**CS 121 Class Project**

Thank you for your purchase of the Baby Block 270 Robot (BB270). In order to use the BB270 you must write a program using the basic robot operations stated below:

* 1. get\_block – Removes and holds one block from the chute. The user must type in each block by hand. (There are six functions that can be used to test the robot described below.)
  2. put\_block – Inserts the block currently held by the robot into an **empty** slot.
  3. remove\_block – Removes a block from a given slot. The slot is then set to a space.
  4. switch\_blocks – Removes a block currently in a slot and replaces it with the block being held by the robot. When finished the robot is holding the block it just removed from the slot.
  5. robot\_ltoreq\_slot – Compares the value of the block (letter) being held by the robot to that of a block in a slot. (If the block held by the robot is less than **or equal** to the block in the slot the result of the compare is TRUE. If the block held by the robot is greater than the block in the slot the result of the compare is FALSE)
  6. shift\_left – Shift the robotic arm one slot to the left. (Cannot go to the left of slot 1)
  7. shift\_right – Shift the robotic arm one slot to the right. (Cannot go to the right of slot 20)
  8. test\_empty – Determines if a slot is empty. The array of slots must be initialize to all spaces or to NULL. (Returns True if empty or False if the slot contains a block.)
  9. print\_slots – Prints the contents of the 20 slots to the screen. You need to submit the output from each of the five test cases when you are finished. Print the slots after each block is placed.

Included with the robot are functions for each of the above operations coded in the C++ Programming Language. The code may be downloaded from the assignments tab in Canvas.

To test your robot write a program that will place a series of blocks into 20 slots in alphabetic order. **Specifically the robot must be able to accomplish this task according to the following requirements:**

1. To begin with all slots must be empty: Set the array of slots to all blanks or to all NULL.
2. Due to a hardware restriction the robot always places the first block into slot 10. You will need to overcome this restriction with clever coding. The block must remain in slot 10 until it has to be moved as part of the alphabetizing process.
3. Blocks will enter the chute in random order.
4. Blocks entering the chute will have a value from ‘A’ through ‘Z ‘. (Uppercase alphabetic characters.)
5. Blocks may repeat. (e.g. there may be two or more blocks with the same letter value.)
6. The robot can take only one block from the chute at a time. It has no knowledge about any other blocks waiting in the chute.
7. The robot can switch the block it is holding with a block in a given slot.
8. The robot can only shift (left or right) one slot at a time. (If you want to shift more than one position you will need to use a loop.)
9. As blocks are placed into the slots they **must be in alphabetic order**. (You are not allowed to randomly place all the blocks and then sort them.)
10. The robot cannot go to the left of slot 1 or to the right of slot 20. (This means that you will have to allow for movement of multiple blocks to the left or right in order to stay within the 20 slots.)
11. You must use the functions provided. However, if you have a better implementation for any of the functions then you may use yours **after approval from the instructor.**
12. You may ( and you will need to ) write additional functions which are composed of calls to the provided functions. For example, to shuffle multiple blocks left or right to open a slot for a new block.
13. Vectors are not allowed.

**Failure to comply with the above requirements will result in a 10% deduction for each requirement that is not met.**

*The Robot Challenge: Your robot will be judged by the fewest number of swapped blocks. To keep up with that number you will need to maintain a count of the number of times the Switch Blocks function is called.*

**Robot Test Cases**

There are five test cases that your robot must pass. They are:

TEST CASE 1: "AXFIUTRPQVWSEYJINYTB"

TEST CASE 2: "ABFGHIJKMOPRSTUVWXYZ"

TEST CASE 3: "ZYXWVUTSRPOKJIIHGFBA"

TEST CASE 4: "AAAAAYYYYYQQQQQXXXXX"

TEST CASE 5: "XXXAAAZZZAAYYVVVVQQQ"

Six functions are provided to assist you with these test cases. By using these functions you do not have to enter each block one at time as required by the get\_block function. There is one function for each individual test case plus another that can be used for any of the five individual test cases. All six functions return one block at a time.

Your output should show the configuration of the blocks in the slots after each block is placed. You may call the print\_slots function to generate that output. You will also need to print out the number of times the robot switched blocks. (Number of times the switch\_blocks function is called.

**How to submit the assignment.**

Submit your results as you have for other homework assignments **plus your C++ source code**. The code **will be downloaded and run by the instructor or the GTA**. Thus, create a MS Word (or other editor) file containing a copy of your source code plus output for each of the five test cases. In addition upload the .cpp source code file. Make sure to include the names of ALL TEAM MEMBERS as comments in the code as well as on the MS Word (or other) document.

**Here is an example showing an arbitrary input of 20 blocks.**

EXAMPLE: Assume the first block is placed in slot 10. The following shows the result of placing 20 random input blocks:

Initial Slot Configuration – All empty

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Input block from chute: M

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  |  |  | **M** |  |  |  |  |  |  |  |  |  |  |

Input block from chute: K

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  |  | **K** | M |  |  |  |  |  |  |  |  |  |  |

Input block from chute: D

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  | **D** | K | M |  |  |  |  |  |  |  |  |  |  |

Input block from chute: P

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  | D | K | M | **P** |  |  |  |  |  |  |  |  |  |

Input block from chute: R

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  |  | D | K | M | P | **R** |  |  |  |  |  |  |  |  |

Input block from chute: J

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  |  | D | **J** | K | M | P | R |  |  |  |  |  |  |  |  |

Input block from chute: F

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  | D | **F** | J | K | M | P | R |  |  |  |  |  |  |  |  |

Input block from chute: W

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  |  | D | F | J | K | M | P | R | **W** |  |  |  |  |  |  |  |

Input block from chute: K (Note: The new K could go in either slot 8 or 9)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  | D | F | J | **K** | K | M | P | R | W |  |  |  |  |  |  |  |

Input block from chute: Y

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  | D | F | J | K | K | M | P | R | W | **Y** |  |  |  |  |  |  |

Input block from chute: S

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  | D | F | J | K | K | M | P | R | **S** | W | Y |  |  |  |  |  |

Input block from chute: N

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  |  | D | F | J | K | K | M | **N** | P | R | S | W | Y |  |  |  |  |

Input block from chute: D (Note: The new D could go in either slot 4 or 5)

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  | D | **D** | F | J | K | K | M | N | P | R | S | W | Y |  |  |  |  |

Input block from chute: X

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  | D | D | F | J | K | K | M | N | P | R | S | W | **X** | Y |  |  |  |

Input block from chute: S (Note: The new S could go in either slot 14 or 15)

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  | D | D | F | J | K | K | M | N | P | R | S | **S** | W | X | Y |  |  |

Input block from chute: Q

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  |  | D | D | F | J | K | K | M | N | P | **Q** | R | S | S | W | X | Y |  |

Input block from chute: B

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  | **B** | D | D | F | J | K | K | M | N | P | Q | R | S | S | W | X | Y |  |

Input block from chute: V

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  |  | B | D | D | F | J | K | K | M | N | P | Q | R | S | S | **V** | W | X | Y |

Input block from chute: Z (Note: All blocks must be shifted left to open slot 20 for Z.)

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot |  | B | D | D | F | J | K | K | M | N | P | Q | R | S | S | V | W | X | Y | **Z** |

Input block from chute: G

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| Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Slot | B | D | D | F | **G** | J | K | K | M | N | P | Q | R | S | S | V | W | X | Y | Z |