

Robinson Crusoe's Prolog Adventure

Course of Methods in Computer Science Education: Analysis

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Introduction

The purpose of this report is to outline the process of creating a learning unit that integrates the story of Robinson Crusoe through the use of Prolog, drawing inspiration from the famous game created in 1976 called Colossal Cave Adventure (also known as Adventure or ADVENT). Advent is a text-based adventure game, released by developer Will Crowther for the PDP-10 mainframe computer. The game consists of several environments through which the player moves and interacts using one- or two-word commands, interpreted by the game's natural language input system.

So, as already mentioned, the main goal of this learning unit is to integrate educational concepts by involving students in the story of Robinson Crusoe, while also leveraging the capabilities of Prolog.

Prerequisites and Class

The proposed learning unit is designed to align with the fourth-year program of the "Liceo Scientifico ind. Scienze Applicate." There are two reasons why this decision was made. Firstly, it follows the ministerial programs for English, where Robinson Crusoe is studied during the fourth year. Secondly, it considers the appropriateness of introducing Prolog during this year, emphasizing the need for students to have a solid foundation in programming basics before delving into a language with relatively complex logic programming paradigms. While getting started with Prolog can be a little difficult, once students understand its basic operation, writing a program should be fairly simple.

In terms of **Computer Science** prerequisites, students need to have basic programming knowledge and logical reasoning skills. The transition to Prolog is highlighted by the focus on declarative programming, especially in the context of logical programming. In order to proceed, it is recommended to have the ability to solve problems and think critically which will be useful to the student in the development of the game and actions to be carried out.

The **Prolog prerequisites** focus on the language's syntax, including facts, rules, and predicates. In detail, during the Prolog-based programming phase, students need to possess the skills to interpret and modify Prolog code that involves clauses and relationships and a proficiency in list manipulation, dynamic predicates using "*dynamic*" and "*assert*" for data management.

As regards the **English literature** topics, students are required to have studied Daniel Defoe, specifically his famous plot named *Robinson Crusoe*. This prior knowledge is crucial for applying logic programming concepts, modeling situations and interactions within the narrative, and implementing Prolog predicates that mirror the actions and decisions in the story.

Learning Objectives and Motivations

Analyzing key aspects of Robinson Crusoe's history and subsequently translating them into Prolog structures offers students the chance to improve their understanding of Computer Science and English Literature topics. So, at the end of the Learning Unit, students will acquire basic knowledge of Prolog, the logical programming paradigm style. In the context of Robinson Crusoe, the learning unit will help facilitate a deeper understanding of the plot and characters through programming.

The guidelines given to students are as follows:

"After studying Daniel Defoe, in particular his work "Robinson Crusoe", identify the key elements of the plot to create an adventure game inspired by the famous game "Colossal Cave Adventure"

using Prolog which we saw during the course. To progress through the game's narrative, the player must make the correct choices that will lead to win.

Furthermore, as illustrated in Defoe's work, faith played a crucial role. Therefore, you have to incorporate puzzles into the game that allow the player to unlock the Bible, which played a vital role for Robinson.

Note: You must work in pairs with a classmates."

Rules given:

- The students can use the plot to consult during the programming session and use all the creativity to create situations and enigmi;
- Additionally, students can use all online documentation and the slides to create Prolog-related code.

Structure of the Lectures

The teaching unit will be delivered in the last month of the first semester of the fourth year. In fact, students at the end of the semester will have acquired the necessary skills in Computer Science. The students will work in pairs in order to help each other. This choice also lies in teaching students to work in teams during a programming session using pair programming. To complete the learning unit, it will take 3 weeks. The students will work in the computer laboratory where Prolog and the SWI-Prolog IDE will already be installed. Considering 2 hours per week, it was decided to divide the lessons as follows:

- **Les. 1:** Introduction to the novel and preliminary discussion;
- **Les. 2-4:** Step-by-step guide to creating your own game using Prolog;
- **Les 5:** Test and debug the game;
- **Les. 6:** Presentation of student projects and final discussion.

During the last lesson students will receive their grades. In the following paragraph we find the related evaluation grid.

Evaluation Grid

Criteria	Well Done	Good	Sufficient	Insufficient
Understanding of Robinson Crusoe*	Thorough understanding with critical analysis and insightful interpretations.	Clear and comprehensive understanding with accurate identification of keys parts of the plot and characters.	Basic understanding of the novel's plot and characters, with some inaccuracies.	Limited understanding of key elements. The students are not able to understand the plot.
Prolog Programming*	Advanced capacities with creative and efficient use of the language.	Good use of Prolog, demonstrating understanding of logical programming and effective implementation.	Basic application of Prolog, with some errors and limitations in complexity.	Difficulty in applying basic Prolog concepts, frequent errors, and lack of understanding.
Game Design and Creativity	Excellent creativity and good integration of Robinson Crusoe elements.	Effectively incorporating creative elements from Robinson Crusoe.	Basic attempts at creativity, but the code lacks depth and effective integration of novel elements.	The students used minimal effort to incorporate novel elements.
Final Presentation	Excellent presentation, confidently conveying all aspects of the project. Also the code is well commented.	Clear and organized presentation, the students were able to explain the features and design choices.	Basic presentation skills, with some difficulty in explain key aspects.	Ineffective presentation, lack of clarity, and difficulty in explaining implemented features.

(*) Please Note: The final grade will be a combination of performance in each criterion, and the criteria are not equally weighted. Emphasis will be placed on Prolog programming skills and understanding of Robinson Crusoe.

Development

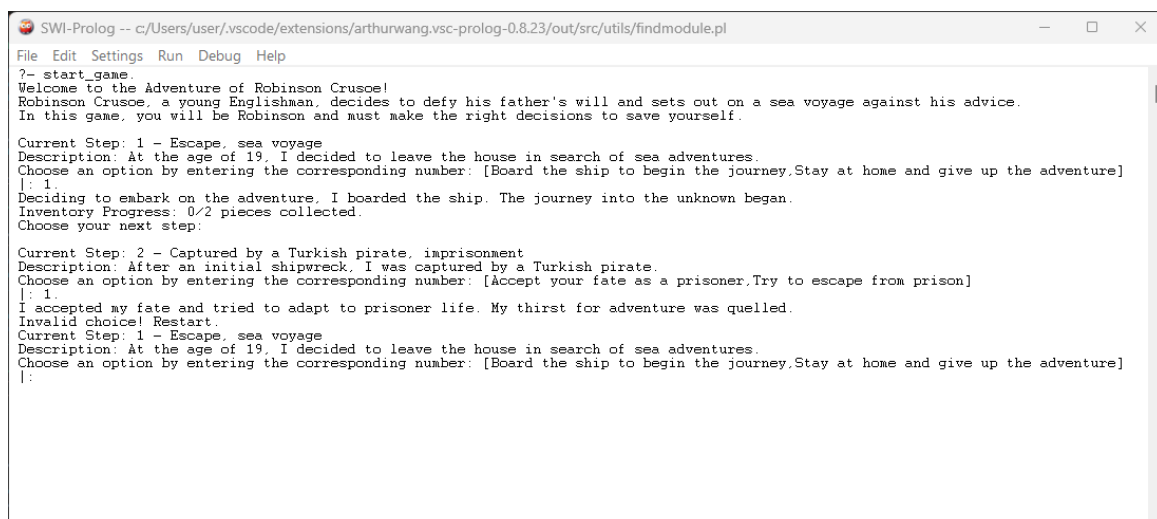
For the development of the LU the students will be followed step-by-step in the laboratory to create a functioning and coherent code in pairs. Two versions of the code were created: one version that contains the optimal solution to obtain the highest score from the students and a sufficient solution of minimum requirements for the lowest grade to pass the Lu.

Optimal Solution

The LU with the highest mark has been realized through the implementation of the code of several functionalities that are summarized as follow:

- **Story Steps:** The story is divided into different steps, each with a title and a detailed description;
- **Choices:** For each step, the player is presented with a set of choices to make.
- **Correct Choices:** Valid choices are explicitly defined for each step;
- **Consequences:** Consequences are provided for each combination of step and choice, describing the outcome of the player's decision;
- **Puzzles:** Some steps involve puzzles that the player needs to solve by providing correct answers;
- **Inventory System:** Implements an inventory system to track collected items.
- **Game Logic:** At least, students have to develop the main logic of the game, including starting the game, handling user choices, progressing through steps, managing puzzles and inventory, and restarting the game.

In the following screenshot, it's possible to see how the code work. The user has to choose between two options to continue the story. When they make a wrong choice, they go back to step 1. This choice is based on making the student memorize the important passages of the story of Robinson Crusoe and on remembering the correct order of events in the plot. Keep in mind that the user has to use the predicate `'start_game.'` in order to initiate the game and make their initial choices for progression.



```
SWI-Prolog -- c:/Users/user/.vscode/extensions/arthurwang.vsc-prolog-0.8.23/out/src/utis/findmodule.pl
File Edit Settings Run Debug Help
?- start_game.
Welcome to the Adventure of Robinson Crusoe!
Robinson Crusoe, a young Englishman, decides to defy his father's will and sets out on a sea voyage against his advice.
In this game, you will be Robinson and must make the right decisions to save yourself.

Current Step: 1 - Escape. sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey,Stay at home and give up the adventure]
|: 1.
Deciding to embark on the adventure. I boarded the ship. The journey into the unknown began.
Inventory Progress: 0/2 pieces collected.
Choose your next step:

Current Step: 2 - Captured by a Turkish pirate. imprisonment
Description: After an initial shipwreck, I was captured by a Turkish pirate.
Choose an option by entering the corresponding number: [Accept your fate as a prisoner,Try to escape from prison]
|: 1.
I accepted my fate and tried to adapt to prisoner life. My thirst for adventure was quelled.
Invalid choice! Restart.
Current Step: 1 - Escape. sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey,Stay at home and give up the adventure]
|:
```

Figure 1: Starting the game

During the game, questions will be presented to the user, and they must provide answers. If the answer is correct, the user obtains a piece of a Bible page. When they collect 2 pieces, they unlock the complete Bible, which holds crucial value for Robinson in the novel.

```

SWI-Prolog -- c:/Users/user/.vscode/extensions/arthurwang.vsc-prolog-0.8.23/out/src/utlis/findmodule.pl
File Edit Settings Run Debug Help
?- start_game.
Welcome to the Adventure of Robinson Crusoe!
Robinson Crusoe, a young Englishman, decides to defy his father's will and sets out on a sea voyage against his advice.
In this game, you will be Robinson and must make the right decisions to save yourself.

Current Step: 1 - Escape, sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey.Stay at home and give up the adventure]
|: 1.
Deciding to embark on the adventure, I boarded the ship. The journey into the unknown began.
Inventory Progress: 0/2 pieces collected.
Choose your next step:

Current Step: 2 - Captured by a Turkish pirate, imprisonment
Description: After an initial shipwreck, I was captured by a Turkish pirate.
Choose an option by entering the corresponding number: [Accept your fate as a prisoner.Try to escape from prison]
|: 2.
With courage, I attempted to escape from the prison. Through cleverness and determination, I managed to break free, gaining a valuable lesson in survival.
Inventory Progress: 0/2 pieces collected.
Choose your next step:

Current Step: 3 - Prosperity in Brazil, buying plantations
Description: In Brazil, I bought a plantation and prospered as a farmer.
Choose an option by entering the corresponding number: [Invest your earnings in new business ventures.Live a peaceful life with your plantation]
|: 1.
I invested my earnings in new ventures. My boldness was rewarded, and the plantation became an even greater success.
All! Put yourself to the test! (write the answer in lowercase):
The Authenticity of the Story:
Is the story based on real events?
|: yes.
Correct! You unlocked a piece of the puzzle.
Inventory Progress: 1/2 pieces collected.
Choose your next step:

Current Step: 4 - Shipwreck on a Desert Island
Description: While traveling to Guinea to purchase slaves for the company, the ship was wrecked on a desert island.
Choose an option by entering the corresponding number: [Explore the island for resources.Try to build a boat to leave the island]
|:

```

Figure 2: Puzzle point

Finally, when the user has chosen all the correct answers, the game will end and he will win, as we can see in the following screen:

```

SWI-Prolog -- c:/Users/user/.vscode/extensions/arthurwang.vsc-prolog-0.8.23/out/src/utlis/findmodule.pl
File Edit Settings Run Debug Help
Current Step: 5 - Solitary life, survival skills
Description: I began a solitary life, building a hut, cultivating the land, raising animals and learning to cook with the island's limited resources.
Choose an option by entering the corresponding number: [Explore the interior of the island for new discoveries.Continue improving your cabin and survival skills]
|: 1.
I focused my efforts on improving my hut and survival skills. This ensured my comfort and well-being on the island.
All! Put yourself to the test! (write the answer in lowercase):
The Famous Parrot:
In the story, what is the name of the famous parrot that accompanies the protagonist on the deserted island?
|: poll.
Correct! You unlocked a piece of the puzzle.
Inventory Progress: 2/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Current Step: 6 - The discovery of the cannibals
Description: After many years, I discovered the presence of cannibals on the island.
Choose an option by entering the corresponding number: [Establish contact with cannibals.Keep your distance and try to avoid cannibals]
|: 1.
I approached the cannibals with a spirit of peace. I saved a native, Friday, and started a relationship that turned into a friendship and a lesson in cross-cultural understanding.
Inventory Progress: 2/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Current Step: 7 - Meeting Friday
Description: Friday and I became friends, after many years in solitude finally I wasn't alone.
Choose an option by entering the corresponding number: [Teach Friday your customs and habits.Let Friday follow his traditions]
|: 1.
I decided to teach Friday my customs. Through this teaching, Friday became a loyal companion, and we learned from each other.
All! Put yourself to the test! (write the answer in lowercase):
Answer Friday's questions:
Friday poses questions about your life on the island. Reflect on the most challenging aspect of your early days in solitude and how you overcame it. The answer is a single word
|: faith.
Correct! You unlocked a piece of the puzzle.
Inventory Progress: 3/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Current Step: 8 - Failed attempt to leave with a small boat
Description: I wanted to leave the island with a small boat, but its size was not sufficient to cross the sea.
Choose an option by entering the corresponding number: [Give up the idea of leaving the island.Continue improving your little boat]
|: 1.
I persisted in improving the small boat. Despite challenges, I maintained hope of leaving the island.
Inventory Progress: 3/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Current Step: 9 - Escape from the island
Description: Finally, I managed to have a ship sufficient enough to make the journey and return home.
Choose an option by entering the corresponding number: [Prepare a strategy to return to homeland.Stay on the island]
|: 1.
Deciding to prepare a strategy opens up new hopes for escape.
Inventory Progress: 3/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Current Step: 10 - Return to my homeland
Description: Back in London, I discovered that I had become rich thanks to the proceeds of the plantation in Brazil.
Choose an option by entering the corresponding number: [Balance your newfound wealth and enjoy life in London.Presume yourself to live new adventures]
|: 1.
Wishing to live new adventures, you continue your quest for knowledge and adventure. The future unfolds before you with endless possibilities. Congratulations! You have completed the game.
Inventory Progress: 3/2 pieces collected.
Congratulations! You have gathered enough puzzle pieces to unlock a special item.
You unlocked a special item: Bible! This item may be useful in your journey.
Choose your next step:

Thank you for playing the Adventure of Robinson Crusoe! Feel free to play again and explore different paths in the story.
true.
?-

```

Figure 3: The winner

Sufficient Solution

As for the solution to achieve a sufficient mark grade, students are not required to implement inventory management and related puzzles, but it is mandatory for them to be able to implement choice management for the conclusion of the game.

Below, some screens will be shown regarding the functioning:

```
SWI-Prolog -- c:/Users/user/vscode/extensions/arthurwang.vsc-prolog-0.8.23/out/src/utlis/findmodule.pl
File Edit Settings Run Debug Help
?- start_game.
Welcome to the Adventure of Robinson Crusoe!
Robinson Crusoe, a young Englishman, decides to defy his father's will and sets out on a sea voyage against his advice.
In this game, you will be Robinson and must make the right decisions to save yourself.

Current Step: 1 - Escape, sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey.Stay at home and give up the adventure]
|: 1.
Deciding to embark on the adventure, I boarded the ship. The journey into the unknown began.
Choose your next step:

Current Step: 2 - Captured by a Turkish pirate, imprisonment
Description: After an initial shipwreck, I was captured by a Turkish pirate.
Choose an option by entering the corresponding number: [Accept your fate as a prisoner.Try to escape from prison]
|: 2.
With courage, I attempted to escape from the prison. Through cleverness and determination, I managed to break free, gaining a valuable lesson in survival.
Choose your next step:

Current Step: 3 - Prosperity in Brazil, buying plantations
Description: In Brazil, I bought a plantation and prospered as a farmer.
Choose an option by entering the corresponding number: [Invest your earnings in new business ventures.Live a peaceful life with your plantation]
|: 1.
I invested my earnings in new ventures. My boldness was rewarded, and the plantation became an even greater success.
Choose your next step:

Current Step: 4 - Shipwreck on a Desert Island
Description: While traveling to Guinea to purchase slaves for the company, the ship was wrecked on a desert island.
Choose an option by entering the corresponding number: [Explore the island for resources.Try to build a boat to leave the island]
|: 1.
I explored the island in search of resources. I encountered new challenges and opportunities that contributed to my survival.
Choose your next step:

Current Step: 5 - Solitary life, survival skills
Description: I began a solitary life, building a hut, cultivating the land, raising animals and learning to cook with the island's limited resources.
Choose an option by entering the corresponding number: [Explore the interior of the island for new discoveries.Continue improving your cabin and survival skills]
|: 2.
I focused my efforts on improving my hut and survival skills. This ensured my comfort and well-being on the island.
Choose your next step:

Current Step: 6 - The discovery of the cannibals
Description: After many years, I discovered the presence of cannibals on the island.
Choose an option by entering the corresponding number: [Establish contact with cannibals.Keep your distance and try to avoid cannibals]
|: 1.
I approached the cannibals with a spirit of peace. I saved a native, Friday, and started a relationship that turned into a friendship and a lesson in cross-cultural understanding.
Choose your next step:

Current Step: 7 - Meeting Friday
Description: Friday and I became friends, after many years in solitude finally I wasn't
Choose an option by entering the corresponding number: [Teach Friday your customs and habits.Let Friday follow his traditions]
|: 2.
I respected Friday's traditions and let him follow his own path. However, this did not help me in trying to escape from the island.
Invalid choice! Restart.
Current Step: 1 - Escape, sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey.Stay at home and give up the adventure]
|:
```

Figure 4: Starting Game

```
SWI-Prolog -- c:/Users/user/vscode/extensions/arthurwang.vsc-prolog-0.8.23/out/src/utlis/findmodule.pl
File Edit Settings Run Debug Help
I accepted my fate and tried to adapt to prisoner life. My thirst for adventure was quenched.
Invalid choice! Restart.
Current Step: 1 - Escape, sea voyage
Description: At the age of 19, I decided to leave the house in search of sea adventures.
Choose an option by entering the corresponding number: [Board the ship to begin the journey.Stay at home and give up the adventure]
|: 1.
Deciding to embark on the adventure, I boarded the ship. The journey into the unknown began.
Choose your next step:

Current Step: 2 - Captured by a Turkish pirate, imprisonment
Description: After an initial shipwreck, I was captured by a Turkish pirate.
Choose an option by entering the corresponding number: [Accept your fate as a prisoner.Try to escape from prison]
|: 2.
With courage, I attempted to escape from the prison. Through cleverness and determination, I managed to break free, gaining a valuable lesson in survival.
Choose your next step:

Current Step: 3 - Prosperity in Brazil, buying plantations
Description: In Brazil, I bought a plantation and prospered as a farmer.
Choose an option by entering the corresponding number: [Invest your earnings in new business ventures.Live a peaceful life with your plantation]
|: 1.
I invested my earnings in new ventures. My boldness was rewarded, and the plantation became an even greater success.
Choose your next step:

Current Step: 4 - Shipwreck on a Desert Island
Description: While traveling to Guinea to purchase slaves for the company, the ship was wrecked on a desert island.
Choose an option by entering the corresponding number: [Explore the island for resources.Try to build a boat to leave the island]
|: 1.
I explored the island in search of resources. I encountered new challenges and opportunities that contributed to my survival.
Choose your next step:

Current Step: 5 - Solitary life, survival skills
Description: I began a solitary life, building a hut, cultivating the land, raising animals and learning to cook with the island's limited resources.
Choose an option by entering the corresponding number: [Explore the interior of the island for new discoveries.Continue improving your cabin and survival skills]
|: 1.
I focused my efforts on improving my hut and survival skills. This ensured my comfort and well-being on the island.
Choose your next step:

Current Step: 6 - The discovery of the cannibals
Description: After many years, I discovered the presence of cannibals on the island.
Choose an option by entering the corresponding number: [Establish contact with cannibals.Keep your distance and try to avoid cannibals]
|: 1.
I approached the cannibals with a spirit of peace. I saved a native, Friday, and started a relationship that turned into a friendship and a lesson in cross-cultural understanding.
Choose your next step:

Current Step: 7 - Meeting Friday
Description: Friday and I became friends, after many years in solitude finally I wasn't
Choose an option by entering the corresponding number: [Teach Friday your customs and habits.Let Friday follow his traditions]
|: 1.
I decided to teach Friday my customs. Through this teaching, Friday became a loyal companion, and we learned from each other.
Choose your next step:

Current Step: 8 - Failed attempt to leave with a small boat
Description: I wanted to leave the island with a small boat, but its size was not sufficient to cross the sea.
Choose an option by entering the corresponding number: [Give up the idea of leaving the island.Continue improving your little boat]
|: 1.
I persisted in improving the small boat. Despite challenges, I maintained hope of leaving the island.
Choose your next step:

Current Step: 9 - Escape from the island
Description: Finally, I managed to have a ship sufficient enough to make the journey and return home.
Choose an option by entering the corresponding number: [Prepare a strategy to return to homeland.Stay on the island]
|: 1.
Deciding to prepare a strategy opens up new hopes for escape.
Choose your next step:

Current Step: 10 - Return to my homeland
Description: Back in London, I discovered that I had become rich thanks to the proceeds of the plantation in Brazil.
Choose an option by entering the corresponding number: [Enjoy your newfound wealth and enjoy life in London.Presume yourself to live new adventures]
|: 1.
Deciding to live new adventures, you continue your quest for knowledge and adventure. The future unfolds before you with endless possibilities. Congratulations! You have completed the game.
Choose your next step:

Thank you for playing the Adventure of Robinson Crusoe! Feel free to play again and explore different paths in the story.
true.
?-
```

Figure 5: End Game