simple initial approach. However this also gives rise to issues of how the agents can all communicate their parts of speech to all the other agents in the sentence, which results in hardware implementation which must then possibly be rethought.

Selection of part of speech is probabilistic in order to allow for randomness to be introduced, and to prevent the convergence towards one preferred adjacency pattern. Learning from an acceptable neighbour simply means incrementing the likelihood of that neighbour's part of speech given the current agent's (new magnet) part of speech. Our approach also assumes that agents learn not from the correction itself, but from acceptable neighbours' parts of speech, i.e., only through positive interactions. This way the user's dislike of a particular word will not create false negatives in the learned adjacency pairs.

Agents learn autonomously through the interactions they are directly involved in. We chose to avoid the paradigm in which agents can also learn vicariously, e.g., by communicating with neighbours (possibly recursively for global vicarious learning) to find out what they have learned about acceptable left and right neighbours through their interactions. The reasoning behind this decision is to ensure that agents develop independent minds (i.e., by learning independently), thereby ensuring variation in learned grammar and allowing for more possibly acceptable combinations of parts of speech rather than tending to behave more and more similarly and converging on the same adjacency grammar (and therefore preventing grammatical variation and novelty) over time.

One difficulty in reconciling ECAgents' independent learning with user-driven interactions arises from the considerable amount of time it takes for a community of communicating agents to learn a sense of grammar, especially when they only learn through their own interactions, and then only from their positive interactions. How is the user's interest level maintained during the long period it takes for agents to display some learned behaviour? Certainly ordinary fridge poetry magnets have proven to be very popular expressive devices, and while these agents display words unpredictably rather than representing the same word, it is our hope that their novel function as conceptually automatic fridge poetry magnets which learn grammar will maintain interest during the initial learning phases. Possibly the perspective of user-determined fridge poetry will need to be adapted to account for unpredictable automatic expressive devices instead, though this will be the subject of further user-studies.

4. HARDWARE

The intention of the project is to eventually create hardware prototypes representing the fridge magnets, in order to enforce a degree of embodiment.

Each fridge magnet is principally represented by:

- A microcontroller
- An LCD displaying 16 characters that is programmed by a micro-controller
- LED-based transmitter/receivers on each side of the display (to communicate with neighbours)
- A switch to change the displayed word.

The microcontroller is connected to an optional accelerometer and a battery, all of which lie behind the LCD display, with an insulated magnet on the back. The accelerometer could serve as a novel interaction technique to randomise words through the shaking of the magnet upon it being picked up.

The microcontroller used for prototyping is an ATMEL ATMega16 AVR, a flexible all-purpose model. Cheaper models could be used once the hardware requirements are fully known. Communication between agents (microcontrollers) is effectuated through bi-directional LED communication modelled on [5].

The 16x1 character LCDs used in prototyping are generic displays based on the KS0066U chip, similar to the Hitachi HD44780 model.

5. IDEAS FOR FUTURE WORK

Presently we focus on learning local syntactic information in the form of parts of speech; we chose not to learn from semantic information as it produces less bizarre (and therefore less interesting) collocations of concepts. We could also learn a global grammatical coherence over time by communicating parts of speech to all the other agents in the sentence after the sentence is finished (assuming either a time interval with no interaction or an explicit end-of-sentence signal). As we discussed above, learning currently occurs only by direct involvement. However, we could adapt this slightly so that immediately adjacent neighbours learn from new neighbours' parts of speech as well. Additionally, while agents learn slowly if they learn from a single user's repeated interactions, they can learn much more if multiple users can play with them, for example via an online interface.

This project also serves as a test bed for ECAgent project goals, where variations of learning schemes, etc. can easily and systematically be implemented and tested. Certainly user studies to investigate interaction benefits and problems in practice will be the next practical step before any alternative learning schemes are investigated.

Allowing a finished sentence to change over time (given no user interaction) by changing words in the same parts of speech (and position) as in the old sentence might increase interest level. Interestingness could also be increased by having multiple communities of agents (e.g., agents on the fridge at home and also on the fridge at work) that communicate their sentences to each other in order to select conceptually similar themes. So, e.g., if the agents at home have "Crazy kangaroos dream wildly", the agents at work might have "Drunk wallabies laze around the pool", in keeping with the Australian animal theme. Another interesting off-shoot lies in the direction of nonlinear word games like Scrabble and crossword puzzles; possibly an interactive and intelligent community of agents could involve the user in such games in a similar manner, though this is left for further thought.

6. REFERENCES

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