Due Date: 06.12.2023

CENG311 Computer Architecture

Programming Assignment #2

In this homework assignment, you will implement **Queue** of recipes with MIPS assembly language. The queue is a simple linked list, with each node's data pointing to a recipe. You are expected to modify the source code provided with this homework.

- You are expected to fill given subroutines with the usages at the Subroutine Usages table.
- In the main subroutine, you should call the other subroutines according to expected operations (Please read each operation carefully!):

  - **Initialize the Recipe List**
    - Create a linked list (queue) to store recipes and store its address.
  - **Create and Add Pancakes Recipe**
    - Create an array with 5 elements for ingredients:
    - Add **Flour** (index 0).
    - Add **Milk** (index 1).
    - Add **Eggs** (index 2).
    - Add **Sugar** (index 3).
    - Add **Baking Powder** (index 4).
    - Create the **Pancakes** recipe using the ingredients array.
    - Enqueue the **Pancakes** recipe into the linked list.
  - **Create and Add Spaghetti Bolognese Recipe**
    - Create an array with 5 elements for ingredients:
    - Add **Spaghetti** (index 0).
    - Add **Ground Beef** (index 1).
    - Add **Tomato Sauce** (index 2).
    - Add **Onion** (index 3).
    - Add **Garlic** (index 4).
    - Create the **Spaghetti Bolognese** recipe using the ingredients array.
    - Enqueue the **Spaghetti Bolognese** recipe into the linked list.
  - **Print Queue Size**
  - **Print Current Recipes in the List**
    - Traverse the linked list and print all recipes.
  - **Dequeue and Print the First Recipe**
    - Dequeue the first recipe (Pancakes) from the list.
    - Print the details of the removed recipe.
  - **Print Queue Size**
  - **Print Remaining Recipes in the List**
    - Traverse and print all remaining recipes in the list.
  - **Dequeue and Print the Next Recipe**
    - Dequeue the next recipe (Spaghetti Bolognese) from the list.
    - Print the details of the removed recipe.
  - **Dequeue and Print the Next Recipe**
    - Dequeue the next recipe (List is empty) from the list.

- Print the details of the removed recipe (No recipe to print).
- **Print Queue Size**
- **Print Remaining Recipes in the List (Empty List)**
  - Traverse and print the linked list (should be empty).
- **Create and Add Chicken Stir-Fry Recipe**
  - Create an array with 5 elements for ingredients:
  - Add **Chicken** (index 0).
  - Add **Bell Peppers** (index 1).
  - Add **Soy Sauce** (index 2).
  - Add **Ginger** (index 3).
  - Add **Garlic** (index 4).
  - Create the **Chicken Stir-Fry** recipe using the ingredients array.
  - Enqueue the **Chicken Stir-Fry** recipe into the linked list.
- **Print Current Recipes in the List**
  - Traverse and print all recipes.
- **Create and Add Caesar Salad Recipe**
  - Create an array with 4 elements for ingredients:
  - Add **Romaine Lettuce** (index 0).
  - Add **Croutons** (index 1).
  - Add **Caesar Dressing** (index 2).
  - Add **Parmesan Cheese** (index 3).
  - Add **Chicken breast** (array size is 4, should give warning)
  - Create the **Caesar Salad** recipe using the ingredients array.
  - Enqueue the **Caesar Salad** recipe into the linked list.
- **Print Queue Size**
- **Print Current Recipes in the List**
  - Traverse and print all recipes.
- **Create and Add Chocolate Chip Cookies Recipe**
  - Create an array with 5 elements for ingredients:
  - Add **Butter** (index 0).
  - Add **Sugar** (index 1).
  - Add **Eggs** (index 2).
  - Add **Flour** (index 3).
  - Add **Chocolate Chips** (index 4).
  - Create the **Chocolate Chip Cookies** recipe using the ingredients array.
  - Enqueue the **Chocolate Chip Cookies** recipe into the linked list.
- **Print Queue Size**
- **Print Current Recipes in the List**
  - Traverse and print all recipes.
- **Search for Recipes by Name**
  - Search for a first recipe by name and print the result.
  - Search for a second recipe by name and print the result.

- Hint: you must print and search recipes with traverse subroutines. Traverse subroutines should be used to go through to operate on each array or linked list element.
- Generic subroutines should be implemented for general operations. For example, linked list related subroutines should only include linked list related operations. You should not include any recipe logic to generic subroutines.
- All variables needed has been declared. Therefore, you should not define any new variable.
- Structures of the array, linked list, and recipe are given.
- Recipe variables are given with the format “rRecipeNumber” Ex: r1. For ingredients, “r#RecipeNumber i#IngredientNumber” Ex: r1i2. Cooking time, difficulty, and rating are “r#RecipeNumber c”, “r#RecipeNumber d”, and “r#RecipeNumber r” respectively Ex: r1c, Ex: r1d, and Ex: r1r.
- Two recipes that will be searched are given as search1 and search2. You can print matched or not matched in findRecipe function since there is no return value.
- There is no freeing for MIPS, so you should not try to free the spaces you allocated.
- Each subroutine should be implemented.
- Homework will be evaluated using QtSpim MIPS simulator.
- Change the assembler source code name to your student id, and upload it e.g., 280000000.asm
- You must only upload the .asm assembler source code file.
- Using artificial intelligence tools is strictly forbidden.
- Any kind of cheating will not be tolerated.

Structures:

Array	
4 Bytes - Address of the Data	4 Bytes - Array Size (Max Element Count)
4 Bytes - Element Size	
Linked List	
4 Bytes - Address of the First Node	4 Bytes - Size
Linked List Node	
4 Bytes - Address of the Data	4 Bytes - Address of the Next Node
Recipe	
4 Bytes - Address of the Name	4 Bytes - Address of the ingredients array
4 Bytes - Cooking Time	4 Bytes - Difficulty
4 Bytes - Rating	

Subroutine Usages:

Subroutine Name	Argument 1 ($a0)	Argument 2 ($a1)	Argument 3 ($a2)	Return Value ($v0)
GENERIC				
createArray	Size of the array (max count)	Size of the elements (bytes)	-	Address of the array
putElementToArray	Address of the array	Index	Address of the element	-
createLinkedList	-	-	-	Address of the linked list
enqueue	Address of the linked list	Address of the element	-	-
dequeue	Address of the linked list	-	-	Head Node address, if empty 0
queueSize	Address of the linked list	-	-	-
traverseArray	Address of the array	Address of the function (printIngredient)	-	-
traverseLinkedList	Address of the linked list	Address of the function (findRecipe, printRecipe)	Extra arguments (string for findRecipe)	-
compareString	Address of the first string	Address of the second string		0 for found, 1 for not found
NON-GENERIC				
createRecipe	Address of the recipe name	Address of ingredients array	Cooking Time	Address of the recipe
	Argument 4 ($a3) Difficulty	Argument 5 (0($sp)) Rating		
findRecipe	Address of the recipe	Searched recipe name	-	-
printRecipe	Address of the recipe	-	-	-
printIngredient	Address of the ingredient	-	-	-

Expected Output:

```
Recipe added.
Recipe added.
List Size: 2
List:
----------------------------------------------------------------------
Recipe name: Pancakes
Ingredients:
        Flour
        Milk
        Eggs
        Sugar
        Baking powder
Cooking time: 15
Difficulty: 2
Rating: 4
Recipe name: Spaghetti Bolognese
Ingredients:
        Spaghetti
        Ground beef
        Tomato sauce
        Garlic
        Onion
Cooking time: 30
Difficulty: 3
Rating: 5
----------------------------------------------------------------------

Recipe removed.
Recipe name: Pancakes
Ingredients:
        Flour
        Milk
        Eggs
        Sugar
        Baking powder
Cooking time: 15
Difficulty: 2
Rating: 4

List Size: 1
List:
----------------------------------------------------------------------
Recipe name: Spaghetti Bolognese
Ingredients:
        Spaghetti
```

Ground beef
Tomato sauce
Garlic
Onion
Cooking time: 30
Difficulty: 3
Rating: 5

Recipe removed.
Recipe name: Spaghetti Bolognese
Ingredients:
Spaghetti
Ground beef
Tomato sauce
Garlic
Onion
Cooking time: 30
Difficulty: 3
Rating: 5

List is empty!
Recipe removed.
No recipe to print!

List Size: 0
List:

List is empty!

Recipe added.
List Size: 1
List:

Recipe name: Chicken Stir-Fry
Ingredients:
Chicken breast
Soy sauce
Bell peppers
Broccoli
Garlic
Cooking time: 20
Difficulty: 3
Rating: 4

Index out of bounds!

Recipe added.
List Size: 2
List:

Recipe name: Chicken Stir-Fry
Ingredients:
    Chicken breast
    Soy sauce
    Bell peppers
    Broccoli
    Garlic
Cooking time: 20
Difficulty: 3
Rating: 4
Recipe name: Caesar Salad
Ingredients:
    Romaine lettuce
    Caesar dressing
    Parmesan cheese
    Croutons
Cooking time: 10
Difficulty: 1
Rating: 4

Recipe added.
List Size: 3
List:

Recipe name: Chicken Stir-Fry
Ingredients:
    Chicken breast
    Soy sauce
    Bell peppers
    Broccoli
    Garlic
Cooking time: 20
Difficulty: 3
Rating: 4
Recipe name: Caesar Salad
Ingredients:
    Romaine lettuce
    Caesar dressing
    Parmesan cheese
    Croutons
Cooking time: 10
Difficulty: 1
Rating: 4

Recipe name: Chocolate Chip Cookies
Ingredients:
- Butter
- Sugar
- Flour
- Eggs
- Chocolate chips

Cooking time: 25
Difficulty: 2
Rating: 5

Recipe not matched!
Recipe matched!
Recipe name: Caesar Salad
Ingredients:
- Romaine lettuce
- Caesar dressing
- Parmesan cheese
- Croutons

Cooking time: 10
Difficulty: 1
Rating: 4
Recipe not matched!

Recipe not matched!
Recipe not matched!
Recipe not matched!