Artificial Intelligence: Forward and Backward Chaining for Cancer Diagnosis and Treatment

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Abstract

Cancer is irregular division and growth of cells within the body that has impacted most people at some point in their lives. In this report, we discuss the applications that an artificial intelligence expert system has toward improving the way we diagnose cancer through symptoms and how we give cancer treatments through these the diagnoses. In our cancer diagnosis we use the method of backward chaining in a goal-driven approach to properly determine whether a person has a cancer by analyzing their symptoms. If the patient tests positive for a cancer, then we move on to our treatment that is handled by the data-driven forward chaining

1. Introduction

1.1. Artificial Intelligence

Artificial intelligence has become increasingly popular within the past few decades as the majority of people interact with artificial intelligence everyday, from searching on Google, using Facebook, through banking, and even with self-driving cars. The vast array of applications that artificial intelligence can apply to makes it difficult to have a fitting definition, yet IBM defines artificial intelligence as "any human-like intelligence exhibited by a computer, robot, or other machine. In popular usage, artificial intelligence refers to the ability of a computer or machine to mimic the capabilities of the human mind—learning from examples and experience, recognizing objects, understanding and responding to language, making decisions, solving problems, and combining these and other capabilities to perform functions a human might perform." [1] This report experiments with artificial intelligence as we build an expert system from C++ that emulates the decision making of a human expert.

1.2. Problem Description

Cancer is a disease where abnormal cells divide uncontrollably and destroy the body tissue of the human host. It is a disease that affects the majority of the people at some point in their lives, whether it be directly or indirectly. Cancer is an issue that affects approximately one in every two women and approximately one in every three men. It is for this reason that cancer killed roughly 9.6 million people worldwide in 2018 alone. [3] With cancer being a leading factor in death and grief among the population, it is important that we do everything we can to minimize the affects cancer can have on people.

The cancers that affect the most people are Skin Cancer, Breast Cancer, Lung Cancer, Prostate Cancer, Colorectal Cancer, Bladder Cancer, Lymphoma, Kidney Cancer and Leukemia, each of which are included in our diagnostic expert system. [3] These cancers can be caused by genetics, but may also be caused by smoking, tobacco, bad diet, low physical activity, sun, radiation, viruses, and other infections. These health risks could be a great way to develop an expert system, "as 40 percent of all cancers diagnosed in the United States link back to tobacco use mainly causing Lung Cancer, Throat Cancer, and Stomach Cancer," yet this report decided to look at the physical symptoms of the patients through user input. [3] It is the assessment of these physical symptoms that could cost thousands to diagnose, yet our program aims to decrease the cost and increase the education surrounding the diagnosis and treatment of cancer.

Cancer diagnosis and treatment is crucial for people with cancer as it can be a malignant disease that spreads with every day that it goes untreated. Late-stage presentation and lack of access to diagnosis and treatment options are common, particularly in low- and middle-income countries. [3] "Comprehensive treatment is reportedly available in more than 90 percent of high income countries, but less than 15 percent of low income countries." [3] By efficiently and effectively employing computers to mimic the behaviors of experts, we aim to decrease the total economic cost of 1.16 trillion dollars that the United States spends annually in healthcare costs. [3] For the average person, the costs associated with cancer exceed their salary and they cannot afford the appointments, cancer treatment, medication, living expenses, and care-giving.

Monthly costs of drugs that help to fight cancer may reach 100,000 dollars in the United States. [2] This coincides with the fact that the average monthly income is 3,600 dollars, yet the average monthly cost of Chemotherapy, Radiation therapy, and Immunotherapy is 1,000-12,000 dollars, 9,000 dollars, and 10,000-12,500 dollars respectively for treatment. [2] We also see that cancer patients are 2.5 times more likely to declare bankruptcy. [2] These statistics help to stress the importance of the many issues surrounding cancer diagnosis and treatment.

With these issues in mind, we set out to build an artificially intelligent expert system that would improve the quality of diagnosis and treatment that patients can receive, cut costs, and effectively mimic the output of oncologists.

1.3. Expert Systems

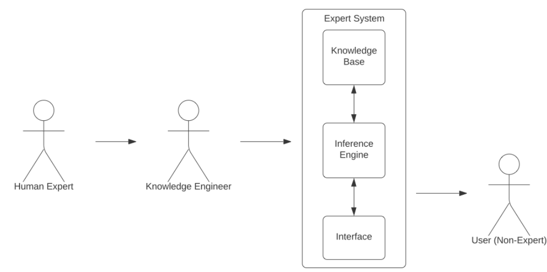

Figure 1. Expert System Diagram

The domain of artificial intelligence is significant in both breadth and depth, yet the main domains that exist today are natural language processing, fuzzy logic, expert systems, neural networks, and robotics. For this report we will be focused specifically on expert systems where an expert system is a computer system that mimics the decision making of a human expert.

Expert systems use a combination of expert human knowledge and logic to solve difficult problems that would normally take a specialist from a given field of study. This domain falls under the branch of expert tasks in artificial intelligence that is used to solve problems in financial analysis, engineering, scientific analysis, and medical diagnosis.

These expert systems are divided into two subsystems with an inference engine to deduce new facts, or conclusions, and a knowledge base consisting of existing facts, or rules. The goal of an expert system is to use these facts for decision-making on issues normally resolved by a professional. These decision-making rules consist mainly of IF-THEN clauses, instead of conventional procedural code, that can efficiently optimize medical decision making.

Expert systems have many benefits that make them ideal for the medical field as they have a low accessibility cost, fast response, non-biased with quality data, low error rate, and can be more cost efficient than an expert. Although expert systems have many benefits, they need to be manually updated, cannot explain logic behind output, and is developed for a specific domain.They are also only as good or as bad as the experts who formulate the rules.

Our solution to the problem is to create an intelligent computer expert system for a hospital to diagnose Cancers and recommend the treatment based on the diagnosis. The cancer expert system will be able to effectively diagnose a variety of different cancers and recommend treatments based on the diagnosis. The cancer expert system will coincide with artificial intelligence concepts by using decision trees, data structures for our knowledge base, autonomy as a stand alone program, and forward/backward chaining to move through our rules.

1.4. Forward and Backward Chaining

Forward Chaining is a method of decision-making based on finding a conclusion, goal, for the output of the expert system based on the data given in the inference rules. Forward Chaining uses these inference rules to extract more data and continues until it reaches the goal.

Backward Chaining is the reverse of Forward Chaining where it starts from the goal and moves backwards by using inference rules to determine the facts that will satisfy that goal.

These approaches differ as Forward Chaining is known as the down-up approach using breadth-first search, while Backward Chaining is known as a top-down approach using depth-first search.

2. Team Contributions

Kent Kenyon

1. Contributed significantly to implementing Backward Chaining.
2. Made all preliminary and final versions of the decision tree.
3. Provided a significant portion of research for both symptoms and treatments of cancers.
4. Provided feedback and guidance in the creation of the Forward Chaining.
5. Made the Rules for chaining.
6. Helped in debugging the expert system.

Taylor Perry

1. Restructured the provided code to make it more understandable.
2. Contributed to implementing Backward Chaining.
3. Provided feedback on all sections of the project.
4. Helped keep the bigger picture in view when the project was broken down.
5. Reviewed the Rules once they were created.
6. Helped in debugging the expert system.

Bryce Strahan

1. Contributed significantly to implementing Forward Chaining.
2. Spent a lot of time researching forward chaining to provide a better understanding.
3. Kept the team on track through discord.
4. Helped in debugging the expert system.

3. Domain

The goal of this project is to create an intelligent computer expert system for a hospital to diagnose Cancers and to recommend the treatment based on the diagnosis.

We want to create decision trees and IF-THEN rules for both forward and backward chaining, then develop a program that show the diagnosis/treatment for our rules containing the cancers: Basal Cell Carcinoma, Squamous Cell Carcinoma, Melanoma, Thyroid Cancer, Leukemia, Breast Cancer, Prostate Cancer, Bladder Cancer, Colorectal Cancer, Testicular Cancer, Penile Cancer, Ovarian Cancer, Cervical Cancer, Lung Cancer, Stomach Cancer, and Brain Cancer.

4. Knowledge Base

A knowledge base is typically a collection of rules with information given by the human expert and designed by a knowledge engineer. This information is a collection of facts about the domain, specifically cancer in our project. Knowledge base facts are typically structured with IF-THEN statements, for example: IF sun is out THEN hot. These facts are then interpreted by our inference engine to deduce new facts and draw conclusions.

Our knowledge base in the cancer expert system is composed of cancer symptoms and cancer treatments. We made rules for our knowledge base by grouping cancers of common symptoms together and ensuring that no two cancers would end on the same leaf nodes on the tree diagram by having the same exact symptoms. Once the tree diagram was made we effectively converted the diagram to the IF-THEN format for our rules.

Figure 2. Example of Decision Tree Connection (clause, clause, conclusion)

IF antecedent THEN consequent

Figure 3. Example of Knowledge Base IF-THEN

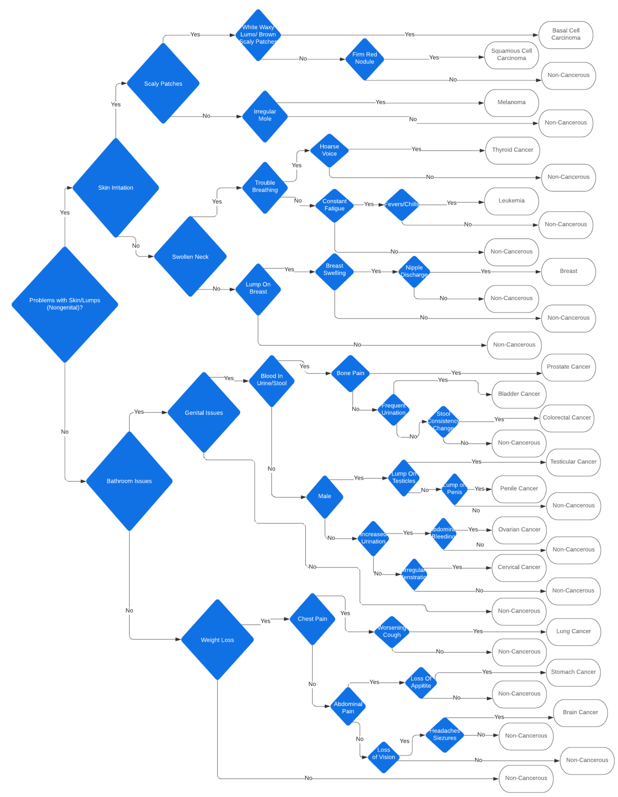

Figure 4. Backward Chaining Tree Diagram

4.1. Decision Tree

Once the problem has been stated, the next step is to somehow diagram the problem so that all aspects of the problem are illustrated as simply as possible. One of the most common diagrams used in working out problems of this sort is the decision tree.

A decision tree is an effective type of diagram because it enables us to visualize all the factors that must be considered in reaching a decision. We are able to look at all the intermediary steps and rules to see how one consideration leads to others, which then lead to more steps.Seeing

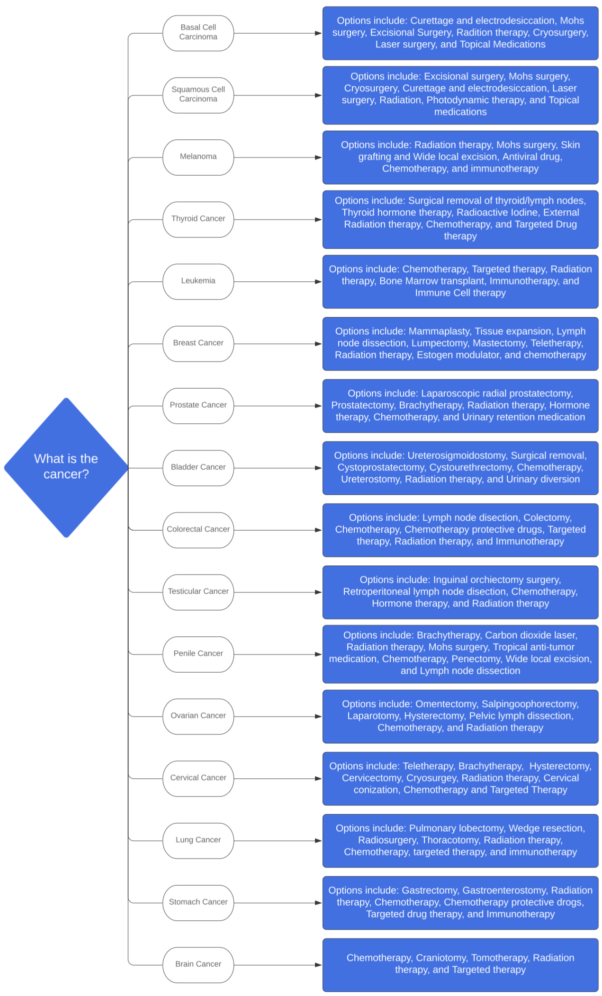

Figure 5. Forward Chaining Tree Diagram

all the intermediary steps between your start and your end is very useful for big expert systems so that you do not get lost in all the data. We used the diagram to keep track of our connections within the rule base and follow through paths.

4.2. Inference Engine

The decision tree example shows a small portion of our decision tree to work through an example. In the tree we have the Cancers as the terminal nodes and the symptoms leading to these terminal nodes. In the tree, we would ask ”Are you experiencing Scaly Patches?” and if the user replies ’Yes’, we would move on to the next

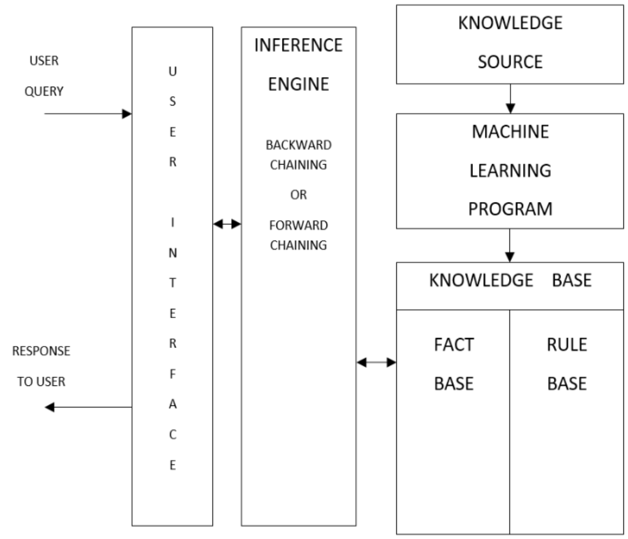

Figure 6. Inference Engine Diagram

question of ”Are you experiencing White Waxy Lump/Brown Scaly Patches?”. If the user had entered ’No’ to the first question they would have been asked ”Are you experiencing Irregular Mole?”. The user would keep answering questions until the desired cancer was met and returns ’positive’ or the user does not have the symptoms of the cancer we are testing for and returns ’negative’. Going off of the decision tree, the user will keep moving from left to right until they reach the cancer that they selected for diagnosis. We tried designing our decision tree to stay fairly even so that we had a fair amount of coverage across the whole tree and did not entertain any big gaps.

When putting the tree diagram into context, each diamond node contains a variable, while the paths are conditions for the diagram. We then have ovals as our conclusion for the type of cancer. This makes establishing rules for the domain much simpler as it puts it in an easy IF-THEN format. This IF-THEN format will be able to be read by the computer, meanwhile a decision tree cannot be read by a computer.

1	IF DIAGNOSIS =	Basal Cell Carcinoma	THEN TREATMENT =	Options include: Curettage and electrodesiccation, Mohs surgery, Excisional Surgery, Radition therapy, Cryosurgery, Laser surgery, and Topical Medications
2	IF DIAGNOSIS =	Squamous Cell Carcinoma	THEN TREATMENT =	Options include: Excisional surgery, Mohs surgery, Cryosurgery, Curettage and electrodesiccation, Laser surgery, Radiation, Photodynamic therapy, and Topical medications
3	IF DIAGNOSIS =	Melanoma	THEN TREATMENT =	Options include: Radiation therapy, Mohs surgery, Skin grafting and Wide local excision, Antiviral drug, Chemotherapy, and Immunotherapy
4	IF DIAGNOSIS =	Thyroid Cancer	THEN TREATMENT =	Options include: Surgical removal of thyroid/lymph nodes, Thyroid hormone therapy, Radioactive Iodine, External Radiation therapy, Chemotherapy, and Targeted Drug therapy
5	IF DIAGNOSIS =	Leukemia	THEN TREATMENT =	Options include: Chemotherapy, Targeted therapy, Radiation therapy, Bone Marrow transplant, Immunotherapy, and Immune Cell therapy
6	IF DIAGNOSIS =	Breast Cancer	THEN TREATMENT =	Options include: Mammaplasty, Tissue expansion, Lymph node dissection, Lumpectomy, Mastectomy, Teletherapy, Radiation therapy, Estogen modulator, and chemotherapy
7	IF DIAGNOSIS =	Prostate Cancer	THEN TREATMENT =	Options include: Laparoscopic radial prostatectomy, Prostatectomy, Brachytherapy, Radiation therapy, Hormone therapy, Chemotherapy, and Urinary retention medication
8	IF DIAGNOSIS =	Bladder Cancer	THEN TREATMENT =	Options include: Ureterosigmoidostomy, Surgical removal, Cystoprostatectomy, Cystourethrectomy, Chemotherapy, Ureterostomy, Radiation therapy, and Urinary diversion
9	IF DIAGNOSIS =	Colorectal Cancer	THEN TREATMENT =	Options include: Lymph node disection, Colectomy, Chemotherapy, Chemotherapy protective drugs, Targeted therapy, Radiation therapy, and Immunotherapy
10	IF DIAGNOSIS =	Testicular Cancer	THEN TREATMENT =	Options include: Inguinal orchiectomy surgery, Retroperitoneal lymph node disection, Chemotherapy, Hormone therapy, and Radiation therapy
11	IF DIAGNOSIS =	Penile Cancer	THEN TREATMENT =	Options include: Brachytherapy, Carbon dioxide laser, Radiation therapy, Mohs surgery, Tropical anti-tumor medication, Chemotherapy, Penectomy, Wide local excision, and Lymph node dissection
12	IF DIAGNOSIS =	Ovarian Cancer	THEN TREATMENT =	Options include: Omentectomy, Salpingoophorectomy, Laparotomy, Hysterectomy, Pelvic lymph dissection, Chemotherapy, and Radiation therapy
13	IF DIAGNOSIS =	Cervical Cancer	THEN TREATMENT =	Options include: Teletherapy, Brachytherapy, Hysterectomy, Cervicectomy, Cryosurgey, Radiation therapy, Cervical conization, Chemotherapy and Targeted Therapy
14	IF DIAGNOSIS =	Lung Cancer	THEN TREATMENT =	Options include: Pulmonary lobectomy, Wedge resection, Radiosurgery, Thoracotomy, Radiation therapy, Chemotherapy, targeted therapy, and immunotherapy
15	IF DIAGNOSIS =	Stomach Cancer	THEN TREATMENT =	Options include: Gastrectomy, Gastroenterostomy, Radiation therapy, Chemotherapy, Chemotherapy protective drogs, Targeted drug therapy, and Immunotherapy
16	IF DIAGNOSIS =	Brain Cancer	THEN TREATMENT =	Chemotherapy, Craniotomy, Tomotherapy, Radiation therapy, and Targeted therapy

Figure 7. Forward Chaining Knowledge Base

4.3. Conversion to IF-THEN

The IF is comprised of conditions and the THEN is evaluated when the IF is true. We can demonstrate the conversion to IF-THEN with the sample 'Constant Fatigue', 'Fevers/Chills', and 'Leukemia'. When looking at this diagram we can see that IF Constant Fatigue = yes AND Fevers/Chills = yes THEN Cancer = Leukemia. The combination of linked decision nodes (diamonds) and a conclusion node (oval) represents an IF-THEN rule. The IF part contains all the decision nodes in the path leading to a conclusion node with each contributing one clause to the IF portion.

This same idea can be applied for a whole connection and connecting all a whole series of yes/no questions to return a type of cancer. The best way to do this to ensure you do not make a mistake is to start at your conclusion and continue left until you cannot go left anymore and marking down each node as you go. You would then create the IF statement by joining the nodes you traversed with the AND operator and create the THEN statement with the conclusion you started

1	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = yes AND Scaly Patches = yes AND White Waxy Lump/Brown Scaly Patches = yes	THEN CANCER =	Basal Cell Carcinoma
2	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = yes AND Scaly Patches = yes AND White Waxy Lump/Brown Scaly Patches = no AND Firm Red Nodule = yes	THEN CANCER =	Squamous Cell Carcinoma
3	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = yes AND Scaly Patches = no AND IrregularMole = yes	THEN CANCER =	Melanoma
4	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = no AND Swollen Neck = yes AND Trouble Breathing = yes AND Hoarse Voice = yes	THEN CANCER =	Thyroid Cancer
5	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = no AND Swollen Neck = yes AND Trouble Breathing = no AND Constant Fatigue = yes AND Fevers/Chills = yes	THEN CANCER =	Leukemia
6	IF SYMPTOMS =	Problems With Skin/Lumps(NonGenital) = yes AND Skin Irritation = no AND Swollen Neck = no AND Lump On Breast = yes AND Breast Swelling = yes AND Nipple Discharge = yes	THEN CANCER =	Breast Cancer
7	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = yes AND Bone Pain = yes	THEN CANCER =	Prostate Cancer
8	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = yes AND Bone Pain = no AND Frequent Urination = yes	THEN CANCER =	Bladder Cancer
9	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = yes AND Bone Pain = no AND Frequent Urination = no AND Stool Consistency Change = yes	THEN CANCER =	Colorectal Cancer
10	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = no AND Male = yes AND Lump On Testicles = yes	THEN CANCER =	Testicular Cancer
11	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = no AND Male = yes AND Lump On Testicles = no AND Lump On Penis = yes	THEN CANCER =	Penile Cancer
12	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = no AND Male = no AND Increased Urination = yes AND Abdominal Bloating = yes	THEN CANCER =	Ovarian Cancer
13	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = yes AND Genital Issues = yes AND Blood In Urine/Stool = no AND Male = no AND Increased Urination = no AND Irregular Menstration = yes	THEN CANCER =	Cervical Cancer
14	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = no AND Weight Loss = yes AND Chest Pain = yes AND Worsening Cough = yes	THEN CANCER =	Lung Cancer
15	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = no AND Weight Loss = yes AND Chest Pain = no AND Adbominal Pain = yes AND Loss of Appitite = yes	THEN CANCER =	Stomach Cancer
16	IF SYMPTOMS =	Problems With Skin/lumps(NonGenital) = no AND Bathroom Issues = no AND Weight Loss = yes AND Chest Pain = no AND Adbominal Pain = no AND Loss of Vision = yes AND Headaches/Seizures = yes	THEN CANCER =	Brain Cancer

Figure 8. Backward Chaining Knowledge Base

with.

5. Methodologies

In our expert technique we use a number of useful tables, or data structures, that will aid in answering questions and making decisions. These data structures are derived directly from the knowledge base. The compliment that works hand-in hand with this knowledge base to draw conclusions is the inference engine.

The inference engine is the ”brain” of the expert system that applies logical rules to the knowledge base to deduce new information. The inference engine makes use of the knowledge base to deduce new knowledge, yet the inference engine must obtain information from the user when their are no rules left that it can run. The inference engine uses the knowledge base to evaluate the rules and provide an answer equivalent to that of a human expert. The two main ways the inference machine is used is through forward chaining and backward chaining.

5.1. Backward Chaining

Backward Chaining is the logical process of moving from the conclusions backward in a logical process to infer unknown truths. This is referred to as goal-driven chaining. This uses an up-down approach where the endpoint is subdivided into sub-goals to prove the truth of facts.

We follow the technique:

1. Choose a conclusion. Record it.

2. Search the conclusion list for the first instance. Place the rule on the conclusion stack using the rule number and a (1) to represent the clause number if found. If not found, notify the user that an answer cannot be found.

3. Instantiate the IF clause

4. If one of the IF clause variables is not instantiated and is not a conclusion variable, then ask the user to enter a value.

5. . If one of the clauses is a conclusion variable, place the conclusion variable’s rule number on the top of the stack and go back to step 3.

6. If top of the stack cannot be instantiated using IF-THEN statement, remove the unit from the top of the stack and search the conclusion list for another instance of conclusion. If this statement is found go back to 3.

7. If no more conclusions are left on conclusion stack, the rule for the previous conclusion is false. If there is no previous conclusion, then notify the user that an answer cannot be found. If there is a previous conclusion, go back to step 6.

8. If the rule on top of the stack can be instantiated, remove it from the stack. If another conclusion variable is underneath, increment the clause number, and for the remaining clauses go back to step 3. If no other conclusion variable is underneath, we have answered our question. The user can come to a conclusion.

Advantages of this backward chaining technique are that it's a floor system, tries to set goals in the order they came to the knowledge base, few data asked/many rules searched, good for debugging/diagnosing, and backward chaining never performs unnecessary inferences.

Disadvantages of backward chaining are that the goal must be known and implementation is hard.

5.2. Forward Chaining

In forward chaining we start with the available data and use inference rules to extract more data from a user until a goal is reached. The inference engine searches the inference rules until it finds one where the antecedent is true. Forward chaining is a data-driven chaining concept, which is backwards of Backward chaining.

We follow the technique:

1. The condition is identified.

2. The condition variable is placed on the conclusion variable queue and value marked on the variable list.

3. The clause variable list is searched for the variable that matches the front of the queue. If found, the rule number and a 1 are placed into the clause variable pointer. If not found, go to step 6.

4. Each variable in the IF clause of the rule that is not already instantiated is now instantiated. The variables are in the clause variable list. If all the clauses are true, the THEN part is invoked.

5. Instantiated THEN part of the variable is placed in the back of the conclusion variable queue.

6. No more IF statements containing the variable that is at the front of the conclusion variable queue, that variable is removed.

7. No more variables on the conclusion variable queue, end the session. If there are more variables, go to step 3.

Advantages of forward chaining are that runs great when problem naturally collects data, can provide much data from few initial facts, and works well with interruption, control, and planning.

Disadvantages of forward chaining include that it can generate non-useful data, inputs might not be relevant to conclusion, and might produce high cost by producing wrong conclusions.

6. Results

7. Analysis of Program and Results

We found it very hard to understand the given provided code and although we tried to base our expert system on the given code, we ended up starting from scratch on most of our code, which made it very difficult to try and complete the project as we had a rocky starting point.

The code was hard to modify and maintain do to the lack of separation of the codes independent parts. The code was also written in C language which is hard to reuse and is not as flexible as C is not object oriented.

GOTO statements in the code affect the performance and efficiency. Existing code uses many switches which affects optimization if we increase the number of rules.

Provided code uses many global variables, which is not a good practice and uses more memory than declaring variables locally. We need to use the variable and clause variable list in an efficient way.

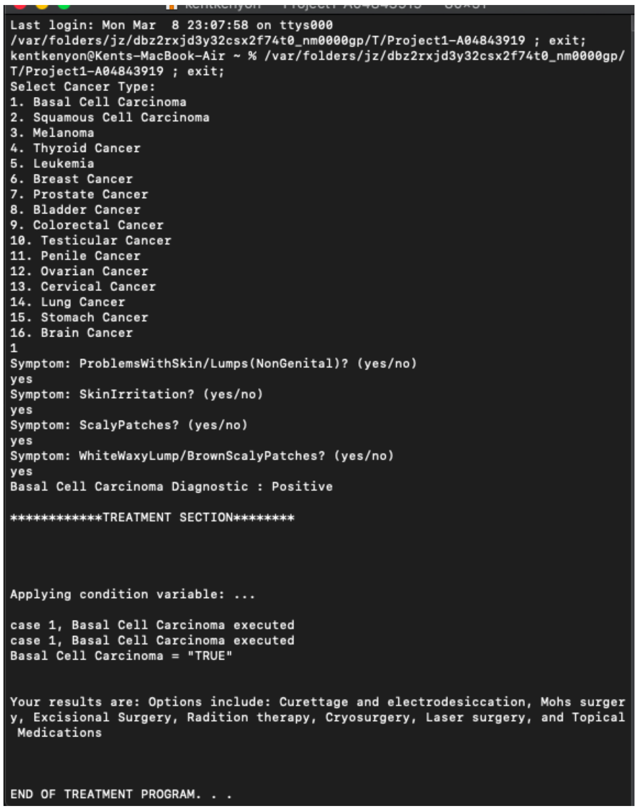

Figure 9. Results

Figure 10. Results

These flaws with the existing code led us to try and make the project from scratch so that we could ideally create a program with no GoTo's, no global variables, and written entirely in C++.

8. Conclusion

We were able to get certain parts of the expert system working and we each understand the concepts of forward and backward chaining, yet we couldn't pull our code together in the end to perfectly work how we wanted it to. We still each learned a lot from this project through trial and error even if the project did not run entirely as smooth as we hoped. Through the experiences brought about in this project we have learned much more about forward and backward chaining.

9. Source Code

*Unfortunately I was unable to figure out how to get my source code into latex so I have included the source code in the GitHub below.

Source Code can be found on GitHub at:

https://github.com/kck46/Artificial-Intelligence-Project-1-.git

References

[1] IBM. What is artificial intelligence (ai)?, 2020.

[2] K. Selby. Americans can't keep up with high cost of cancer treatment, 2020.

[3] WorldHealthOrganizaton. Cancer key facts, 2021.

```
T/Project1-A04843919 ; exit;
Select Cancer Type:
1. Basal Cell Carcinoma
2. Squamous Cell Carcinoma
3. Melanoma
4. Thyroid Cancer
5. Leukemia
6. Breast Cancer
7. Prostate Cancer
8. Bladder Cancer
9. Colorectal Cancer
10. Testicular Cancer
11. Penile Cancer
12. Ovarian Cancer
13. Cervical Cancer
14. Lung Cancer
15. Stomach Cancer
16. Brain Cancer
10
Symptom: ProblemsWithSkin/Lumps(NonGenital)? (yes/no)
no
Symptom: BathroomIssues? (yes/no)
yes
Symptom: GenitalIssues? (yes/no)
yes
Symptom: BloodInUrine/Stool? (yes/no)
no
Symptom: Male? (yes/no)
yes
Symptom: LumpOnTesticles? (yes/no)
yes
Testicular Cancer Diagnostic : Positive

************TREATMENT SECTION********



Applying condition variable: ...

case 1, Basal Cell Carcinoma executed
case 1, Basal Cell Carcinoma executed
Basal Cell Carcinoma = "TRUE"


Your results are: Options include: Curettage and electrodesiccation, Mohs surger
y, Excisional Surgery, Radition therapy, Cryosurgery, Laser surgery, and Topical
 Medications



END OF TREATMENT PROGRAM. . .


[Process completed]
```

Figure 11. Results