



Concordia University

Engineering and Computer Science

COMP 5361

Discrete Structures and Formal Languages

Programming Assignment-2 Report

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Problem statement:

1. Write a Python program that takes as input a truth assignment A for propositional variables $P = \{P_1, P_2, \dots, P_n\}$ and a propositional sentence S involving these variables, and produces output True or False, depending on whether the given assignment A satisfies the sentence S or not. To show that your program works, run your program on the following input

$((P_1 \wedge P_2) \vee (P_3 \wedge \text{True})) \vee ((\neg P_1 \wedge \neg P_3) \wedge P_2)$.

Note that your program should work for any $n \geq 1$, and other inputs also will be given as tests.

2. Write a Python program that takes input P and S as in Question 1, generates the truth table for S, and outputs Tautology, Contingency, or Contradiction, depending on which category S falls into. To show that your program works, run your program on the following inputs

(a) $(\neg P_1 \wedge (P_1 \vee P_2)) \rightarrow P_2$

(b) $P_2 \wedge (P_1 \rightarrow \neg P_2) \wedge (\neg P_1 \rightarrow \neg P_2)$

(c) $(P_1 \rightarrow (P_2 \rightarrow P_3)) \rightarrow ((P_1 \rightarrow P_2) \rightarrow P_3)$

Program Logic:

The program takes user input of either user wants to calculate value for truth assignments of the equation or truth table for the equation. Once selected, the equation is taken as an input and if the user wants to calculate the value of truth assignments then based on the number of variables, the user is asked to provide boolean value for each variable.

The program uses List and Dictionary data structure of the python language, however, list is converted as a stack implementation. Multiple stacks are used in order to generate and store postfix expression sequence and display sequence. Dictionary is used to keep the variables as a key and boolean truth assignment as a value and used for evaluating postfix expression.

- Some intermediate functions are created in-order to evaluate the Conditional, Bi-Conditional, Disjunction and other operations.
- Some constants are used in-order to map/compare static assignments.

`generate_expression` function takes the entered equation and calculates its postfix expression. After generating a postfix expression, `evaluate_expression` function performs evaluation of the postfix expression based on the boolean value entered by the user for the variables. This function takes a boolean assignment for variables and produces the result.

Ex. $((A \wedge B) \Rightarrow C)$ to postfix $[A, B, \wedge, C, \Rightarrow]$

On the other hand, displaying the truth table option is selected by the user then `calculate_truth_table_and_equivalence` is getting called, this function generates the possibilities of the boolean values for each of the variables. If the equation contains 3 variables then possibilities are having the eight unique combinations of boolean values. After that, `evaluate_expression` function performs the evaluation of postfix expression with specific boolean values and returns to the `calculate_truth_table_and_equivalence` function and later values are getting displayed by the same function. This continues till all possible boolean combinations of values are evaluated. Later, based on the result values, the function determines either entered expression is Tautology, Contradiction or Contingency.

How to Run:

- **Run Program (Command: `python asgn2.py`)**

When the program runs user is displayed with following menu in the console

```
COMP-5361 Assignment-2 Menu
```

```
-----
```

1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit

Select:

The user needs to select any one of the available options at a time, otherwise it will raise an error for invalid choice.

After selecting either of the choice 1 or 2, the user needs to give an input of a propositional logic equation. If the equation is invalid the user needs to repeat the same process again.

```
Please enter valid propositional logic equation : ((A ^ B) => C)
```

For choice 1, the user needs to give boolean inputs for variables in order to compute output from the truth assignments.

```
Please enter bool value for A : True
```

```
Please enter bool value for B : True
```

```
Please enter bool value for C : False
```

Then, for choice 1 below, the result will be displayed.

```
=====
The value of expression ( ( A  $\wedge$  B ) => C ) : False
=====
```

And, for choice 2 below, the result will be displayed.

A	B	C	(A \wedge B)	((A \wedge B) => C)
False	False	False	False	True
False	False	True	False	True
False	True	False	False	True
False	True	True	False	True
True	False	False	False	True
True	False	True	False	True
True	True	False	True	False
True	True	True	True	True

```
=====
Solution : Contingency
=====
```

Test Cases:

```

COMP-5361 COMP-5361-Assignment-2 asgn2.py
Project COMP-5361 (Documents/COMP-5361)
COMP-5361-Assignment-1
COMP-5361-Assignment-2
  asgn2.py
  README.md
  COMP-5361-Python-Finite-Aut
  External Libraries
  Scratches and Consoles

335 opz = self.ppz()
336 display_op1 = self.display_list_ppz()
337 display_op2 = self.display_list_ppz()
338 if exp in CONJUNCTION_OPERATORS:
339     val = calculate_conjunction(op1, op2)
340 elif exp in DISJUNCTION_OPERATORS:
341     val = calculate_disjunction(op1, op2)
342 elif exp in EX_OR_OPERATORS:
343     val = calculate_ex_or(op1, op2)
344 elif exp in CONDITIONAL_OPERATORS:
345     val = calculate_conditional(op1, op2)
346 elif exp in BI_CONDITIONAL_OPERATORS:
347     val = calculate_bi_conditional(op1, op2)
348 Equivalency - evaluate_expression()

Terminal: asgn2.py
(tutorial) ypaniya@yashs-MacBook-Pro COMP-5361-Assignment-2 % python asgn2.py

COMP-5361 Assignment-2 Menu
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit
Select: 1

Please enter valid propositional logic equation : ((P1  $\wedge$  P2)  $\vee$  (P3  $\wedge$  True))  $\vee$  (( $\neg$ P1  $\wedge$   $\neg$ P3)  $\wedge$  P2)

Please enter bool value for P1 : True
Please enter bool value for P2 : False
Please enter bool value for P3 : True

=====
The value of expression ( ( P1  $\wedge$  P2 )  $\vee$  ( P3  $\wedge$  True ) )  $\vee$  ( (  $\neg$  P1  $\wedge$   $\neg$  P3 )  $\wedge$  P2 ) : True
=====

COMP-5361 Assignment-2 Menu
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit
Select:
  
```

Question 1

```
COMP-5361 COMP-5361-Assignment-2 asgn2.py
Project COMP-5361 (Documents/Comp-5361)
COMP-5361-Assignment-1
COMP-5361-Assignment-2
asgn2.py
passgn2.pdf
README.md
COMP-5361-Python-Finite-Auto
External Libraries
Scratches and Consoles

338 opz = self.pop()
339 display_op1 = self.display_list_pop()
340 display_op2 = self.display_list_pop()
341 if exp in CONJUNCTION_OPERATORS:
342     val = calculate_conjunction(op1, op2)
343 elif exp in DISJUNCTION_OPERATORS:
344     val = calculate_disjunction(op1, op2)
345 elif exp in EX_OR_OPERATORS:
346     val = calculate_ex_or(op1, op2)
347 elif exp in CONDITIONAL_OPERATORS:
348     val = calculate_conditional(op1, op2)
349 elif exp in BI_CONDITIONAL_OPERATORS:
350     val = calculate_bi_conditional(op1, op2)
351
352 Equivalency : evaluate_expression()

Terminal: asgn2.py +
(tutorial) ypanya@Yashs-MacBook-Pro COMP-5361-Assignment-2 % python asgn2.py

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit

Select: 2

Please enter valid propositional logic equation : (~P1 ^ (P1 v P2)) ^ P2

=====
P1 P2 ~P1 (P1 v P2) (~P1 ^ (P1 v P2)) ((~P1 ^ (P1 v P2)) ^ P2)
=====
False False True False True True
False True True True True True
True False False True False True
True True False True False True
=====
Solution : Tautology
=====

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit
```

Question 2 (a)

```
COMP-5361 COMP-5361-Assignment-2 asgn2.py
Project COMP-5361 (Documents/Comp-5361)
COMP-5361-Assignment-1
COMP-5361-Assignment-2
asgn2.py
passgn2.pdf
README.md
COMP-5361-Python-Finite-Auto
External Libraries
Scratches and Consoles

338 opz = self.pop()
339 display_op1 = self.display_list_pop()
340 display_op2 = self.display_list_pop()
341 if exp in CONJUNCTION_OPERATORS:
342     val = calculate_conjunction(op1, op2)
343 elif exp in DISJUNCTION_OPERATORS:
344     val = calculate_disjunction(op1, op2)
345 elif exp in EX_OR_OPERATORS:
346     val = calculate_ex_or(op1, op2)
347 elif exp in CONDITIONAL_OPERATORS:
348     val = calculate_conditional(op1, op2)
349 elif exp in BI_CONDITIONAL_OPERATORS:
350     val = calculate_bi_conditional(op1, op2)
351
352 Equivalency : evaluate_expression()

Terminal: asgn2.py +
(tutorial) ypanya@Yashs-MacBook-Pro COMP-5361-Assignment-2 % python asgn2.py

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit

Select: 2

Please enter valid propositional logic equation : P2 ^ (P1 ^ ~P2) ^ (~P1 ^ ~P2)

=====
P1 P2 ~P1 (P1 ^ ~P2) (P2 ^ (P1 ^ ~P2)) (~P1 ^ ~P2) ((P2 ^ (P1 ^ ~P2)) ^ (~P1 ^ ~P2))
=====
False False True True False True True False
False True False True True True False False
True False True True False False True False
True True False False False False True False
=====
Solution : Contradiction
=====

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit
```

Question 2 (b)

```

COMP-5361 COMP-5361-Assignment-2 asgn2.py
Project COMP-5361 (Documents/COMP-5361-Assignment-2)
COMP-5361-Assignment-2
  asgn2.py
  README.md
  External Libraries
  Scratches and Consoles
  Pull Requests

351 op2 = self.pop()
352 display_op1 = self.display_list_pop()
353 display_op2 = self.display_list_pop()
354 if exp in CONJUNCTION_OPERATORS:
355     val = calculate_conjunction(op1, op2)
356 elif exp in DISJUNCTION_OPERATORS:
357     val = calculate_disjunction(op1, op2)
358 elif exp in EX_OR_OPERATORS:
359     val = calculate_ex_or(op1, op2)
360 elif exp in CONDITIONAL_OPERATORS:
361     val = calculate_conditional(op1, op2)
362 elif exp in BI_CONDITIONAL_OPERATORS:
363     val = calculate_biconditional(op1, op2)
364
365 (Equivalency - evaluate_expression)

Terminal: asgn2.py +
(tutorial) ypantry@Yashs-MacBook-Pro: COMP-5361-Assignment-2 % python asgn2.py

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit

Select: 2

Please enter valid propositional Logic equation : (P1 + (P2 + P3)) + ((P1 + P2) + P3)

=====
P1 P2 P3 (P2 + P3) (P1 + (P2 + P3)) (P1 + P2) ((P1 + P2) + P3) ((P1 + (P2 + P3)) + ((P1 + P2) + P3))
=====
False False False True True True False False
False False True True True True True True
False True False False True True False False
False True True True True True True True
True False False True True False True True
True False True True True False True True
True True False False False True False False
True True True True True True True True
=====
Solution : Contingency
=====

COMP-5361 Assignment-2 Menu
-----
1. Produce output from truth assignments
2. Display truth table and propositional equivalences
3. Exit

Select: 2

Please enter valid propositional Logic equation : (P1 + (P2 + P3)) + ((P1 + P2) + P3)

=====
P1 P2 P3 (P2 + P3) (P1 + (P2 + P3)) (P1 + P2) ((P1 + P2) + P3) ((P1 + (P2 + P3)) + ((P1 + P2) + P3))
=====
False False False True True True False False
False False True True True True True True
False True False False True True False False
False True True True True True True True
True False False True True False True True
True False True True True False True True
True True False False False True False False
True True True True True True True True
=====
Solution : Contingency
=====

```

Question 2 (c)

References:

- <https://stackoverflow.com/questions/53526207/how-do-i-add-a-row-of-dashes-between-the-first-two-print-lines-in-python>
- <https://www.w3resource.com/python-exercises/challenges/1/python-challenges-1-exercise-56.php>
- https://rosettacode.org/wiki/Truth_table