Tokamak Elementary: Visual Novel Meets Natural Language Understanding

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Abstract

"Tokamak Elementary" is a game built around a custom conversational engine. The player can talk with "Toki", the AI-controlled character as with a chatbot. Toki is a gentle spirit creature summoned from the world of spirits. As such, Toki starts from a mostly clean slate and it's up to the player to teach them basic concepts of our world (such as what animals are) and how to interact with humans (such as returning greetings).

One part of the game is a sandbox environment where the player chats with Toki in freeform natural language. (Figure 1) This part is fun because the player can interact with a goofy AI and teach it things. (Consider (Lionhead Studios 2001).) The other part of the game is a school Toki has to go and pretend to be a human. This part is a non-interactive scripted visual novel with a branching dialog tree. (Figure 2) This part is fun because of a complex plot involving school children, magical creatures, and fusion reactors.

The novelty of the game comes from the interaction of these two parts. At school Toki's conversational engine gets the dialog from other characters as input. Toki answers according to its engine, just like when speaking to the player. The dialog branches are selected by simple checks on Toki's output. (Usually via regular expressions.)

Gameplay alternates between the two parts. Toki goes to school, faces challenges and initially fails them. The player then gets to talk to Toki at home and teach them new facts and rules. When the player sends Toki back to school, they will go through the same day (same dialog tree), but Toki will give different responses due to an updated knowledge base. This will lead to new branches of the dialog tree and eventually a successful completion of the day.

The school setting is an opportunity for real educational content. In our video walk-through of the demo (Darabos 2020) we meet Sophie, the music teacher who explains the chromatic scale and a musical interval. Tokamak Elementary does not directly quiz the player, but progress is gated behind Toki achieving good grades. The player is tasked with explaining real-world concepts to Toki. Sometimes teaching someone else is the best way to learn a lesson ourselves.

Our conversational engine parses inputs based on a constituency parse tree generated by the Berkeley Neural Parser (Kitaev and Klein 2018). The parse tree is recursively matched against the parse trees of all rules stored in Toki's knowledge base. The best matching combination of rules is executed. The rules query and update the knowledge base and craft a response. There are rules that allow the player to add new rules, for example teaching Toki to say "hello" when greeted.

The neural network-based parsing approach allows some flexibility in the input. But we can't hope to understand all possible inputs. While providing a challenge and telling an interesting story, the visual novel part also serves to demonstrate to the player the kind of grammar structures that Toki understands. (Figure 3)

Crafting a response is also challenging. The rules give example responses, and our engine performs substitution according to the actual rule execution context. We use SpaCy (Honnibal and Montani 2017) to tokenize and tag the template sentence and Pattern (Smedt and Daelemans 2012) for conjugation to match the target tags.

Tokamak Elementary is under development. The focus so far has been on demonstrating that the basic concept works. We have a playable demo that includes the sandbox mode and a single short day at school. (As shown in the video walk-through.) We plan to add more days with a gradual ramp up of difficulty and an unfolding of the story. When we add new scenes, we add grammar and knowledge representation features as needed. (Such as past tense and a concept of timelines.) This accumulation of natural language understanding also improves the sandbox chat experience.

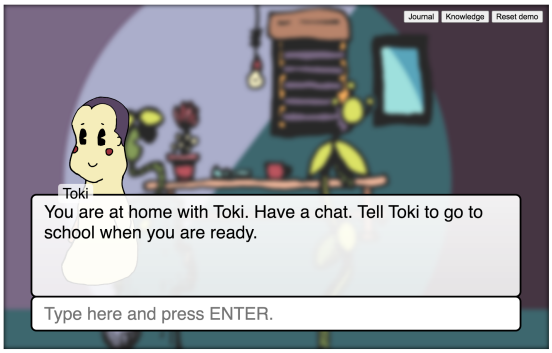

Figure 1: The free natural language chat interface where the player can chat with Toki.

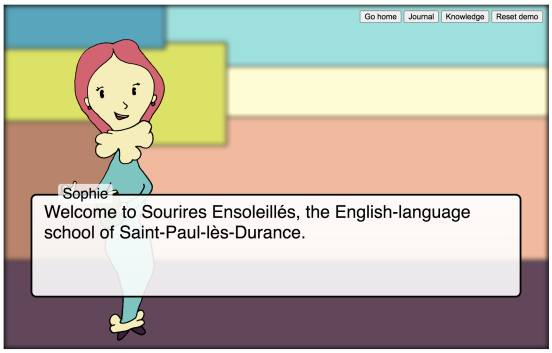

Figure 2: Toki goes to a school near the ITER nuclear fusion research site. Could there be a connection between fusion and magic?

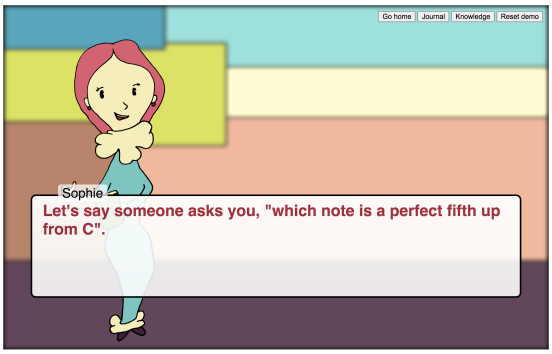

Figure 3: A line from the visual novel part of the game. The text that demonstrates grammar that Toki can understand is highlighted in red. This is also an example of educational content in Tokamak Elementary. The player has to teach Toki some music theory to progress.

References

Darabos, D. 2020. Tokamak elementary demo 2020. https://www.youtube.com/watch?v=5_V5fDM9lrI.

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Smedt, T. D., and Daelemans, W. 2012. Pattern for python. *Journal of Machine Learning Research* 13(66):2063–2067.

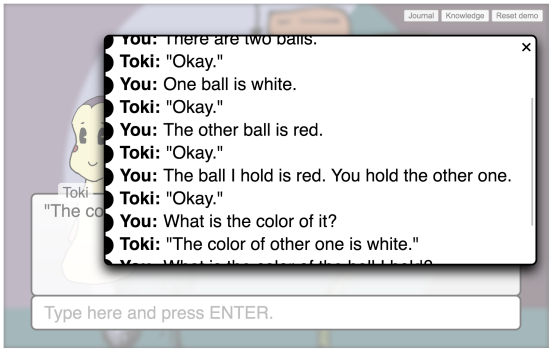

Figure 4: A journal feature lets the player access the full transcript of everything so far. Here we can see how Toki managed to complete a simple logical reasoning task.

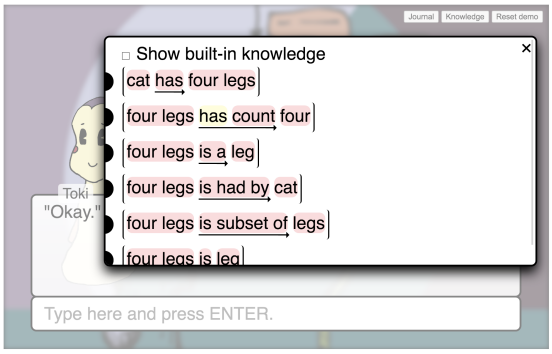

Figure 5: Once a required magical item is obtained, the player gets the ability to directly inspect Toki's knowledge base. Here we see the knowledge base entries created upon hearing "a cat has four legs."