



PROJECT 1

FORWARD AND BACKWARD CHAINING

Artificial Intelligence CS4346



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TYLER GATES

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THE PROBLEM DESCRIPTION

We as a team work to create a program to help a freshman student who needs advising on their major in college and then career based on major for once they graduate. This is done through an expert system that will continually ask them questions based upon their answers to previous questions to home in on a conclusion.

THE DOMAIN

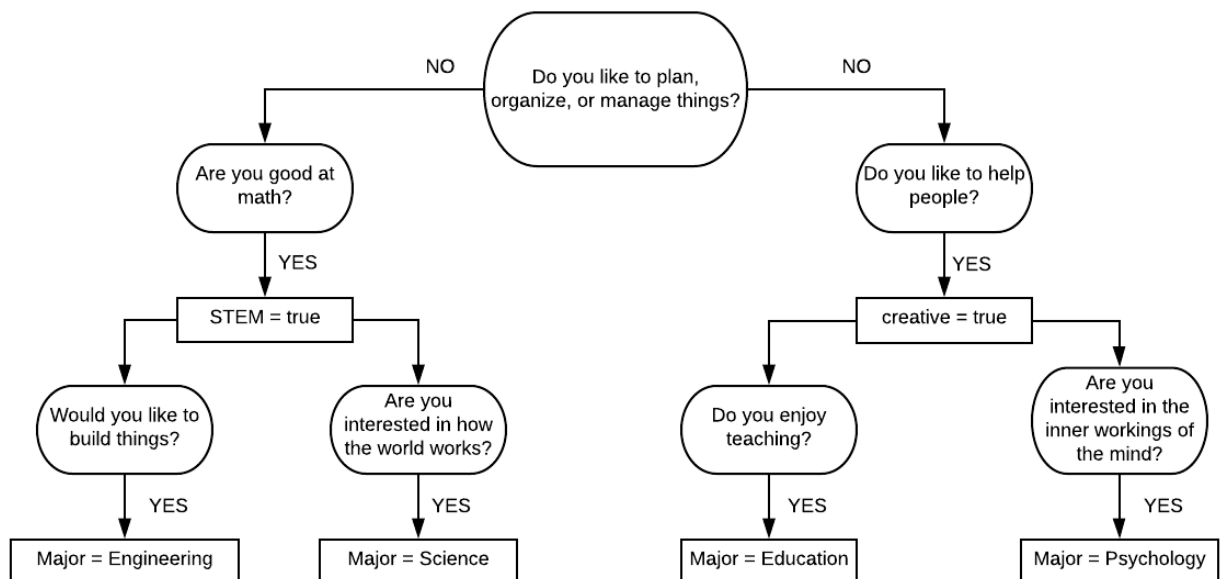
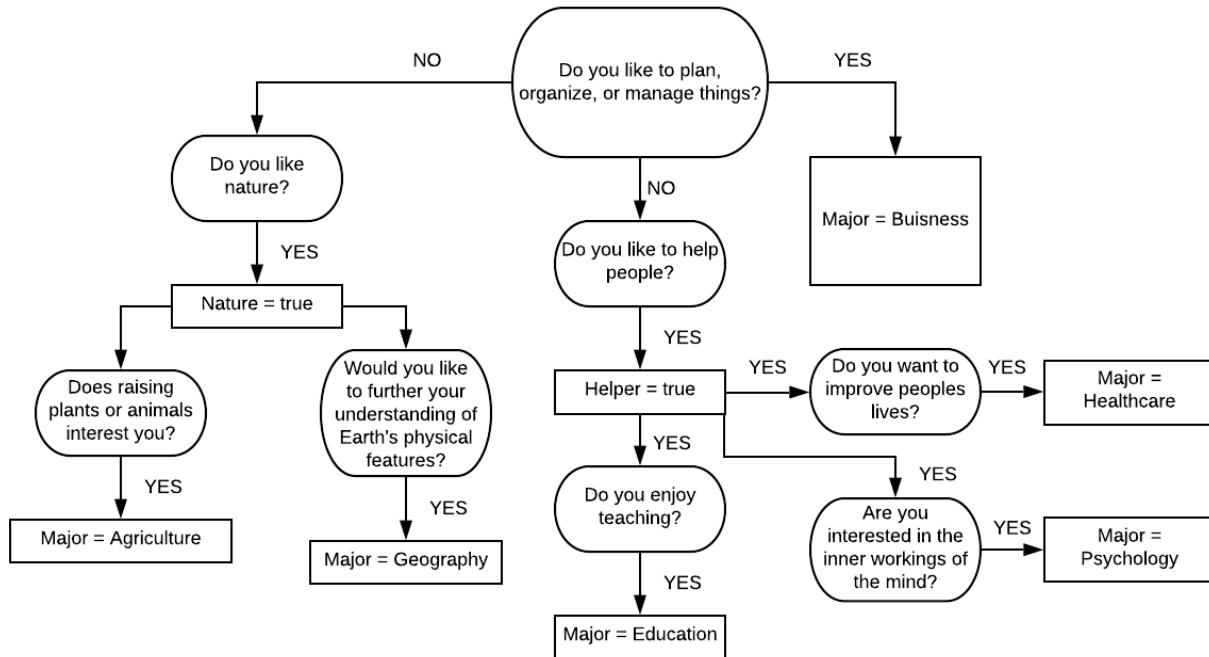
The expert system is created by backward chaining and forward chaining algorithms. This system includes ten different choices of major, with each major having five different careers to choose from. There are fourteen questions involved in the backward chaining, and fifty questions included in forward chaining for a total of sixty-four questions. The majors include Geography, Agriculture, Education, Psychology, Healthcare, Engineering, Science, English, and Art. With each having their five respective career paths for a total of fifty different conclusions. Each question creates two branching paths, one for answering “yes” and the other for answering “no”.

METHODOLOGIES

Both backward chaining and forward chaining rely on decision trees, they each differ in how they traverse their trees. Backward chaining is goal driven, it starts with a defined goal or conclusion and works backward to figure out how that goal can be reached. In example, the conclusion could be major, the backward chaining will prompt the user questions to try to reach that conclusion. Forward chaining is fact driven, it starts with a fact and works its way forward towards any conclusion. In example, the fact could be our major was engineering, the user would then be prompted questions that are children of the engineering fact, this becomes the new fact and the cycle will be repeated until a terminal node is reached.

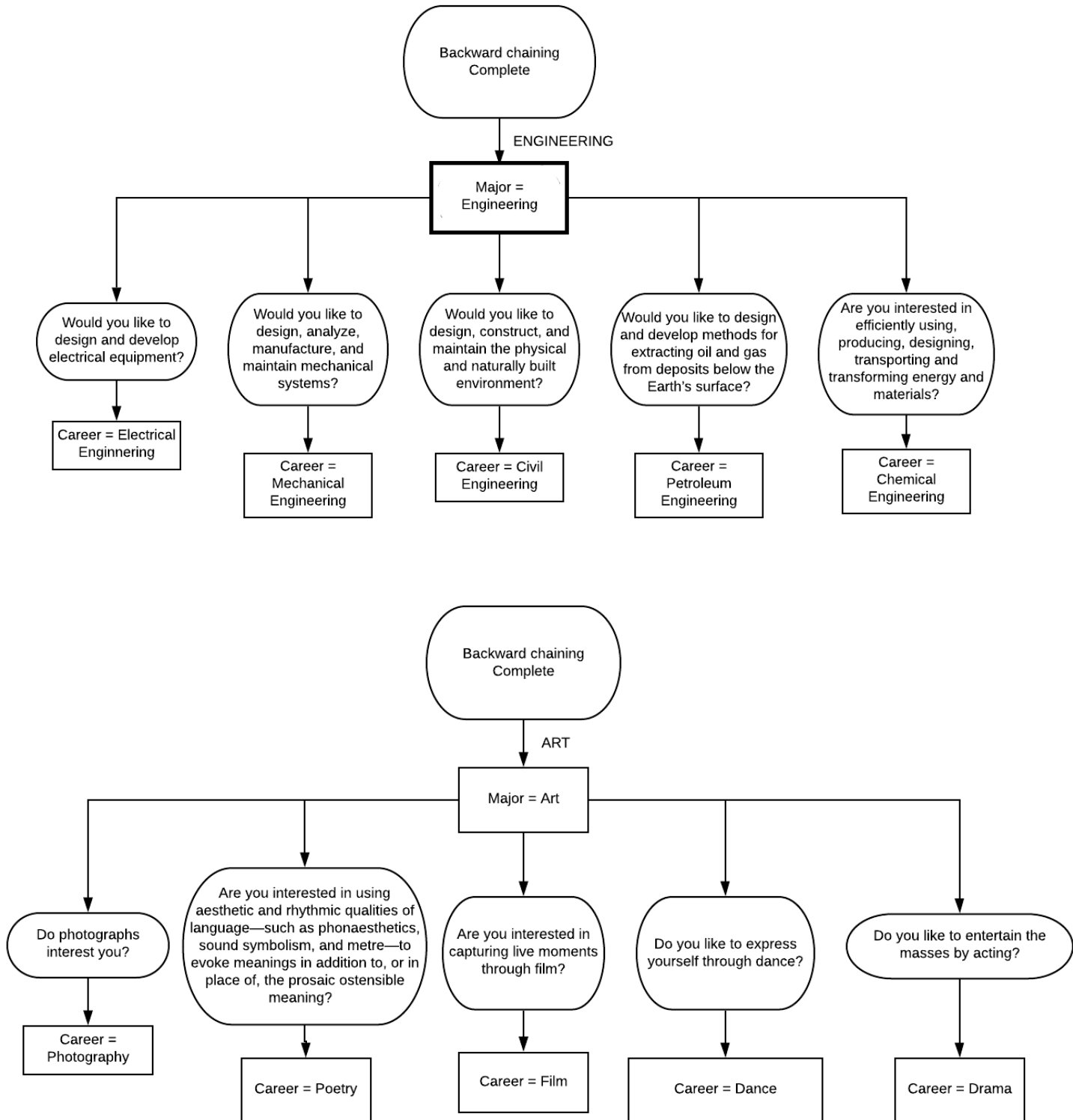
BACKWARD CHAINING DECISION TREE

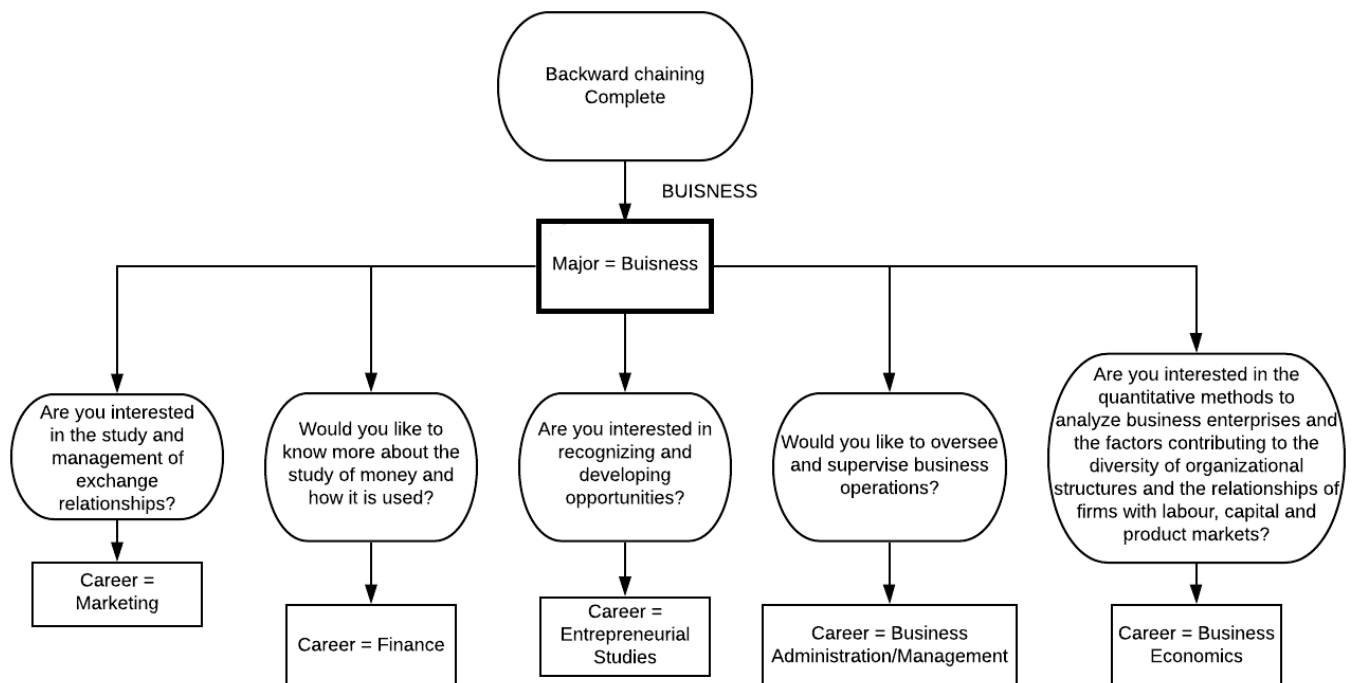
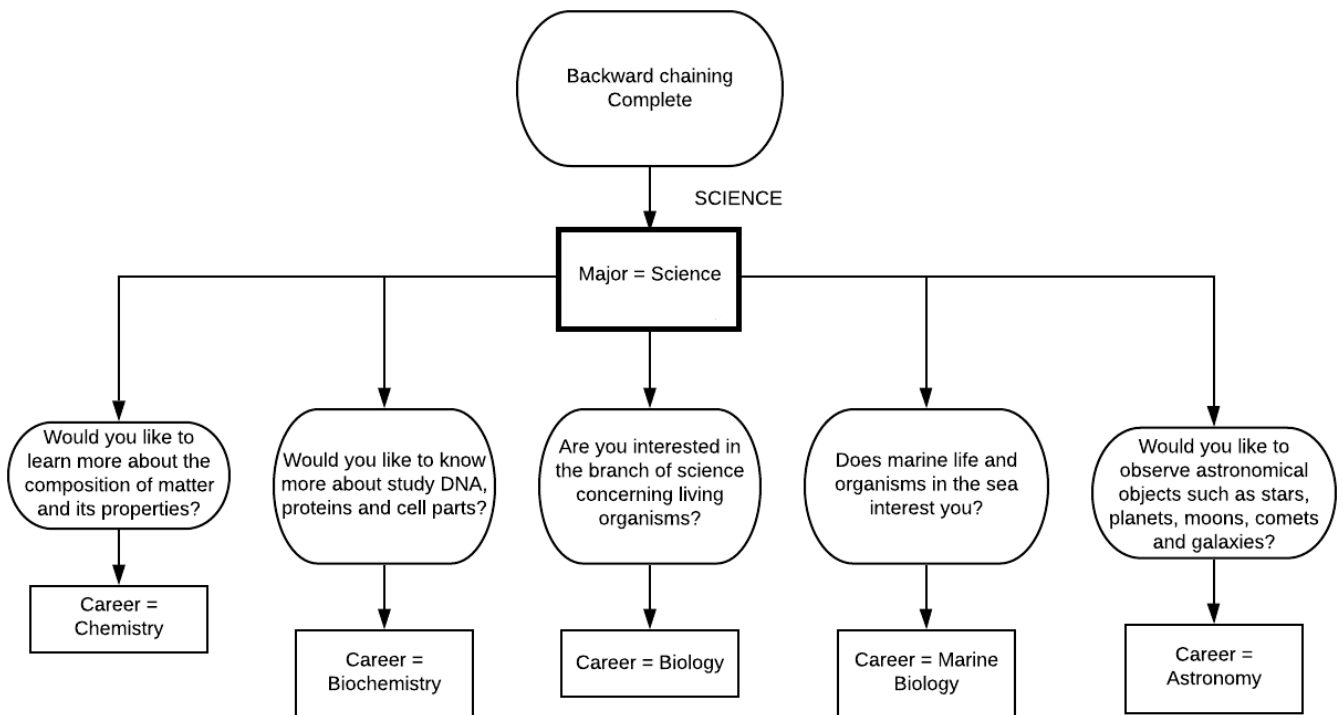
The tree will be cut into pieces for neatness

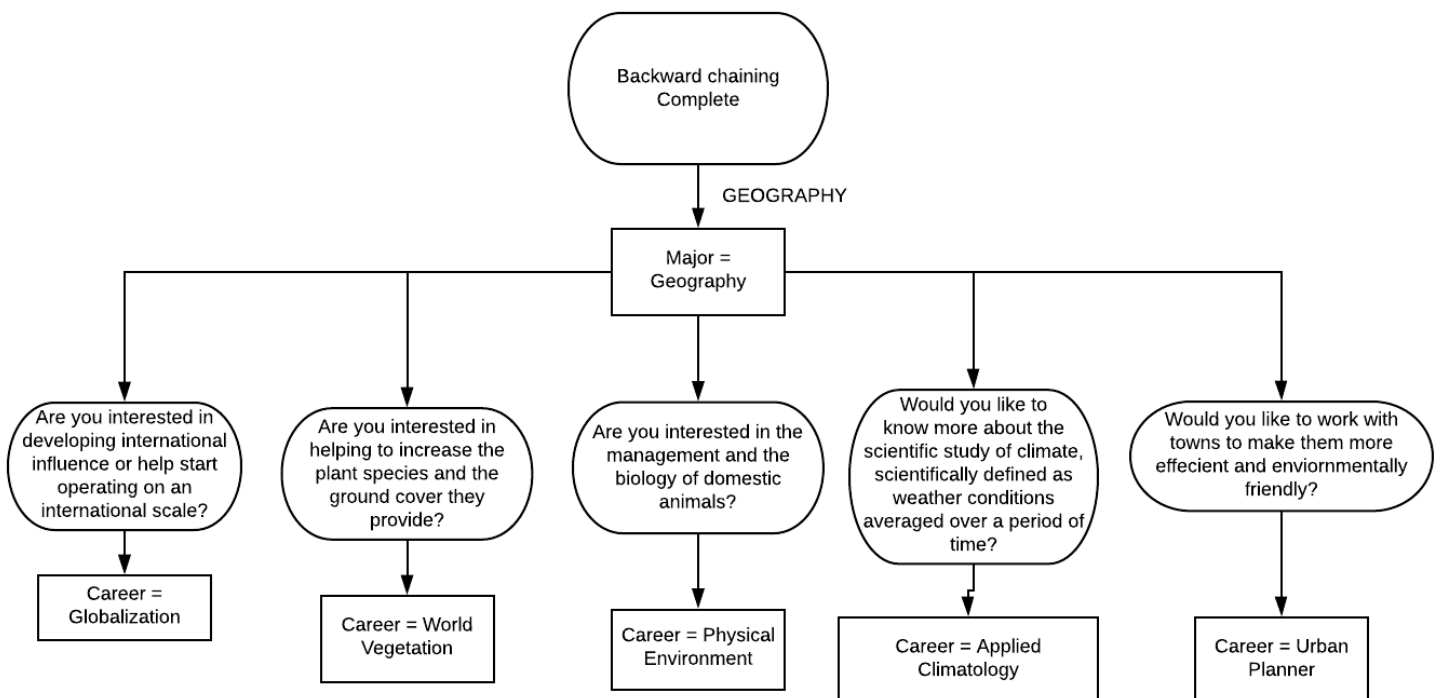
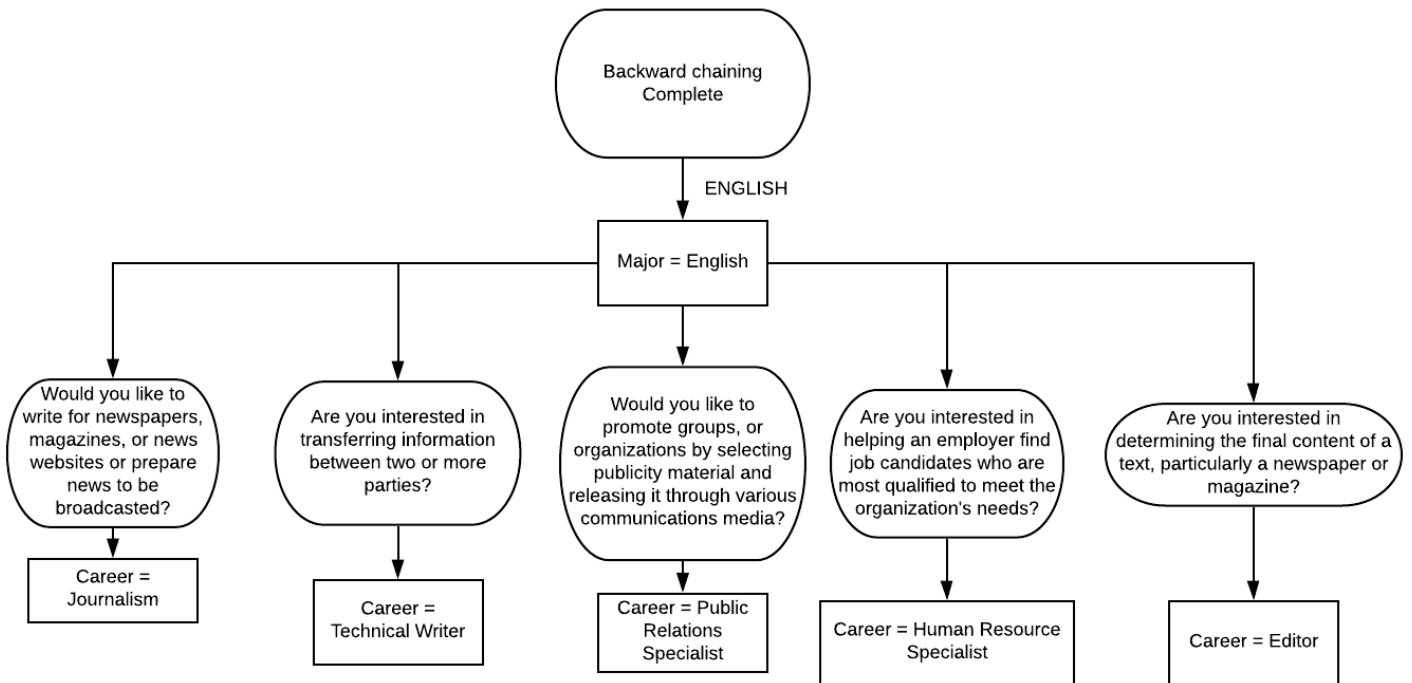


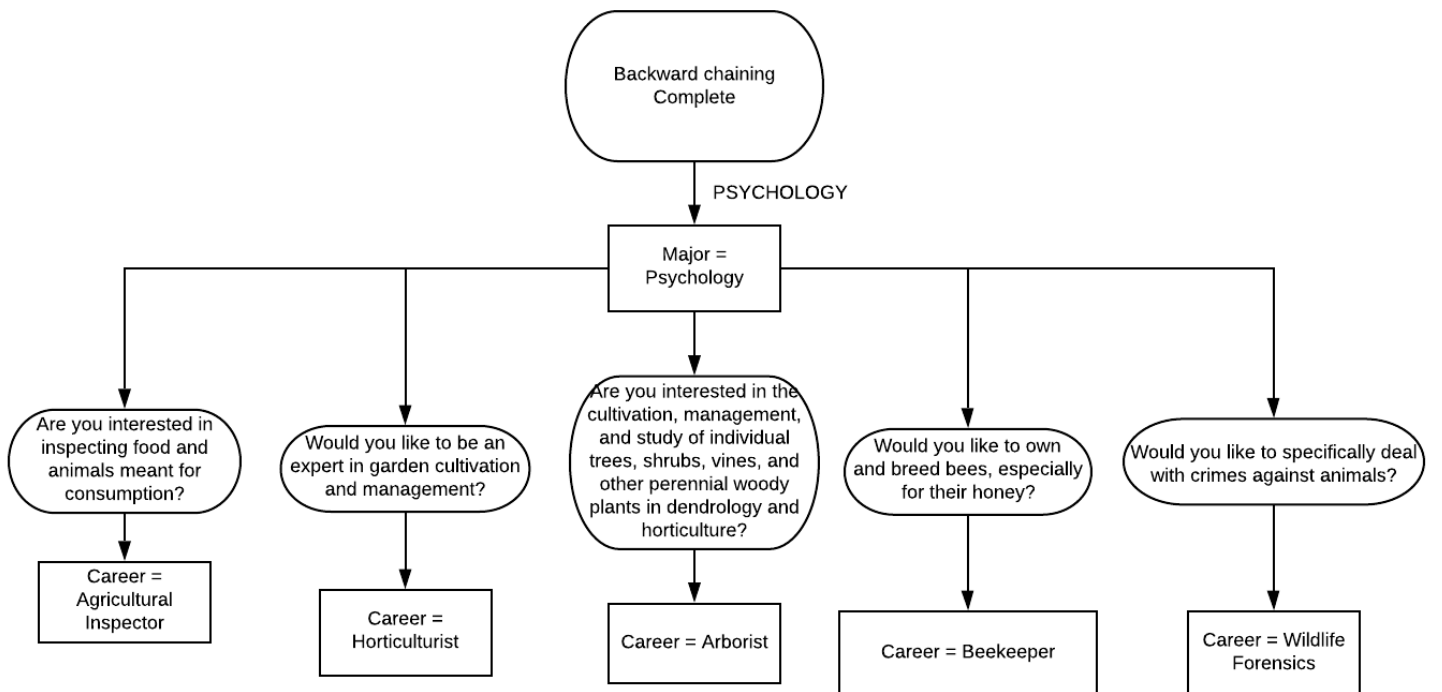
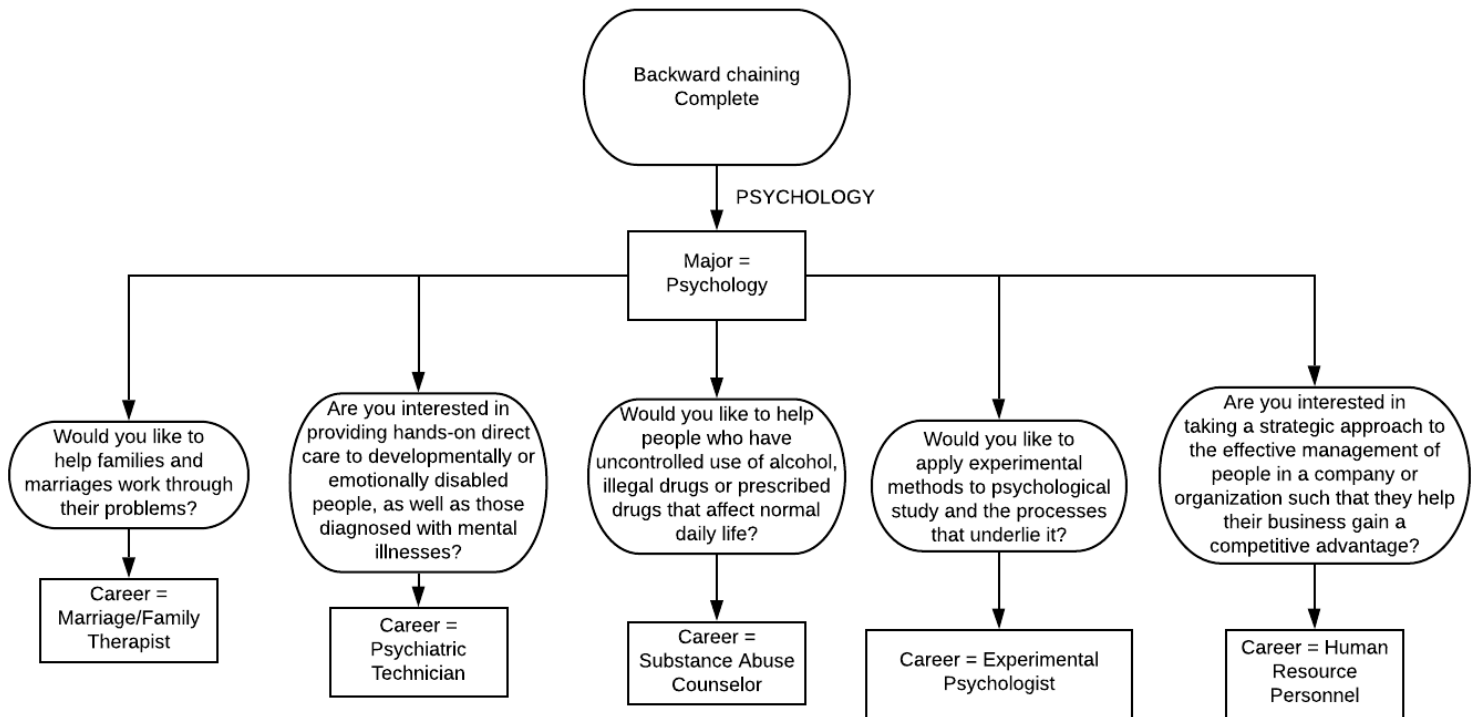
FORWARD CHAINING DECISION TREE

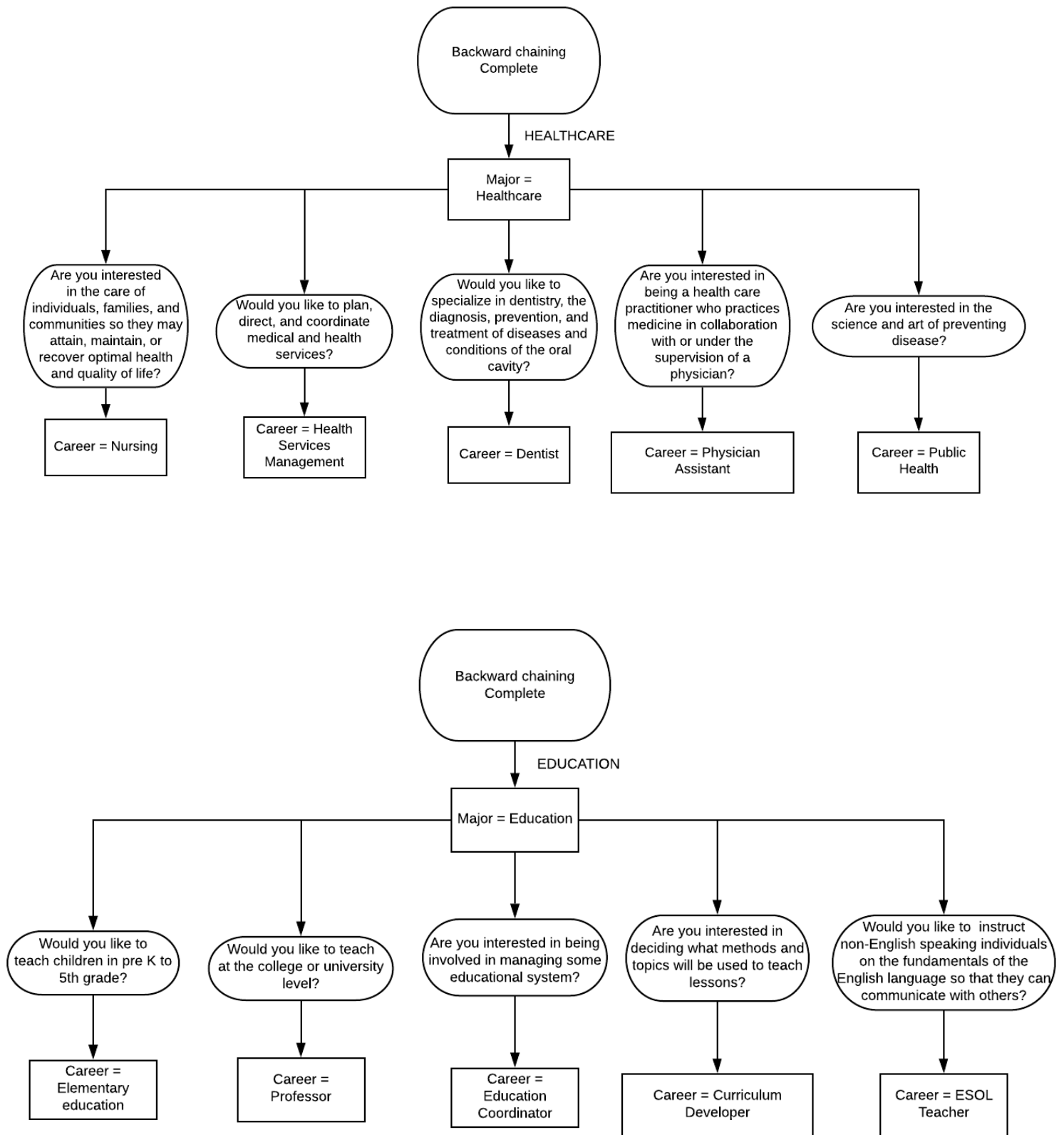
The tree will be cut into pieces for neatness











RULES

Backward Chaining:

1. If "Do you like to plan/organize/manage things?" == YES
Then MAJOR = BUSINESS
2. If "Do you like to plan/organize/manage things?" == NO && "Do you like to help people?" == YES
Then Helper = YES
3. If Helper == YES && "Do you enjoy teaching?" == YES
Then MAJOR = EDUCATION
4. If Helper == YES && "Are you interested in the inner workings of the mind?" == YES
Then MAJOR = PSYCHOLOGY
5. If Helper = YES && "Do you want to improve people's lives?" == YES
Then MAJOR = HEALTHCARE
6. If "Do you like to plan/organize/manage things?" == NO && "Do you like nature?" == YES
Then Naturalist = YES
7. If Naturalist == YES && "Does raising plants/animals interest you?" == YES
Then MAJOR = AGRICULTURE
8. If Naturalist == YES && "Would you like to further your understanding of Earth's physical features?" == YES
Then MAJOR = GEOGRAPHY
9. If "Do you like to plan/organize/manage things?" == YES && "Are you good at math?" == YES
Then STEM = YES
10. If STEM == YES && "Would you like to build things?" == YES
Then MAJOR = ENGINEERING
11. If STEM == YES && "Are you interested in how the world works?" == YES
Then MAJOR = SCIENCE
12. If "Do you like to plan/organize/manage things?" == YES && "Do you enjoy being creative?" == YES
Then Creative = YES
13. If Creative == YES && "Do you like to read/write?" == YES
Then MAJOR = ENGLISH
14. If Creative == YES && "Do you appreciate art?" == YES
Then MAJOR = ART

RULES

FORWARD CHAINING:

1. If MAJOR == ENGINEERING && "Would you like to design and develop electrical equipment?" == YES
Then Career = Electrical Engineering
2. If MAJOR == ENGINEERING && "Would you like to design, analyze, manufacture, and maintain mechanical systems?" == YES
Then Career = Mechanical Engineering
3. If MAJOR == ENGINEERING && "Would you like to design, construct, and maintain the physical and naturally built environment?" == YES
Then Career = Civil Engineering
4. If MAJOR == ENGINEERING && "Would you like to design and develop methods for extracting oil and gas from deposits below the Earth's surface?" == YES
Then Career = Petroleum Engineering
5. If MAJOR == ENGINEERING && "Are you interested in efficiently using, producing, designing, transporting and transforming energy and materials?" == YES
Then Career = Chemical Engineering
6. If MAJOR == SCIENCE && "Would you like to learn more about the composition of matter and its properties?" == YES
Then Career = Chemistry
7. If MAJOR == SCIENCE && "Would you like to know more about study DNA, proteins and cell parts?" == YES
Then Career = Biochemistry
8. If MAJOR == SCIENCE && "Are you interested in the branch of science concerning living organisms?" == YES
Then Career = Biology
9. If MAJOR == SCIENCE && "Does marine life and organisms in the sea interest you?" == YES
Then Career = Marine Biology
10. If MAJOR == SCIENCE && "Would you like to observe astronomical objects such as stars, planets, moons, comets and galaxies?" == YES
Then Career = Astronomy
11. If MAJOR == BUSINESS && "Are you interested in the study and management of exchange relationships?" == YES
Then Career = Marketing

12. If MAJOR == BUSINESS && “Would you like to know more about the study of money and how it is used?” == YES

Then Career = Finance

13. If MAJOR == BUSINESS && “Are you interested in recognizing and developing opportunities?” == YES

Then Career = Entrepreneurial Studies

14. If MAJOR == BUSINESS && “Would you like to oversee and supervise business operations?” == YES

Then Career = Business Administration/Management

15. If MAJOR == BUSINESS && “Are you interested in the quantitative methods to analyze business enterprises and the factors contributing to the diversity of organizational structures and the relationships of firms with labour, capital and product markets?” == YES

Then Career = Business Economics

16. If MAJOR == ART && “Do photographs interest you?” == YES

Then Career = Photography

17. If MAJOR == ART && “Are you interested in using aesthetic and rhythmic qualities of language—such as phonesthetics, sound symbolism, and meter—to evoke meanings in addition to, or in place of, the prosaic ostensible meaning?” == YES

Then Career = Poetry

18. If MAJOR == ART && “Are you interested in capturing live moments through film?” == YES

Then Career = Film

19. If MAJOR == ART && “Do you like to express yourself through dance?” == YES

Then Career = Dance

20. If MAJOR == ART && “Do you like to entertain the masses by acting?” == YES

Then Career = Drama

21. If MAJOR == ENGLISH && “Would you like to write for newspapers, magazines, or news websites or prepare news to be broadcasted?” == YES

Then Career = Journalism

22. If MAJOR == ENGLISH && “Are you interested in transferring information between two or more parties?” == YES

Then Career = Technical Writer

23. If MAJOR == ENGLISH && “Would you like to promote groups, or organizations by selecting publicity material and releasing it through various communications media?” == YES

Then Career = Public Relations Specialist

24. If MAJOR == ENGLISH && "Are you interested in helping an employer find job candidates who are most qualified to meet the organization's needs?" == YES

Then Career = Human Resource Specialist

25. If MAJOR == ENGLISH && "Are you interested in determining the final content of a text, particularly a newspaper or magazine?" == YES

Then Career = Editor

26. If MAJOR == GEOGRAPHY && "Are you interested in developing international influence or help start operating on an international scale?" == YES

Then Career = Globalization

27. If MAJOR == GEOGRAPHY && "Are you interested in helping to increase the plant species and the ground cover they provide?" == YES

Then Career = World Vegetation

28. If MAJOR == GEOGRAPHY && "Are you interested in the management and the biology of domestic animals?" == YES

Then Career = Physical Environment

29. If MAJOR == GEOGRAPHY && "Would you like to know more about the scientific study of climate, scientifically defined as weather conditions averaged over a period of time?" == YES

Then Career = Applied Climatology

30. If MAJOR == GEOGRAPHY && "Would you like to work with towns to make them more efficient and environmentally friendly?" == YES

Then Career = Urban Planner

31. If MAJOR == PSYCHOLOGY && "Would you like to help families and marriages work through their problems?" == YES

Then Career = Marriage/Family Therapist

32. If MAJOR == PSYCHOLOGY && "Are you interested in providing hands-on direct care to developmentally or emotionally disabled people, as well as those diagnosed with mental illnesses?" == YES

Then Career = Psychiatric Technician

33. If MAJOR == PSYCHOLOGY && "Would you like to help people who have uncontrolled use of alcohol, illegal drugs or prescribed drugs that affect normal daily life?" == YES

Then Career = Substance Abuse Counselor

34. If MAJOR == PSYCHOLOGY && "Would you like to apply experimental methods to psychological study and the processes that underlie it?" == YES

Then Career = Experimental Psychologist

35. If MAJOR == PSYCHOLOGY && "Are you interested in taking a strategic approach to the effective management of people in a company or organization such that they help their business gain a competitive advantage?" == YES

Then Career = Human Resource Personnel

36. If MAJOR == AGRICULTURE && "Are you interested in inspecting food and animals meant for consumption?" == YES

Then Career = Agricultural Inspector

37. If MAJOR == AGRICULTURE && "Would you like to be an expert in garden cultivation and management?" == YES

Then Career = Horticulturist

38. If MAJOR == AGRICULTURE && "Are you interested in the cultivation, management, and study of individual trees, shrubs, vines, and other perennial woody plants in dendrology and horticulture?" == YES

Then Career = Arborist

39. If MAJOR == AGRICULTURE && "Would you like to own and breed bees, especially for their honey?" == YES

Then Career = Beekeeper

40. If MAJOR == AGRICULTURE && "Would you like to specifically deal with crimes against animals?" == YES

Then Career = Wildlife Forensics

41. If MAJOR == HEALTHCARE && "Are you interested in the care of individuals, families, and communities so they may attain, maintain, or recover optimal health and quality of life?" == YES

Then Career = Nursing

42. If MAJOR == HEALTHCARE && "Would you like to plan, direct, and coordinate medical and health services?" == YES

Then Career = Health Services Management

43. If MAJOR == HEALTHCARE && "Would you like to specialize in dentistry, the diagnosis, prevention, and treatment of diseases and conditions of the oral cavity?" == YES

Then Career = Dentist

44. If MAJOR == HEALTHCARE && "Are you interested in being a health care practitioner who practices medicine in collaboration with or under the supervision of a physician?" == YES

Then Career = Physician Assistant

45. If MAJOR == HEALTHCARE && "Are you interested in the science and art of preventing disease?" == YES

Then Career = Public Health

46. If MAJOR == EDUCATION && "Would you like to teach children in pre K to 5th grade?" == YES

Then Career = Elementary education

47. If MAJOR == EDUCATION && "Would you like to teach at the college or university level?" == YES

Then Career = Professor

48. If MAJOR == EDUCATION && "Are you interested in being involved in managing some educational system?" == YES

Then Career = Education Coordinator

49. If MAJOR == EDUCATION && "Are you interested in deciding what methods and topics will be used to teach lessons?" == YES

Then Career = Curriculum Developer

50. If MAJOR == EDUCATION && "Would you like to instruct non-English speaking individuals on the fundamentals of the English language so that they can communicate with others?" == YES

Then Career = ESOL Teacher

PROGRAM IMPLEMENTATION

For the expert system we decided to create a GUI that has a message box, and two buttons, each labeled “YES” and “NO” respectively. The GUI is run through cMain and cApp both classes created with the wxWidgets, a cross platform GUI library. The application runs in cApp. We created multiple classes for the program: A Clause variable list class, which stores two string vectors, one for the clause variables, and the other for its corresponding conditions needed for the rules. A variable list class, that stores a two hash map of two strings, each for a variable list and for a conclusion list. A knowledge base class that stores a hash map of an int and a string, with a getter function for easy access. A Conclusion list that stores a hash map for a string and integer queue, along with a get and pop function. A conclusion stack class that has a stack for the conclusion stack rule, conclusion stack variable, and conclusion stack clause, as well as getters and setters.


```
//cApp.h
#pragma once

#include "wx/wx.h"
#include "cMain.h"

class cApp : public wxApp
{
public:
    cApp();
    ~cApp();

private:
    cMain* m_frame1 = nullptr;
public:
    virtual bool OnInit();
};

#pragma once
```

```
//cApp.cpp
#include "cApp.h"
#include "Engine.h"

wxIMPLEMENT_APP(cApp);

cApp::cApp() {
}

cApp::~cApp() {
}

/*OnInit is the initialization of the GUI app, this is where everything beings.*/
bool cApp::OnInit() {
    //variable_list
    std::map<std::string, std::string> variable_list;
    variable_list.insert({ std::string("Do you like to plan/organize/manage
things?\n"), std::string("") });
    variable_list.insert({ std::string("Do you like to help?\n"), std::string("") });
    variable_list.insert({ std::string("Do you enjoy teaching?\n"), std::string("")
});
    variable_list.insert({ std::string("Are you interested in the inner workings of
the mind?\n"), std::string("") });
    variable_list.insert({ std::string("Do you want to improve peoples lives?\n"),
std::string("") });
    variable_list.insert({ std::string("Would you like to further your understanding
of the earth's physical features?\n"), std::string("") });
    variable_list.insert({ std::string("Does raising plants/animals interest you?\n"),
std::string("") });
    variable_list.insert({ std::string("Would you like to build things?\n"),
std::string("") });
    variable_list.insert({ std::string("Are you interested in how the world
works?\n"), std::string("") });
    variable_list.insert({ std::string("Do you like to read/write\n"), std::string("")
});
    variable_list.insert({ std::string("Do you appreciate art?\n"), std::string("")
});
    variable_list.insert({ std::string("Do you like nature?\n"), std::string("") });
    variable_list.insert({ std::string("Do you enjoy being creative?\n"),
std::string("") });
    variable_list.insert({ std::string("Are you good at math?\n"), std::string("") });

    //conclusion_list
    std::map<std::string, std::string> conclusion_list;
    conclusion_list.insert({ std::string("MAJOR"), std::string("") });
    conclusion_list.insert({ std::string("NATURIST"), std::string("") });
    conclusion_list.insert({ std::string("HELPER"), std::string("") });
    conclusion_list.insert({ std::string("STEM"), std::string("") });
    conclusion_list.insert({ std::string("CREATOR"), std::string("") });

    //knowledge_base
    std::map<int, std::string> knowledge_base;
    knowledge_base.insert({ 10, std::string("BUSINESS") });
    knowledge_base.insert({ 20, std::string("YES") });
}
```

```
knowledge_base.insert({ 30, std::string("EDUCATION") });
knowledge_base.insert({ 40, std::string("PSYCHOLOGY") });
knowledge_base.insert({ 50, std::string("HEALTHCARE") });
knowledge_base.insert({ 60, std::string("YES") });
knowledge_base.insert({ 70, std::string("AGRICULTURE") });
knowledge_base.insert({ 80, std::string("GEOGRAPHY") });
knowledge_base.insert({ 90, std::string("YES") });
knowledge_base.insert({ 100, std::string("ENGINEERING") });
knowledge_base.insert({ 110, std::string("SCIENCE") });
knowledge_base.insert({ 120, std::string("YES") });
knowledge_base.insert({ 130, std::string("ENGLISH") });
knowledge_base.insert({ 140, std::string("ART") });

//major_queue
std::queue<int> major_queue;
major_queue.push(10);
major_queue.push(30);
major_queue.push(40);
major_queue.push(50);
major_queue.push(70);
major_queue.push(80);
major_queue.push(100);
major_queue.push(110);
major_queue.push(130);
major_queue.push(140);

std::queue<int> naturist_queue;
naturist_queue.push(60);

std::queue<int> helper_queue;
helper_queue.push(20);

std::queue<int> stem_queue;
stem_queue.push(90);

std::queue<int> creator_queue;
creator_queue.push(120);

//conclusion list
std::map<std::string, std::queue<int> > con_ls;
con_ls.insert({ std::string("MAJOR"),major_queue });
con_ls.insert({ std::string("NATURIST"),naturist_queue });
con_ls.insert({ std::string("HELPER"),helper_queue });
con_ls.insert({ std::string("STEM"),stem_queue });
con_ls.insert({ std::string("CREATOR"),creator_queue });

//clause_variable_list
std::vector<std::string> clause_variable_list;
for (int i = 0; i < 196; i++) {
    clause_variable_list.push_back(std::string(""));
}
clause_variable_list[0] = "Do you like to plan/organize/manage things?\n";
clause_variable_list[14] = "Do you like to plan/organize/manage things?\n";
clause_variable_list[15] = "Do you like to help?\n";
clause_variable_list[28] = "HELPER";
clause_variable_list[29] = "Do you enjoy teaching?\n";
clause_variable_list[42] = "HELPER";
```

```

        clause_variable_list[43] = "Are you interested in the inner workings of the
mind?\n";
        clause_variable_list[56] = "HELPER";
        clause_variable_list[57] = "Do you want to improve peoples lives?\n";
        clause_variable_list[70] = "Do you like to plan/organize/manage things?\n";
        clause_variable_list[71] = "Do you like nature?\n";
        clause_variable_list[84] = "NATURIST";
        clause_variable_list[85] = "Does raising plants/animals interest you?\n";
        clause_variable_list[98] = "NATURIST";
        clause_variable_list[99] = "Would you like to further your understanding of the
earth's physical features?\n";
        clause_variable_list[112] = "Do you like to plan/organize/manage things?\n";
        clause_variable_list[113] = "Are you good at math?\n";
        clause_variable_list[126] = "STEM";
        clause_variable_list[127] = "Would you like to build things?\n";
        clause_variable_list[140] = "STEM";
        clause_variable_list[141] = "Are you interested in how the world works?\n";
        clause_variable_list[154] = "Do you like to plan/organize/manage things?\n";
        clause_variable_list[155] = "Do you enjoy being creative?\n";
        clause_variable_list[168] = "CREATOR";
        clause_variable_list[169] = "Do you like to read/write\n";
        clause_variable_list[182] = "CREATOR";
        clause_variable_list[183] = "Do you appreciate art?\n";

//clause_conditions_list
std::vector<std::string> clause_conditions_list;
for (int i = 0; i < 196; i++) {
    clause_conditions_list.push_back(std::string(""));
}
clause_conditions_list[0] = "YES";
clause_conditions_list[14] = "NO";
clause_conditions_list[15] = "YES";
clause_conditions_list[28] = "YES";
clause_conditions_list[29] = "YES";
clause_conditions_list[42] = "YES";
clause_conditions_list[43] = "YES";
clause_conditions_list[56] = "YES";
clause_conditions_list[57] = "YES";
clause_conditions_list[70] = "NO";
clause_conditions_list[71] = "YES";
clause_conditions_list[84] = "YES";
clause_conditions_list[85] = "YES";
clause_conditions_list[98] = "YES";
clause_conditions_list[99] = "YES";
clause_conditions_list[112] = "NO";
clause_conditions_list[113] = "YES";
clause_conditions_list[126] = "YES";
clause_conditions_list[127] = "YES";
clause_conditions_list[140] = "YES";
clause_conditions_list[141] = "YES";
clause_conditions_list[154] = "NO";
clause_conditions_list[155] = "YES";
clause_conditions_list[168] = "YES";
clause_conditions_list[169] = "YES";
clause_conditions_list[182] = "YES";
clause_conditions_list[183] = "YES";

//variable list for forward chaining

```

```
std::map<std::string, std::string> fvar_list;

fvar_list.insert({ std::string("Would you like to design and develop electrical
equipment? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to design, analyze, manufacture,
and maintain mechanical systems? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to design, construct, and maintain
the physical and naturally built environment? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to design and develop methods for
extracting oil and gas from deposits below the Earth's surface? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in efficiently using,
producing, designing, transporting and transforming energy and materials? \n"),
std::string("") });
fvar_list.insert({ std::string("Would you like to learn more about the composition
of matter and its properties? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the branch of science
concerning living organisms? \n"), std::string("") });
fvar_list.insert({ std::string("Does marine life and organisms in the sea interest
you? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to observe astronomical objects
such as stars, planets, moons, comets and galaxies? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the study and management of
exchange relationships? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to know more about the study of
money and how it is used? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in recognizing and developing
opportunities? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to oversee and supervise business
operations? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the quantitative methods to
analyze business enterprises and the factors contributing to the diversity of
organizational structures and the relationships of firms with labour, capital and product
markets? \n"), std::string("") });
fvar_list.insert({ std::string("Do photographs interest you? \n"), std::string("")
});
fvar_list.insert({ std::string("Are you interested in using aesthetic and rhythmic
qualities of language—such as phonaesthetics, sound symbolism, and metre—to evoke
meanings in addition to, or in place of, the prosaic ostensible meaning?\n"),
std::string("") });
fvar_list.insert({ std::string("Are you interested in capturing live moments
through film? \n"), std::string("") });
fvar_list.insert({ std::string("Do you like to express yourself through dance?
\n"), std::string("") });
fvar_list.insert({ std::string("Do you like to entertain the masses by acting?
\n"), std::string("") });
fvar_list.insert({ std::string("Would you like to write for newspapers, magazines,
or news websites or prepare news to be broadcasted? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in transferring information
between two or more parties? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to promote groups, or organizations
by selecting publicity material and releasing it through various communications
media?\n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in helping an employer find job
candidates who are most qualified to meet the organization's needs? \n"),
std::string("") });
fvar_list.insert({ std::string("Are you interested in determining the final
content of a text, particularly a newspaper or magazine?\n"), std::string("") });
```

```
fvar_list.insert({ std::string("Are you interested in developing international
influence or help start operating on an international scale? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in helping to increase the
plant species and the ground cover they provide? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the management and the
biology of domestic animals? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to know more about the scientific
study of climate, scientifically defined as weather conditions averaged over a period of
time? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to work with towns to make them
more effecient and environmentally friendly? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to help families and marriages work
through their problems? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in providing hands-on direct
care to developmentally or emotionally disabled people, as well as those diagnosed with
mental illnesses? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to help people who have
uncontrolled use of alcohol, illegal drugs or prescribed drugs that affect normal daily
life? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to apply experimental methods to
psychological study and the processes that underlie it? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in taking a strategic approach
to the effective management of people in a company or organization such that they help
their business gain a competitive advantage? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in inspecting food and animals
meant for consumption? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to be an expert in garden
cultivation and management? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the cultivation, management,
and study of individual trees, shrubs, vines, and other perennial woody plants in
dendrology and horticulture? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to own and breed bees, especially
for their honey? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to specifically deal with crimes
against animals? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the care of individuals,
families, and communities so they may attain, maintain, or recover optimal health and
quality of life?\n"), std::string("") });
fvar_list.insert({ std::string("Would you like to plan, direct, and coordinate
medical and health services? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to specialize in dentistry, the
diagnosis, prevention, and treatment of diseases and conditions of the oral cavity?
\n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in being a health care
practitioner who practices medicine in collaboration with or under the supervision of a
physician? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in the science and art of
preventing disease? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to teach children in pre K to 5th
grade? \n"), std::string("") });
fvar_list.insert({ std::string("Would you like to teach at the college or
university level? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in being involved in managing
some educational system? \n"), std::string("") });
fvar_list.insert({ std::string("Are you interested in deciding what methods and
topics will be used to teach lessons? \n"), std::string("") });
```

```
fvar_list.insert({ std::string("Would you like to instruct non-English speaking  
individuals on the fundamentals of the English language so that they can communicate with  
others? \n"), std::string("") });
```

```
Engine *vrooom = new Engine(variable_list, conclusion_list, knowledge_base,  
con_ls,  
    clause_variable_list, clause_conditions_list, fvar_list);
```

```
vrooom->backwarddone = false;  
vrooom->done = false;  
vrooom->startp("MAJOR");  
m_frame1 = new cMain(vrooom);  
m_frame1->Show();  
return true;  
}
```

```
//ClauseVariableList.h
#ifndef CLAUSEVARIABLELIST_H
#define CLAUSEVARIABLELIST_H
#include <vector>
#include<string>

class ClauseVariableList
{
public:
    ClauseVariableList(std::vector<std::string> clause_variable_list,
                      std::vector<std::string> clause_conditions_list);
    /** Default constructor */
    ClauseVariableList();
    /** Default destructor */
    virtual ~ClauseVariableList();

    std::string getVar(int clause_num);
    std::string getCondition(int clause_num);

private:
    std::vector<std::string> clause_variable_list;
    std::vector<std::string> clause_conditions_list;
};

#endif // CLAUSEVARIABLELIST_H
```



```
//ClauseVariableList.cpp
#include "ClauseVariableList.h"

ClauseVariableList::ClauseVariableList(std::vector<std::string> clause_variable_list,
std::vector<std::string> clause_conditions_list)
{
    this->clause_variable_list = clause_variable_list;
    this->clause_conditions_list = clause_conditions_list;
}

ClauseVariableList::ClauseVariableList()
{}

//Getters
std::string ClauseVariableList::getVar(int clause_num){
    return clause_variable_list.at(clause_num);
}

std::string ClauseVariableList::getCondition(int clause_num){
    return clause_conditions_list.at(clause_num);
}

ClauseVariableList::~ClauseVariableList()
{}

```

```
//cMain.h
#pragma once
#include "wx/wx.h"
#include "Engine.h"

class cMain : public wxFrame
{
public:
    cMain(Engine *egn);
    ~cMain();

public:
    wxButton* m_btn1 = nullptr;
    wxButton* m_btn2 = nullptr;
    wxTextCtrl* m_msg1 = nullptr;
    Engine* egn;
    //fEngine* feng;
    bool startq = false;
    std::string currentvar;
    bool finBackward = false;
    void OnYESClicked(wxCommandEvent& evt);
    void OnNOClicked(wxCommandEvent& evt);

    wxDECLARE_EVENT_TABLE();
};

#pragma once
```

```

//cMain.cpp
#include "cMain.h"

/*The event table associates the ID of items in the frame with functions
   i.e. 10001 is m_btn1, if m_btn1 is clicked it will initiate OnYESClicked*/
wxBEGIN_EVENT_TABLE(cMain, wxFrame)
EVT_BUTTON(10001, OnYESClicked)
EVT_BUTTON(10002, OnNOClicked)
wxEND_EVENT_TABLE()

/*creates a frame with 2 buttons, and a message box, and a pointer to an engine object*/
cMain::cMain(Engine *egn) : wxFrame(nullptr, wxID_ANY, "Career Advising", wxPoint(200,
10), wxSize(555, 465),
    wxDEFAULT_FRAME_STYLE & ~(wxRESIZE_BORDER | wxMAXIMIZE_BOX))
{
    m_btn1 = new wxButton(this, 10001, "YES", wxPoint(10, 315), wxSize(250, 100));
    m_btn2 = new wxButton(this, 10002, "NO", wxPoint(280, 315), wxSize(250, 100));
    m_msg1 = new wxTextCtrl(this, 10003, "Welcome, do you want to begin?\n",
wxPoint(15, 10), wxSize(510, 300),
    wxTE_READONLY | wxTE_MULTILINE, wxDefaultValidator, "");
    this->egn = egn;
}

/*Deletes the egn and shuts down cMain*/
cMain::~cMain() {
    delete egn;
}

/*OnYESClicked takes the event of the YES button being clicked and uses this to initiate
the
engine loop returning the next needed question. Returns YES for that variable
property(question), and also outputs
the next question needed to be answered. Once the backward chaining is completed, it
will switch to a different
variable list for forward chaining*/
void cMain::OnYESClicked(wxCommandEvent& evt) {
    *m_msg1 << "YES\n";
    if (this->startq == false) {
        this->currentvar = this->egn->loop();
        *m_msg1 << this->currentvar;
        this->startq = true;
    }
    else {
        if (!egn->backwarddone) {
            egn->var_list.setVarProperty(this->currentvar, "YES");
        }
        else
            egn->fvar_list.setVarProperty(this->currentvar, "YES");
        this->currentvar = this->egn->loop();
        *m_msg1 << this->currentvar;
        this->startq = true;
    }
    evt.Skip();
}

```

```
/*OnNOClicked takes the event of the NO button being clicked and returns NO for that
variable property(question),
while also outputting the next question needed. Once the backward chaining is
completed, it will switch to a
different variable list for forward chaining*/
void cMain::OnNOClicked(wxCommandEvent& evt) {
    *m_msg1 << "NO\n";
    if (this->startq == false) {
        wxFrame::Close(true);
    }
    else {
        if (!egn->backwarddone) {
            egn->var_list.setVarProperty(this->currentvar, "NO");
        }
        else
            egn->fvar_list.setVarProperty(this->currentvar, "NO");
        this->currentvar = this->egn->loop();
        *m_msg1 << this->currentvar;
        this->startq = true;
    }
    evt.Skip();
}
```

```
#ifndef CONCLUSIONLIST_H
```

```
//ConclusionList.h
#define CONCLUSIONLIST_H
#include <map>
#include<queue>
#include<string>
class ConclusionList
{
public:
    ConclusionList(std::map<std::string, std::queue<int> > con_ls);
    /** Default constructor */
    ConclusionList();
    /** Default destructor */
    virtual ~ConclusionList();

    /**Setters*/

    /**Getters*/
    int getRuleNumber(std::string conclusion_var);

    /**POP?*/
    void popRuleNumber(std::string conclusion_var);

private:
    std::map<std::string, std::queue<int> > con_ls;
};

#endif // CONCLUSIONLIST_H
```

```
//ConclusionList.cpp
#include "ConclusionList.h"

ConclusionList::ConclusionList(std::map<std::string, std::queue<int> > con_ls)
{this->con_ls = con_ls;}
/**Default Constructor*/
ConclusionList::ConclusionList()
{}

/**Getters*/
int ConclusionList::getRuleNumber(std::string conclusion_var){
    std::map<std::string, std::queue<int> >::iterator it = con_ls.find(conclusion_var);
    if (it != con_ls.end()){
        if(it->second.empty()){
            return -1;
        }
        else{
            int result=it->second.front();
            return result;
        }
    }
    else
        return -2;
}

/**POP?*/
void ConclusionList::popRuleNumber(std::string conclusion_var){
    std::map<std::string, std::queue<int> >::iterator it = con_ls.find(conclusion_var);
    if (it != con_ls.end()){
        it->second.pop();
    }
}

/**Default Destructor*/
ConclusionList::~~ConclusionList()
{}
```

```
//ConclusionStack.h
#ifndef CONCLUSIONSTACK_H
#define CONCLUSIONSTACK_H
#include <string>
#include <stack>
class ConclusionStack
{
public:
    ConclusionStack(std::string var);
    /** Default constructor */
    ConclusionStack();
    /** Default destructor */
    virtual ~ConclusionStack();

    /**Setters*/
    void setStackRule(int rule);
    void setStackVar(std::string var);
    void setStackClause(int clause);
    void setStackRVC(int rule, std::string var, int clause);

    /**Getters*/
    int getStackRule();
    std::string getStackVar();
    int getStackClause();
    int getCurrentStackNum();

    /**POP*/
    void popStackRule();
    void popStackVar();
    void popStackClause();

    /**Check if Stack is Empty of Variables or Conclusions*/
    bool VarStackEmpty();

private:
    std::stack<int> stack_rule;//conclusion stack rule
    std::stack<std::string>stack_var;//conclusion stack variable or conclusion
    std::stack<int> stack_clause; //conclusion stack clause
};

#endif // CONCLUSIONSTACK_H
```

```
//ConclusionStack.cpp
#include "ConclusionStack.h"
#include "VariableList.h"

ConclusionStack::ConclusionStack(std::string var){setStackVar(var);}
/**Default Constructor*/
ConclusionStack::ConclusionStack()
{}
/**Setters*/
void ConclusionStack:: setStackRule(int rule){stack_rule.push(rule);}

void ConclusionStack:: setStackVar(std::string var){stack_var.push(var);}

void ConclusionStack:: setStackClause(int clause){stack_clause.push(clause);}

void ConclusionStack:: setStackRVC(int rule, std::string var, int clause){
    stack_rule.push(rule);
    stack_var.push(var);
    stack_clause.push(clause);
}

/**Getters*/
int ConclusionStack:: getStackRule(){
    return stack_rule.top();
}
/**/
std::string ConclusionStack:: getStackVar(){
    return stack_var.top();
}
/**/
int ConclusionStack:: getStackClause(){
    return stack_clause.top();
}

/**POP?*/
void ConclusionStack:: popStackRule(){
    stack_rule.pop();
}
void ConclusionStack:: popStackVar(){
    stack_var.pop();
}
void ConclusionStack:: popStackClause(){
    stack_clause.pop();
}

/** Check if Stack Empty */
bool ConclusionStack::VarStackEmpty(){
    return stack_var.empty();
}

ConclusionStack::~ConclusionStack()
{
    //dtor
}
```



```

//Engine.h
#ifndef ENGINE_H
#define ENGINE_H
#include "VariableList.h"
#include "ConclusionList.h"
#include "ClauseVariableList.h"
#include "ConclusionStack.h"
#include "KnowledgeBase.h"
#include <string>
using namespace std;
class Engine
{
public:
    Engine(
        std::map<std::string, std::string> variable_list= std::map<std::string,
std::string>(),
        std::map<std::string, std::string> conclusion_list = std::map<std::string,
std::string>(),
        std::map<int, std::string> knowledge_base = std::map<int, std::string>(),
        std::map<std::string, std::queue<int> > con_ls = std::map<std::string,
std::queue<int> >(),
        std::vector<std::string> clause_variable_list = std::vector<std::string>(),
        std::vector<std::string> clause_conditions_list= std::vector<std::string>(),
        std::map<std::string, std::string> fvar_list = std::map<std::string,
std::string>());

        std::string conclusion;
        std::string results;
        std::string current_var;
        std::string loop();
        void updateconclusionStack(std::string con_var);
        VariableList var_list;
        ConclusionList con_list;
        ClauseVariableList clause_var_list;
        ConclusionStack conclusion_stack;
        KnowledgeBase knowlg_base;
        void startp(std::string conclusion);

        bool backwarddone; // flag for backwardchaining completion
        bool done; // flag for forward chaining questioning
        VariableList fvar_list; //Forward chaining Questions and Variable property
        std::string Major; // set to backward chaining result
        int s; // iterators
        int statementNumber; /* statement number */

        std::string var;
        string setQuestions(string& Major, VariableList a);
        queue<string> condiVariableQueue;
        string run(VariableList fvar_list);

};
#endif // ENGINE_H

```

```

//Engine.cpp
#include "Engine.h"

/*Initializes the engine with the appropriate information*/
Engine::Engine(std::map<std::string, std::string> variable_list,
    std::map<std::string, std::string> conclusion_list,
    std::map<int, std::string> knowledge_base,
    std::map<std::string, std::queue<int> > con_ls,
    std::vector<std::string> clause_variable_list,
    std::vector<std::string> clause_conditions_list,
    std::map<std::string, std::string> fvar_list)
{
    this->var_list = VariableList(variable_list, conclusion_list);
    this->knowlg_base = KnowledgeBase(knowledge_base);
    this->con_list = ConclusionList(con_ls);
    this->clause_var_list = ClauseVariableList(clause_variable_list,
clause_conditions_list);
    this->fvar_list = VariableList(fvar_list, conclusion_list);
}

/*Adds string to conclusion stack*/
void Engine::startp(std::string conclusion) {
    conclusion_stack = ConclusionStack(conclusion);
}

/*loop is where the entire program takes place, it will loop through forward
and backward chaining here incrementally based on GUI events*/
std::string Engine::loop() {

    while (!conclusion_stack.VarStackEmpty()) {
        std::string current_con = conclusion_stack.getStackVar();
        updateconclusionStack(current_con);
        std::string property = "";
        int current_cls = conclusion_stack.getStackClause() - 2;

        bool fullfilled = true;
        if (current_cls < -1) {
            conclusion_stack.popStackVar();
            std::string result = "UNDEFINED";
            var_list.updateCon(current_con, result);
            fullfilled = false;
        }

        int i = 0;
        while (i < var_list.var_size && fullfilled) {
            current_cls++;
            std::string clause_var = clause_var_list.getVar(current_cls);
            if (clause_var == "")
                break;
            else {
                if (var_list.searchConVar(clause_var) == "VAR") {
                    bool var_define = var_list.isVarSet(clause_var);
                    if (!var_define) {
                        this->current_var = clause_var;
                        return clause_var;
                    }
                }
                property = var_list.getVarProperty(clause_var);
                if (property != clause_var_list.getCondition(current_cls)) {

```

```

        fullfilled = false;
        conclusion_stack.popStackRule();
        conclusion_stack.popStackClause();
        con_list.popRuleNumber(current_con);
    }
}
else {
    property = var_list.getConProperty(clause_var);
    if (property == "") {
        conclusion_stack.setStackVar(clause_var);
        fullfilled = false;
    }
    else {
        if (property != clause_var_list.getCondition(current_cls)) {
            conclusion_stack.popStackRule();
            conclusion_stack.popStackClause();
            fullfilled = false;
            con_list.popRuleNumber(current_con);
        }
    }
}
}
i++;
}

if (fullfilled) {
    con_list.popRuleNumber(current_con);
    int rule_nmb = conclusion_stack.getStackRule();

    conclusion_stack.popStackClause();
    conclusion_stack.popStackRule();
    conclusion_stack.popStackVar();
    std::string result = knowlg_base.getResult(rule_nmb);
    var_list.updateCon(current_con, result);
    this->conclusion = current_con;
    this->results = result;
}
}
if (backwarddone) {
    return run(fvar_list);
}
Major = this->results;
backwarddone = true;
if (this->results == "")
    return run(fvar_list);
return "Major: " + this->results + "\nPress YES/NO to continue\n";
}

/*updateconclusionStack updates the conclusion stack with a new conclusion variable
con_var*/
void Engine:: updateconclusionStack(std::string con_var) {
    int rule_num = con_list.getRuleNumber(con_var);
    int clause_number = var_list.var_size * (rule_num / 10 - 1) + 1;

    conclusion_stack.setStackClause(clause_number);
    conclusion_stack.setStackRule(rule_num);
}

```

```
/*Runs the forward chaining part of the code*/
string Engine::run(VariableList fvar_list) {
    /*Prompts the user for input on the property of the variable(questions)
    Will continue to loop until a YES is reached, or will continue until All NOs are
    reached where it will output RESTART PROGRAM*/
    if (fvar_list.getVarProperty(var) == "NO") {
        done = false;
    }
    if (!done)
        return setQuestions(Major, fvar_list);

    /*Runs through the if part of the if then statements*/
    if ((Major == "ENGINEERING") &&
        (fvar_list.getVarProperty("Would you like to design and develop electrical
equipment? \n") == "YES")) {
        s = 1; statementNumber = 1;
    }
    if ((Major == "ENGINEERING") &&
        (fvar_list.getVarProperty("Would you like to design, analyze, manufacture,
and maintain mechanical systems? \n") == "YES")) {
        s = 1; statementNumber = 2;
    }
    if ((Major == "ENGINEERING") &&
        (fvar_list.getVarProperty("Would you like to design, construct, and maintain
the physical and naturally built environment? \n") == "YES")) {
        s = 1; statementNumber = 3;
    }
    if ((Major == "ENGINEERING") &&
        (fvar_list.getVarProperty("Would you like to design and develop methods for
extracting oil and gas from deposits below the Earth's surface? \n") == "YES")) {
        s = 1; statementNumber = 4;
    }
    if ((Major == "ENGINEERING") &&
        (fvar_list.getVarProperty("Are you interested in efficiently using,
producing, designing, transporting and transforming energy and materials? \n") == "YES"))
    {
        s = 1; statementNumber = 5;
    }
    if ((Major == "SCIENCE") &&
        (fvar_list.getVarProperty("Would you like to learn more about the composition
of matter and its properties? \n") == "YES")) {
        s = 1; statementNumber = 2;
    }
    if ((Major == "SCIENCE") &&
        (fvar_list.getVarProperty("Would you like to know more about study DNA,
proteins and cell parts? \n") == "YES")) {
        s = 1; statementNumber = 2;
    }
    if ((Major == "SCIENCE") &&
        (fvar_list.getVarProperty("Are you interested in the branch of science
concerning living organisms? \n") == "YES")) {
        s = 1; statementNumber = 8;
    }
    if ((Major == "SCIENCE") &&
        (fvar_list.getVarProperty("Does marine life and organisms in the sea interest
you? \n") == "YES")) {
```

```
s = 1; statementNumber = 9;
}
if ((Major == "SCIENCE") &&
    (fvar_list.getVarProperty("Would you like to observe astronomical objects
such as stars, planets, moons, comets and galaxies? \n") == "YES")) {
    s = 1; statementNumber = 10;
}
if ((Major == "BUSINESS") &&
    (fvar_list.getVarProperty("Are you interested in the study and management of
exchange relationships? \n") == "YES")) {
    s = 1; statementNumber = 11;
}
if ((Major == "BUSINESS") &&
    (fvar_list.getVarProperty("Would you like to know more about the study of
money and how it is used? \n") == "YES")) {
    s = 1; statementNumber = 12;
}
if ((Major == "BUSINESS") &&
    (fvar_list.getVarProperty("Are you interested in recognizing and developing
opportunities? \n") == "YES")) {
    s = 1; statementNumber = 13;
}
if ((Major == "BUSINESS") &&
    (fvar_list.getVarProperty("Would you like to oversee and supervise business
operations? \n") == "YES")) {
    s = 1; statementNumber = 14;
}
if ((Major == "BUSINESS") &&
    (fvar_list.getVarProperty("Are you interested in the quantitative methods to
analyze business enterprises and the factors contributing to the diversity of
organizational structures and the relationships of firms with labour, capital and product
markets? \n") == "YES")) {
    s = 1; statementNumber = 15;
}
if ((Major == "ART") &&
    (fvar_list.getVarProperty("Do photographs interest you? \n") == "YES")) {
    s = 1; statementNumber = 16;
}
if ((Major == "ART") &&
    (fvar_list.getVarProperty("Are you interested in using aesthetic and rhythmic
qualities of language—such as phonaesthetics, sound symbolism, and metre—to evoke
meanings in addition to, or in place of, the prosaic ostensible meaning?\n") == "YES")) {
    s = 1; statementNumber = 17;
}
if ((Major == "ART") &&
    (fvar_list.getVarProperty("Are you interested in capturing live moments
through film? \n") == "YES")) {
    s = 1; statementNumber = 18;
}
if ((Major == "ART") &&
    (fvar_list.getVarProperty("Do you like to express yourself through dance?
\n") == "YES")) {
    s = 1; statementNumber = 19;
}
if ((Major == "ART") &&
    (fvar_list.getVarProperty("Do you like to entertain the masses by acting?
\n") == "YES")) {
    s = 1; statementNumber = 20;
```

```
    }
    if ((Major == "ENGLISH") &&
        (fvar_list.getVarProperty("Would you like to write for newspapers, magazines,
or news websites or prepare news to be broadcasted? \n") == "YES")) {
        s = 1; statementNumber = 21;
    }
    if ((Major == "ENGLISH") &&
        (fvar_list.getVarProperty("Are you interested in transferring information
between two or more parties? \n") == "YES")) {
        s = 1; statementNumber = 22;
    }
    if ((Major == "ENGLISH") &&
        (fvar_list.getVarProperty("Would you like to promote groups, or organizations
by selecting publicity material and releasing it through various communications
media?\n") == "YES")) {
        s = 1; statementNumber = 23;
    }
    if ((Major == "ENGLISH") &&
        (fvar_list.getVarProperty("Are you interested in helping an employer find job
candidates who are most qualified to meet the organization's needs? \n") == "YES")) {
        s = 1; statementNumber = 24;
    }
    if ((Major == "ENGLISH") &&
        (fvar_list.getVarProperty("Are you interested in determining the final
content of a text, particularly a newspaper or magazine?\n") == "YES")) {
        s = 1; statementNumber = 25;
    }
    if ((Major == "GEOGRAPHY") &&
        (fvar_list.getVarProperty("Are you interested in developing international
influence or help start operating on an international scale? \n") == "YES")) {
        s = 1; statementNumber = 26;
    }
    if ((Major == "GEOGRAPHY") &&
        (fvar_list.getVarProperty("Are you interested in helping to increase the
plant species and the ground cover they provide? \n") == "YES")) {
        s = 1; statementNumber = 27;
    }
    if ((Major == "GEOGRAPHY") &&
        (fvar_list.getVarProperty("Are you interested in the management and the
biology of domestic animals? \n") == "YES")) {
        s = 1; statementNumber = 28;
    }
    if ((Major == "GEOGRAPHY") &&
        (fvar_list.getVarProperty("Would you like to know more about the scientific
study of climate, scientifically defined as weather conditions averaged over a period of
time? \n") == "YES")) {
        s = 1; statementNumber = 29;
    }
    if ((Major == "GEOGRAPHY") &&
        (fvar_list.getVarProperty("Would you like to work with towns to make them
more effecient and environmentally friendly? \n") == "YES")) {
        s = 1; statementNumber = 30;
    }
    if ((Major == "PSYCHOLOGY") &&
        (fvar_list.getVarProperty("Would you like to help families and marriages work
through their problems? \n") == "YES")) {
        s = 1; statementNumber = 31;
```

```
    }
    if ((Major == "PSYCHOLOGY") &&
        (fvar_list.getVarProperty("Are you interested in providing hands-on direct
care to developmentally or emotionally disabled people, as well as those diagnosed with
mental illnesses? \n") == "YES")) {
        s = 1; statementNumber = 32;
    }
    if ((Major == "PSYCHOLOGY") &&
        (fvar_list.getVarProperty("Would you like to help people who have
uncontrolled use of alcohol, illegal drugs or prescribed drugs that affect normal daily
life? \n") == "YES")) {
        s = 1; statementNumber = 33;
    }
    if ((Major == "PSYCHOLOGY") &&
        (fvar_list.getVarProperty("Would you like to apply experimental methods to
psychological study and the processes that underlie it? \n") == "YES")) {
        s = 1; statementNumber = 34;
    }
    if ((Major == "PSYCHOLOGY") &&
        (fvar_list.getVarProperty("Are you interested in taking a strategic approach
to the effective management of people in a company or organization such that they help
their business gain a competitive advantage? \n") == "YES")) {
        s = 1; statementNumber = 35;
    }
    if ((Major == "AGRICULTURE") &&
        (fvar_list.getVarProperty("Are you interested in inspecting food and animals
meant for consumption? \n") == "YES")) {
        s = 1; statementNumber = 36;
    }
    if ((Major == "AGRICULTURE") &&
        (fvar_list.getVarProperty("Would you like to be an expert in garden
cultivation and management? \n") == "YES")) {
        s = 1; statementNumber = 37;
    }
    if ((Major == "AGRICULTURE") &&
        (fvar_list.getVarProperty("Are you interested in the cultivation, management,
and study of individual trees, shrubs, vines, and other perennial woody plants in
dendrology and horticulture? \n") == "YES")) {
        s = 1; statementNumber = 38;
    }
    if ((Major == "AGRICULTURE") &&
        (fvar_list.getVarProperty("Would you like to own and breed bees, especially
for their honey? \n") == "YES")) {
        s = 1; statementNumber = 39;
    }
    if ((Major == "AGRICULTURE") &&
        (fvar_list.getVarProperty("Would you like to specifically deal with crimes
against animals? \n") == "YES")) {
        s = 1; statementNumber = 40;
    }
    if ((Major == "HEALTHCARE") &&
        (fvar_list.getVarProperty("Are you interested in the care of individuals,
families, and communities so they may attain, maintain, or recover optimal health and
quality of life?\n") == "YES")) {
        s = 1; statementNumber = 41;
    }
    if ((Major == "HEALTHCARE") &&
```

```

        (fvar_list.getVarProperty("Would you like to plan, direct, and coordinate
medical and health services? \n") == "YES")) {
            s = 1; statementNumber = 42;
        }
        if ((Major == "HEALTHCARE") &&
            (fvar_list.getVarProperty("Would you like to specialize in dentistry, the
diagnosis, prevention, and treatment of diseases and conditions of the oral cavity? \n")
== "YES")) {
            s = 1; statementNumber = 43;
        }
        if ((Major == "HEALTHCARE") &&
            (fvar_list.getVarProperty("Are you interested in being a health care
practitioner who practices medicine in collaboration with or under the supervision of a
physician? \n") == "YES")) {
            s = 1; statementNumber = 44;
        }
        if ((Major == "HEALTHCARE") &&
            (fvar_list.getVarProperty("Are you interested in the science and art of
preventing disease? \n") == "YES")) {
            s = 1; statementNumber = 45;
        }
        if ((Major == "EDUCATION") &&
            (fvar_list.getVarProperty("Would you like to teach children in pre K to 5th
grade? \n") == "YES")) {
            s = 1; statementNumber = 46;
        }
        if ((Major == "EDUCATION") &&
            (fvar_list.getVarProperty("Would you like to teach at the college or
university level? \n") == "YES")) {
            s = 1; statementNumber = 47;
        }
        if ((Major == "EDUCATION") &&
            (fvar_list.getVarProperty("Are you interested in being involved in managing
some educational system? \n") == "YES")) {
            s = 1; statementNumber = 48;
        }
        if ((Major == "EDUCATION") &&
            (fvar_list.getVarProperty("Are you interested in deciding what methods and
topics will be used to teach lessons? \n") == "YES")) {
            s = 1; statementNumber = 49;
        }
        if ((Major == "EDUCATION") &&
            (fvar_list.getVarProperty("Would you like to instruct non-English speaking
individuals on the fundamentals of the English language so that they can communicate with
others? \n") == "YES")) {
            s = 1; statementNumber = 50;
        }
    }
    switch (statementNumber)
    {
        case 1:
            return "Career = Electrical Engineering\n";
            break;
        case 2:
            return "Career = Mechanical Engineering\n";
            break;
        case 3:

```



```
        return "Career = Civil Engineering\n";
        break;
    case 4:
        return "Career = Petroleum Engineering\n";
        break;
    case 5:
        return "Career = Chemical Engineering\n";
        break;

    case 6:
        return "Career = Chemistry\n";
        break;
    case 7:
        return "Career = Biochemistry\n";
        break;
    case 8:
        return "Career = Biology\n";
        break;
    case 9:
        return "Career = Marine Biology\n";
        break;
    case 10:
        return "Career = Astronomy\n";
        break;

    case 11:
        return "Career = Marketing\n";
        break;
    case 12:
        return "Career = Finance\n";
        break;
    case 13:
        return "Career = Entrepreneurial Studies\n";
        break;
    case 14:
        return "Career = Business Administration/Management\n";
        break;
    case 15:
        return "Career = Business Economics\n";
        break;

    case 16:
        return "Career = Photography\n";
        break;
    case 17:
        return "Career = Poetry\n";
        break;
    case 18:
        return "Career = Film\n";
        break;
    case 19:
        return "Career = Dance\n";
        break;
    case 20:
        return "Career = Drama\n";
```

```
        break;

    case 21:
        return "Career = Journalism\n";
        break;
    case 22:
        return "Career = Technical Writer\n";
        break;
    case 23:
        return "Career = Public Relations Specialist\n";
        break;
    case 24:
        return "Career = Human Resource Specialist\n";
        break;
    case 25:
        return "Career = Editor\n";
        break;

    case 26:
        return "Career = Globalization\n";
        break;
    case 27:
        return "Career = World Vegetation\n";
        break;
    case 28:
        return "Career = Physical Environment\n";
        break;
    case 29:
        return "Career = Applied Climatology\n";
        break;
    case 30:
        return "Career = Urban Planner\n";
        break;

    case 31:
        return "Career = Marriage/Family Therapist\n";
        break;
    case 32:
        return "Career = Psychiatric Technician\n";
        break;
    case 33:
        return "Career = Substance Abuse Counselor\n";
        break;
    case 34:
        return "Career = Experimental Psychologist\n";
        break;
    case 35:
        return "Career = Human Resource Personnel\n";
        break;

    case 36:
        return "Career = Agricultural Inspector\n";
        break;
    case 37:
```

```
        return "Career = Horticulturist\n";
        break;
    case 38:
        return "Career = Arborist\n";
        break;
    case 39:
        return "Career = Beekeeper\n";
        break;
    case 40:
        return "Career = Wildlife Forensics\n";
        break;

    case 41:
        return "Career = Nursing\n";
        break;
    case 42:
        return "Career = Health Services Management\n";
        break;
    case 43:
        return "Career = Dentist\n";
        break;
    case 44:
        return "Career = Physician Assistant\n";
        break;
    case 45:
        return "Career = Public Health\n";
        break;

    case 46:
        return "Career = Elementary education\n";
        break;
    case 47:
        return "Career = Professor\n";
        break;
    case 48:
        return "Career = Education Coordinator\n";
        break;
    case 49:
        return "Career = Curriculum Developer\n";
        break;
    case 50:
        return "Career = ESOL Teacher\n";
        break;
    }
    return "Whoops, looks like you picked the wrong major!\nPlease restart the program
and try again!";
}

/*setQuestions takes the major achieved through backward chaining and uses it to set the
fvar_list variable property to YES/NO by returning the question to the message box and
letting the
button press event set the variable property*/
```

```
string Engine::setQuestions(string& Major, VariableList fvar_list)
{
    if (Major == "ENGINEERING")
    {
        if (fvar_list.getVarProperty("Would you like to design and develop electrical
equipment? \n") == "")
        {
            done = true;
            var = "Would you like to design and develop electrical equipment? \n";
            return "Would you like to design and develop electrical equipment? \n";
        }

        if (fvar_list.getVarProperty("Would you like to design, analyze, manufacture,
and maintain mechanical systems? \n") == "")
        {
            done = true;
            var = "Would you like to design, analyze, manufacture, and maintain
mechanical systems? \n";
            return "Would you like to design, analyze, manufacture, and maintain
mechanical systems? \n";
        }

        if (fvar_list.getVarProperty("Would you like to design, construct, and
maintain the physical and naturally built environment? \n") == "")
        {
            done = true;
            var = "Would you like to design, construct, and maintain the physical and
naturally built environment? \n";
            return "Would you like to design, construct, and maintain the physical
and naturally built environment? \n";
        }

        if (fvar_list.getVarProperty("Would you like to design and develop methods
for extracting oil and gas from deposits below the Earth's surface? \n") == "")
        {
            done = true;
            var = "Would you like to design and develop methods for extracting oil
and gas from deposits below the Earth's surface? \n";
            return "Would you like to design and develop methods for extracting oil
and gas from deposits below the Earth's surface? \n";
        }

        if (fvar_list.getVarProperty("Are you interested in efficiently using,
producing, designing, transporting and transforming energy and materials? \n") == "")
        {
            done = true;
            var = "Are you interested in efficiently using, producing, designing,
transporting and transforming energy and materials? \n";
            return "Are you interested in efficiently using, producing, designing,
transporting and transforming energy and materials? \n";
        }

        return "UH-OH Doesn't seem like you chose the right profession! :(\\nPlease
restart the Application!\\n";
    }
    if (Major == "SCIENCE")
    {
```

```
        if (fvar_list.getVarProperty("Would you like to learn more about the
composition of matter and its properties? \n") == "")
        {
            done = true;
            var = "Would you like to learn more about the composition of matter and
its properties? \n";
            return "Would you like to learn more about the composition of matter and
its properties? \n";
        }

        if (fvar_list.getVarProperty("Would you like to know more about study DNA,
proteins and cell parts? \n") == "")
        {
            done = true;
            var = "Would you like to know more about study DNA, proteins and cell
parts? \n";
            return "Would you like to know more about study DNA, proteins and cell
parts? \n";
        }

        if (fvar_list.getVarProperty("Are you interested in the branch of science
concerning living organisms? \n") == "")
        {
            done = true;
            var = "Are you interested in the branch of science concerning living
organisms? \n";
            return "Are you interested in the branch of science concerning living
organisms? \n";
        }

        if (fvar_list.getVarProperty("Does marine life and organisms in the sea
interest you? \n") == "")
        {
            done = true;
            var = "Does marine life and organisms in the sea interest you? \n";
            return "Does marine life and organisms in the sea interest you? \n";
        }

        if (fvar_list.getVarProperty("Would you like to observe astronomical objects
such as stars, planets, moons, comets and galaxies? \n") == "")
        {
            done = true;
            var = "Would you like to observe astronomical objects such as stars,
planets, moons, comets and galaxies? \n";
            return "Would you like to observe astronomical objects such as stars,
planets, moons, comets and galaxies? \n";
        }

        return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
    }
    if (Major == "BUSINESS")
    {

        if (fvar_list.getVarProperty("Are you interested in the study and management
of exchange relationships? \n") == "")
```

```
{
    done = true;
    var = "Are you interested in the study and management of exchange
relationships? \n";
    return "Are you interested in the study and management of exchange
relationships? \n";
}
if (fvar_list.getVarProperty("Would you like to know more about the study of
money and how it is used? \n") == "")
{
    done = true;
    var = "Would you like to know more about the study of money and how it is
used? \n";
    return "Would you like to know more about the study of money and how it
is used? \n";
}

if (fvar_list.getVarProperty("Are you interested in recognizing and
developing opportunities? \n") == "")
{
    done = true;
    var = "Are you interested in recognizing and developing opportunities?
\n";
    return "Are you interested in recognizing and developing opportunities?
\n";
}

if (fvar_list.getVarProperty("Would you like to oversee and supervise
business operations? \n") == "")
{
    done = true;
    var = "Would you like to oversee and supervise business operations?
\n";
    return "Would you like to oversee and supervise business operations?
\n";
}

if (fvar_list.getVarProperty("Are you interested in the quantitative methods
to analyze business enterprises and the factors contributing to the diversity of
organizational structures and the relationships of firms with labour, capital and product
markets? \n") == "")
{
    done = true;
    var = "Are you interested in the quantitative methods to analyze business
enterprises and the factors contributing to the diversity of organizational structures
and the relationships of firms with labour, capital and product markets? \n";
    return "Are you interested in the quantitative methods to analyze
business enterprises and the factors contributing to the diversity of organizational
structures and the relationships of firms with labour, capital and product markets? \n";
}

return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
}

if (Major == "ART")
{
```

```
    if (fvar_list.getVarProperty("Do photographs interest you? \n") == "")
    {
        done = true;
        var = "Do photographs interest you? \n";
        return "Do photographs interest you? \n";
    }

    if (fvar_list.getVarProperty("Are you interested in using aesthetic and
rhythmic qualities of language—such as phonaesthetics, sound symbolism, and metre—to
evoke meanings in addition to, or in place of, the prosaic ostensible meaning?\n") == "")
    {
        done = true;
        var = "Are you interested in using aesthetic and rhythmic qualities of
language—such as phonaesthetics, sound symbolism, and metre—to evoke meanings in addition
to, or in place of, the prosaic ostensible meaning?\n";
        return "Are you interested in using aesthetic and rhythmic qualities of
language—such as phonaesthetics, sound symbolism, and metre—to evoke meanings in addition
to, or in place of, the prosaic ostensible meaning?\n";
    }

    if (fvar_list.getVarProperty("Are you interested in capturing live moments
through film? \n") == "")
    {
        done = true;
        var = "Are you interested in capturing live moments through film? \n";
        return "Are you interested in capturing live moments through film? \n";
    }

    if (fvar_list.getVarProperty("Do you like to express yourself through dance?
\n") == "")
    {
        done = true;
        var = "Do you like to express yourself through dance? \n";
        return "Do you like to express yourself through dance? \n";
    }

    if (fvar_list.getVarProperty("Do you like to entertain the masses by acting?
\n") == "")
    {
        done = true;
        var = "Do you like to entertain the masses by acting? \n";
        return "Do you like to entertain the masses by acting? \n";
    }

    return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
}
if (Major == "ENGLISH")
{
    if (fvar_list.getVarProperty("Would you like to write for newspapers,
magazines, or news websites or prepare news to be broadcasted? \n") == "")
    {
        done = true;
        var = "Would you like to write for newspapers, magazines, or news
websites or prepare news to be broadcasted? \n";
```

```
        return "Would you like to write for newspapers, magazines, or news
websites or prepare news to be broadcasted? \n";
    }

    if (fvar_list.getVarProperty("Are you interested in transferring information
between two or more parties? \n") == "")
    {
        done = true;
        var = "Are you interested in transferring information between two or more
parties? \n";
        return "Are you interested in transferring information between two or
more parties? \n";
    }

    if (fvar_list.getVarProperty("Would you like to promote groups, or
organizations by selecting publicity material and releasing it through various
communications media?\n") == "")
    {
        done = true;
        var = "Would you like to promote groups, or organizations by selecting
publicity material and releasing it through various communications media?\n";
        return "Would you like to promote groups, or organizations by selecting
publicity material and releasing it through various communications media?\n";
    }

    if (fvar_list.getVarProperty("Are you interested in helping an employer find
job candidates who are most qualified to meet the organization's needs? ") == "")
    {
        done = true;
        var = "Are you interested in helping an employer find job candidates who
are most qualified to meet the organization's needs? \n";
        return "Are you interested in helping an employer find job candidates who
are most qualified to meet the organization's needs? \n";
    }

    if (fvar_list.getVarProperty("Are you interested in determining the final
content of a text, particularly a newspaper or magazine?\n") == "")
    {
        done = true;
        var = "Are you interested in determining the final content of a text,
particularly a newspaper or magazine?\n";
        return "Are you interested in determining the final content of a text,
particularly a newspaper or magazine?\n";
    }

    return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
}
if (Major == "GEOGRAPHY")
{
    if (fvar_list.getVarProperty("Are you interested in developing international
influence or help start operating on an international scale? \n") == "")
    {
        done = true;
        var = "Are you interested in developing international influence or help
start operating on an international scale? \n";
```



```
        return "Are you interested in developing international influence or help
start operating on an international scale? \n";
    }

    if (fvar_list.getVarProperty("Are you interested in helping to increase the
plant species and the ground cover they provide? \n") == "")
    {
        done = true;
        var = "Are you interested in helping to increase the plant species and
the ground cover they provide? \n";
        return "Are you interested in helping to increase the plant species and
the ground cover they provide? \n";
    }

    if (fvar_list.getVarProperty("Are you interested in the management and the
biology of domestic animals? \n") == "")
    {
        done = true;
        var = "Are you interested in the management and the biology of domestic
animals? \n";
        return "Are you interested in the management and the biology of domestic
animals? \n";
    }

    if (fvar_list.getVarProperty("Would you like to know more about the
scientific study of climate, scientifically defined as weather conditions averaged over a
period of time? \n") == "")
    {
        done = true;
        var = "Would you like to know more about the scientific study of climate,
scientifically defined as weather conditions averaged over a period of time? \n";
        return "Would you like to know more about the scientific study of
climate, scientifically defined as weather conditions averaged over a period of time?
\n";
    }

    if (fvar_list.getVarProperty("Would you like to work with towns to make them
more effecient and environmentally friendly? \n") == "")
    {
        done = true;
        var = "Would you like to work with towns to make them more effecient and
environmentally friendly? \n";
        return "Would you like to work with towns to make them more effecient and
environmentally friendly? \n";
    }

    return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
}
if (Major == "Psychology")
{
    if (fvar_list.getVarProperty("Would you like to help families and marriages
work through their problems? \n") == "")
    {
        done = true;
```

```
        var = "Would you like to help families and marriages work through their
problems? \n";
        return "Would you like to help families and marriages work through their
problems? \n";
    }
    if (fvar_list.getVarProperty("Are you interested in providing hands-on direct
care to developmentally or emotionally disabled people, as well as those diagnosed with
mental illnesses? \n") == "")
    {
        done = true;
        var = "Are you interested in providing hands-on direct care to
developmentally or emotionally disabled people, as well as those diagnosed with mental
illnesses? \n";
        return "Are you interested in providing hands-on direct care to
developmentally or emotionally disabled people, as well as those diagnosed with mental
illnesses? \n";
    }

    if (fvar_list.getVarProperty("Would you like to help people who have
uncontrolled use of alcohol, illegal drugs or prescribed drugs that affect normal daily
life? \n") == "")
    {
        done = true;
        var = "Would you like to help people who have uncontrolled use of
alcohol, illegal drugs or prescribed drugs that affect normal daily life? \n";
        return "Would you like to help people who have uncontrolled use of
alcohol, illegal drugs or prescribed drugs that affect normal daily life? \n";
    }

    if (fvar_list.getVarProperty("Would you like to apply experimental methods to
psychological study and the processes that underlie it? \n") == "")
    {
        done = true;
        var = "Would you like to apply experimental methods to psychological
study and the processes that underlie it? \n";
        return "Would you like to apply experimental methods to psychological
study and the processes that underlie it? \n";
    }
    if (fvar_list.getVarProperty("Are you interested in taking a strategic
approach to the effective management of people in a company or organization such that
they help their business gain a competitive advantage? \n") == "")
    {
        done = true;
        var = "Are you interested in taking a strategic approach to the effective
management of people in a company or organization such that they help their business gain
a competitive advantage? \n";
        return "Are you interested in taking a strategic approach to the
effective management of people in a company or organization such that they help their
business gain a competitive advantage? \n";
    }

    return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
}
if (Major == "AGRICULTURE")
{
```

```
        if (fvar_list.getVarProperty("Are you interested in inspecting food and
animals meant for consumption? \n") == "")
        {
            done = true;
            var = "Are you interested in inspecting food and animals meant for
consumption? \n";
            return "Are you interested in inspecting food and animals meant for
consumption? \n";
        }

        if (fvar_list.getVarProperty("Would you like to be an expert in garden
cultivation and management? \n") == "")
        {
            done = true;
            var = "Would you like to be an expert in garden cultivation and
management? \n";
            return "Would you like to be an expert in garden cultivation and
management? \n";
        }

        if (fvar_list.getVarProperty("Are you interested in the cultivation,
management, and study of individual trees, shrubs, vines, and other perennial woody
plants in dendrology and horticulture? \n") == "")
        {
            done = true;
            var = "Are you interested in the cultivation, management, and study of
individual trees, shrubs, vines, and other perennial woody plants in dendrology and
horticulture? \n";
            return "Are you interested in the cultivation, management, and study of
individual trees, shrubs, vines, and other perennial woody plants in dendrology and
horticulture? \n";
        }

        if (fvar_list.getVarProperty("Would you like to own and breed bees,
especially for their honey? \n") == "")
        {
            done = true;
            var = "Would you like to own and breed bees, especially for their honey?
\n";
            return "Would you like to own and breed bees, especially for their honey?
\n";
        }

        if (fvar_list.getVarProperty("Would you like to specifically deal with crimes
against animals? \n") == "")
        {
            done = true;
            var = "Would you like to specifically deal with crimes against animals?
\n";
            return "Would you like to specifically deal with crimes against animals?
\n";
        }

        return "UH-OH Doesn't seem like you chose the right profession! :(\\nPlease
restart the Application!\\n";
    }
    if (Major == "HEALTHCARE")
```

```
{  
    if (fvar_list.getVarProperty("Are you interested in the care of individuals,  
families, and communities so they may attain, maintain, or recover optimal health and  
quality of life?\n") == "")  
    {  
        done = true;  
        var = "Are you interested in the care of individuals, families, and  
communities so they may attain, maintain, or recover optimal health and quality of  
life?\n";  
        return "Are you interested in the care of individuals, families, and  
communities so they may attain, maintain, or recover optimal health and quality of  
life?\n";  
    }  
  
    if (fvar_list.getVarProperty("Would you like to plan, direct, and coordinate  
medical and health services? \n") == "")  
    {  
        done = true;  
        var = "Would you like to plan, direct, and coordinate medical and health  
services? \n";  
        return "Would you like to plan, direct, and coordinate medical and health  
services? \n";  
    }  
  
    if (fvar_list.getVarProperty("Would you like to specialize in dentistry, the  
diagnosis, prevention, and treatment of diseases and conditions of the oral cavity? \n")  
== "")  
    {  
        done = true;  
        var = "Would you like to specialize in dentistry, the diagnosis,  
prevention, and treatment of diseases and conditions of the oral cavity? \n";  
        return "Would you like to specialize in dentistry, the diagnosis,  
prevention, and treatment of diseases and conditions of the oral cavity? \n";  
    }  
  
    if (fvar_list.getVarProperty("Are you interested in being a health care  
practitioner who practices medicine in collaboration with or under the supervision of a  
physician? \n") == "")  
    {  
        done = true;  
        var = "Are you interested in being a health care practitioner who  
practices medicine in collaboration with or under the supervision of a physician? \n";  
        return "Are you interested in being a health care practitioner who  
practices medicine in collaboration with or under the supervision of a physician? \n";  
    }  
  
    if (fvar_list.getVarProperty("Are you interested in the science and art of  
preventing disease? \n") == "")  
    {  
        done = true;  
        var = "Are you interested in the science and art of preventing disease?  
\n";  
        return "Are you interested in the science and art of preventing disease?  
\n";  
    }  
}
```

```
        return "UH-OH Doesn't seem like you chose the right profession! :(\nPlease
restart the Application!\n";
    }
    if (Major == "EDUCATION")
    {

        if (fvar_list.getVarProperty("Would you like to teach children in pre K to
5th grade? \n") == "")
        {
            done = true;
            var = "Would you like to teach children in pre K to 5th grade? \n";
            return "Would you like to teach children in pre K to 5th grade? \n";
        }

        if (fvar_list.getVarProperty("Would you like to teach at the college or
university level? \n") == "")
        {
            done = true;
            var = "Would you like to teach at the college or university level? \n";
            return "Would you like to teach at the college or university level? \n";
        }

        if (fvar_list.getVarProperty("Are you interested in being involved in
managing some educational system? \n") == "")
        {
            done = true;
            var = "Are you interested in being involved in managing some educational
system? \n";
            return "Are you interested in being involved in managing some educational
system? \n";
        }

        if (fvar_list.getVarProperty("Are you interested in deciding what methods and
topics will be used to teach lessons? \n") == "")
        {
            done = true;
            var = "Are you interested in deciding what methods and topics will be
used to teach lessons? \n";
            return "Are you interested in deciding what methods and topics will be
used to teach lessons? \n";
        }

        if (fvar_list.getVarProperty("Would you like to instruct non-English
speaking individuals on the fundamentals of the English language so that they can
communicate with others? \n") == "")
        {
            done = true;
            var = "Would you like to instruct non-English speaking individuals on
the fundamentals of the English language so that they can communicate with others? \n";
            return "Would you like to instruct non-English speaking individuals on
the fundamentals of the English language so that they can communicate with others? \n";
        }

        return "UH-OH Doesn't seem like you chose the right profession! :(\n Please
restart the Application!\n";
    }
}
```

```
        return "You answered No to all the questions! Maybe college isnt for you!\nPlease  
restart the Application if you reconsider!\n";  
    }
```

```
//KnowledgeBase.h
#ifndef KNOWLEDGEBASE_H
#define KNOWLEDGEBASE_H
#include <string>
#include <map>
class KnowledgeBase
{
    public:
        KnowledgeBase(std::map<int, std::string> knowledge_base);
        /** Default constructor */
        KnowledgeBase();
        /** Default destructor */
        virtual ~KnowledgeBase();
        std::string getResult(int rule_nmb);

    private:
        std::map<int, std::string> knowledge_base;
};

#endif // KNOWLEDGEBASE_H
```

```
//KnowledgeBase.cpp
#include "KnowledgeBase.h"

KnowledgeBase::KnowledgeBase(std::map<int, std::string> knowledge_base)
{
    this->knowledge_base = knowledge_base;
}

KnowledgeBase::KnowledgeBase(){}

std::string KnowledgeBase::getResult(int rule_nmb){
    if(knowledge_base.count(rule_nmb)){
        return knowledge_base[rule_nmb];
    }
    else
        return std::string("NO Here know!!");
}

KnowledgeBase::~KnowledgeBase(){}

```



```
//VariableList.h
#ifndef VARIABLELIST_H
#define VARIABLELIST_H
#include <map>
#include <string>
#include <iostream>
class VariableList
{
public:
    /** Default constructor */
    VariableList();
    VariableList(std::map<std::string, std::string> variable_list,
        std::map<std::string, std::string> conclusion_list);
    /** Default destructor */
    virtual ~VariableList();

    /**Setters*/
    void setVariableList(std::map<std::string, std::string> var_list);
    void setThisVariable(std::string variable, std::string property);

    /**Getters*/
    std::string getConProperty(std::string con);
    std::string getVarProperty(std::string var);
    std::string searchConVar(std::string var);
    void updateCon(std::string con, std::string property);
    void setVarProperty(std::string var, std::string yn);
    int var_size;
    bool isVarSet(std::string var);

private:
    std::map<std::string, std::string> variable_list;
    std::map<std::string, std::string> conclusion_list;
};

#endif // VARIABLELIST_H
```

```
//VariableList.cpp
#include "VariableList.h"

/*defines all the variables needed for variable list*/
VariableList::VariableList(std::map<std::string, std::string> variable_list,
    std::map<std::string, std::string> conclusion_list)
{
    //ctor
    this->variable_list = variable_list;
    this->conclusion_list = conclusion_list;
    this->var_size = (int)variable_list.size();
}

VariableList::VariableList() {}

/*getConProperty gets the conclusion property of the string con inside the
conclusion list, if it is there, otherwise returns not_here_CON*/
std::string VariableList::getConProperty(std::string con) {
    if (conclusion_list.count(con) == 1) {
        return conclusion_list[con];
    }
    else
        return std::string("not_here_CON");
}

/*isVarSet checks to see if the variable in variable_list is set or not*/
bool VariableList::isVarSet(std::string var) {
    if (variable_list.count(var) == 1) {
        std::string result = variable_list[var];
        if (result == "") {
            return false;
        }
        else
            return true;
    }
    else
        return false;
}

/*getVarProperty Returns the variable property of string var inside variable_list returns
YES/NO
if found, returns not_here_VAR if not found*/
std::string VariableList::getVarProperty(std::string var) {
    if (variable_list.count(var) == 1) {
        std::string result = variable_list[var];
        return result;
    }
    else
        return std::string("not_here_VAR");
}

/*setVarProperty sets the string var inside variable list to yes or no if the variable
exists*/
void VariableList::setVarProperty(std::string var, std::string yn) {
    if (variable_list.count(var) == 1) {
        variable_list[var] = yn;
    }
}
```

```
    }  
}  
  
/*searchConVar Determines if .count with ID var is Conclusion or Variable*/  
std::string VariableList::searchConVar(std::string var) {  
    if (variable_list.count(var) == 1) {  
        return std::string("VAR");  
    }  
    else  
        return std::string("CON");  
}  
  
/*updateCon adds a conclusion property to a conclusion inside conclusionlist*/  
void VariableList::updateCon(std::string con, std::string property) {  
    std::map<std::string, std::string>::iterator it = conclusion_list.find(con);  
  
    if (it != conclusion_list.end())  
        it->second = property;  
}  
  
VariableList::~~VariableList() {}
```

COPY OF PROGRAM RUNS

The image displays two screenshots of a graphical user interface for a program titled "Career Advising". Each window has a title bar with standard minimize, maximize, and close buttons. The interface consists of a large text area for questions and a scroll bar on the right, and two large buttons labeled "YES" and "NO" at the bottom.

Top Screenshot:

Welcome, do you want to begin?
YES
Do you like to plan/organize/manage things?
NO
Do you like to help?
NO
Do you like nature?
YES
Does raising plants/animals interest you?
NO
Would you like to further your understanding of the earth's physical features?
YES
Major: GEOGRAPHY
Press YES/NO to continue
YES
Are you interested in developing international influence or help start operating on an international scale?
YES
Career = Globalization

Bottom Screenshot:

Welcome, do you want to begin?
YES
Do you like to plan/organize/manage things?
NO
Do you like to help?
YES
Do you enjoy teaching?
YES
Major: EDUCATION
Press YES/NO to continue
YES
Would you like to teach children in pre K to 5th grade?
NO
Would you like to teach at the college or university level?
YES
Career = Professor

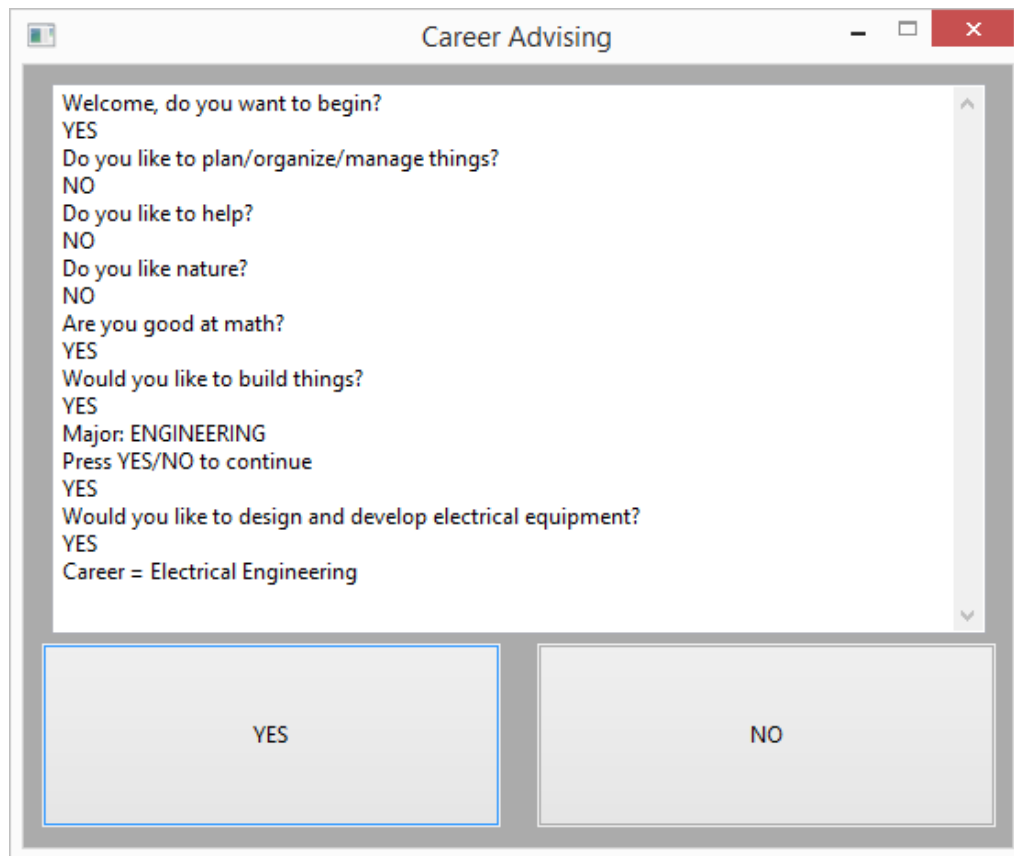
The image displays two sequential screenshots of a software application window titled "Career Advising". The window has a standard Windows-style title bar with minimize, maximize, and close buttons. The main content area is a text box with a vertical scrollbar on the right. Below the text box are two large, light gray buttons labeled "YES" and "NO".

Top Screenshot:

Welcome, do you want to begin?
YES
Do you like to plan/organize/manage things?
NO
Do you like to help?
NO
Do you like nature?
NO
Are you good at math?
NO
Do you enjoy being creative?
NO
You answered No to all the questions! Maybe college isnt for you!
Please restart the Application if you reconsider!

Bottom Screenshot:

Welcome, do you want to begin?
YES
Do you like to plan/organize/manage things?
YES
Major: BUSINESS
Press YES/NO to continue
YES
Are you interested in the study and management of exchange relationships?
NO
Would you like to know more about the study of money and how it is used?
NO
Are you interested in recognizing and developing opportunities?
YES
Career = Entrepreneurial Studies



A screenshot of a software window titled "Career Advising". The window has a standard Windows-style title bar with a minimize button, a maximize button, and a close button. The main content area is a text box with a vertical scrollbar on the right. The text inside the box reads:

Welcome, do you want to begin?
YES
Do you like to plan/organize/manage things?
NO
Do you like to help?
NO
Do you like nature?
NO
Are you good at math?
YES
Would you like to build things?
YES
Major: ENGINEERING
Press YES/NO to continue
YES
Would you like to design and develop electrical equipment?
YES
Career = Electrical Engineering

Below the text box, there are two large, light gray buttons. The left button is labeled "YES" and the right button is labeled "NO". The "YES" button has a blue border, indicating it is the active or selected option.

ANALYSIS OF THE PROGRAM

For this program we broke it up into objects for easier use and neatness as opposed to having everything inside of one file. We also decided to use hash maps for both forward and backward chaining that made chaining much more efficient. We didn't have to use any sort of equation to find certain variables or clauses which made finding the correct variables inside the list easier. The GUI we created needed to be able to output all the questions as well as take in the answers to the questions. Each button had inside it a call to the engine function that runs the code, the first initial yes starts the chaining process. It then takes the pointer of the next question by outputting the returned string from the loop, then waits for an event, either YES or NO being clicked, the YES/NO would check flags inside the engine that allowed it to continue through the function. This process would continue until a conclusion is reached.

ANALYSIS OF THE RESULTS

The memory usage states that it constantly uses 6mb worth of the memory. Creating a GUI for the platform has potentially increased the memory usage, although we have nothing to compare it to. The efficiency could have been affected by the very large variable names we have created. They essentially became the ID as well as the string displayed in the GUI message box. Replacing the strings with something smaller and only calling the second string in the hash map could have made the code perform faster. In terms of the algorithms, the route we chose is much faster than using equations and looping algorithms, our way cuts the fluff.

Conclusion

This project has helped me build teambuilding skills, time management skills, problem solving skills, and increased my frustration tolerance. This is the first project where I dared to create a GUI for the assignment, without it being required. I learned how to import and use libraries and have become slightly adept at using wxWidgets. I have also learned how to improve the code that was given and in doing so learned how to use forward and backward chaining principles to create an expert system application. My job in this assignment was

to create the GUI, and augment both the forward and backward chaining to work not only together, but with the GUI as well.

References

<https://docs.wxwidgets.org/3.0/>

An online manual to using wxWidgets GUI library

<https://www.youtube.com/watch?v=FOIbK4bJKS8&t=1744s>

A tutorial on how to set up and use the GUI

<https://stackoverflow.com/>

General questions I had where I needed to know why I had an error

Helped with hash maps, correct parameters, etc.

AI and Expert Systems: A Comprehensive Guide By Levine

Used this books chapters 5 and 6 to gain a better understanding of forward and backward chaining.