Doctors Assistant Program

New Mexico

Supercomputing Challenge

Final Report

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Team #83

Taos High School

Team Members

Sawyer Solfest

Henry Tosta

Skylar Spriggs

J Ryan Cox

Teacher(s)

Tracy Galligan

Project Mentors

N/A

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Executive Summary:

Without fields in medicine, society would not be where it is today. Despite the rapid progress within medical fields, and perfection of said methods, human error is ever – present. In the National Academy of Medicine's study, misdiagnosis rates are very high. A misdiagnosis could be the difference between life or death, making it extremely important for doctors to be as accurate as possible. The Doctor's Assistance Program attempts to reduce the amount of human error present in diagnosis. The program uses "yes or no" questions based on patient's knowledge of their condition. For emergency situations, the patient will be rushed to the ER, and won't use the program. This program could also save doctors time, allowing them to easily prioritize which patients need the most attention. This can also separate doctors from hypochondriacs, saving time by allowing patients that need the soonest attention to be assisted first. The program can also assist in reducing the percent error of diagnoses, ultimately lowering the misdiagnosis rate. Misdiagnosis rates are more stable within their recent years, gradually decreasing since the 1990s. The program could help improve misdiagnosis rates, gradually lowering the percentage over time. By further developing the program, the team can cover more ailments and signs of developing ailments. For example, multiple lower respiratory tract infections in a short period could be an early sign of pneumonia if the patient also suffers symptoms of cardiomegaly. The program could be further expanded by storing past patient data and patient files for the hospital or clinic. This then allows further use the stored data to advise doctors in their diagnoses. The program has great potential to help doctors and patients save time and lives with continued expansion and testing of the program.

Problem Statement:

In multiple medical fields, misdiagnosis is an ongoing issue when treating patients. Most patients receive a proper medical diagnosis, however, despite the majority diagnostic success, many receive false medical opinions. According to The Washington Post, "[m]ore than 20 percent of patients who sought a second opinion at one of the nation's premier medical institutions had been misdiagnosed by their primary care providers, according to new research published" (Bernstein, Lenny). The issue of misdiagnosis is ongoing at institutions that possess the highest levels of medical acclaim in the country. The rates below represent America's diagnosis rates in 2017 (Fig.1).

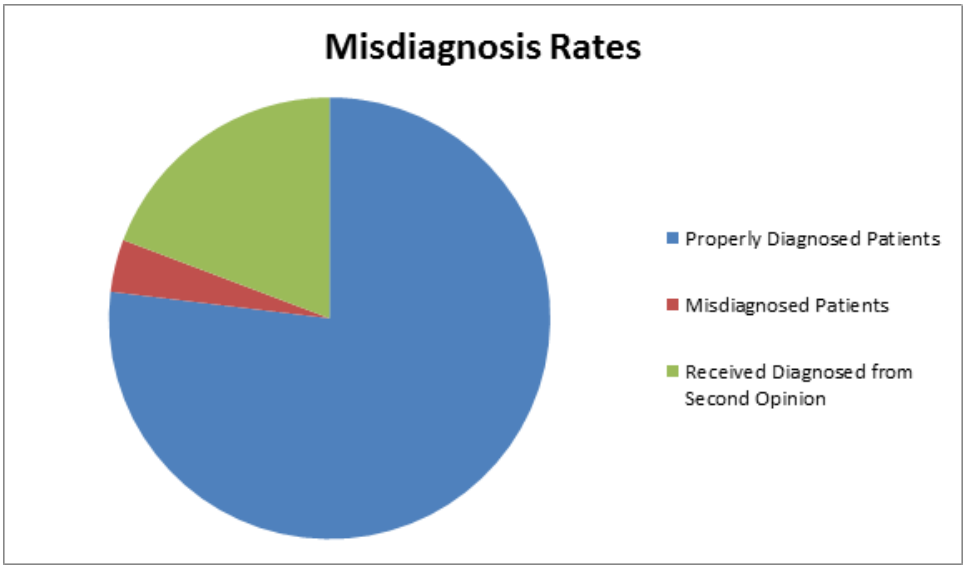

Fig.1

Method of Problem Resolution:

The Doctors Assistant Program's purpose is to provide precursory data on the patient's ailments, prioritize what patients get seen first depending on ailment severity and to prevent hypochondriacs from wasting a medical professional's time. Using computer programs that can

record the patient's symptoms and send a report to the doctor along with possible symptoms to limit human error on the doctor's part. The program will focus on the simplification of the clinical process.

The diversification of ailments within modern medicine is problematic for diagnostics. Datasets have been created for the ailments using symptom found through research. The program will question the potential patient's symptoms, the program will then send gathered data to the patient's practitioner. The information will give doctors a base to build their diagnosis upon. If the program provides information, it could cut down on the time taken by the diagnosis. According to Michon "A large number of medical malpractice lawsuits stem from the misdiagnosis or delayed diagnosis of a medical condition, illness, or injury" (Michon). The information could speed up the diagnosis and make it more accurate.

The program will create a portfolio of potential ailments, the severity of the ailments within the patient's portfolio allows the medical professionals using the program to prioritize the patients with more severe ailments. The base filing system to sort ailments into levels of likelihood depending on the number of matching symptoms inputted by the patient has been implemented. By looking at the data from the filing system the heath care provider can prioritize the order of patients seen. According to Lake et al. "Every day in clinical practice, nurses work in complex, dynamic and uncertain situations" (Lake et al. 376). The program would make the clinical process easier for doctors and nurses.

The program provides the solution with an initial diagnostic based on patient input, like a doctor's initial screening of a patient. The program asks a series of questions based on what ailment the patient believes they are suffering. If the patient believes they are suffering from the flu, the program will provide a set of questions to determine the number of symptoms directly

related to the flu that are affecting the patient. The program then determines if some symptoms are shared between ailments. If the patient has 5 symptoms of the flu affecting it the program will determine if those symptoms are shared with any other ailments to determine any other possible causes. The program does this to ensure that all possible causes are presented to the doctor so the initial impression of the patient can be as accurate as possible. The program also allows patients to provide additional symptoms the doctor should know about, such as having diarrhea when the patient believe they're suffering from the flu. Providing these additional symptoms should help the accuracy of the initial impression for the doctor. The program only determines an initial diagnostic to give the doctor a more accurate initial impression of the patient's condition and diagnose them accurately.

The determination of the symptoms affecting the patient is provided by the patient, always allowing human error. This flaw cannot be fixed without automated equipment that properly determines the issue and therefore cannot be bypassed. The diagnostic that provides the doctor with a better initial impression of the patient's condition will always be subject to the human error. When using the program doctors should remember that human error is always part of the program and can choose to disregard the advice the program provides. The program should never be used as an official diagnostic because the input likely doesn't come from a medical professional. Human error will always be present in all functions of the program and cannot be bypassed by conventional methods, therefore the program should be considered a non-official source of advice for a diagnostic.

Verification and Validation of Model:

We took our symptom sets for ailments from sites on the internet that were verified by multiple sites. For example, the symptoms for lower respiratory tract infections are "shortness of

breath, weakness, fever, coughing and fatigue." according to Wikipedia, Healthline, and Temple Health. The article from Healthline was also medically reviewed by "Deborah Weatherspoon, PhD, RN, CRNA, specialty in Pain Management, on March 4, 2019" (Healthline). We've made sure our sources are accurate when creating our symptom sets.

The program itself runs from user input, allowing human error in all cases. The human error cannot be avoided because the programs functions are centered around the user input. Therefore, we cannot provide validation for the method of this program, but we can view the program differently as an advisory program. By creating not making the program vital, it doesn't take away the medical professional's own interpretation and diagnosis. Instead the program gives an initial impression of the patient's condition based on the results of the questions. The program doesn't affect diagnosis, only the initial impression of patient's condition.

The program hasn't been field tested. No data has been acquired to determine if the program makes an impact in the real world because it's still in development. The program lacks the expansive database that a medical dictionary would have. This flaw exists because integrating that amount of data would take too much time for our small team and therefore is a hindrance to completing the functionality of the program. The program also needs to include several more functions before field testing, like patient stored information and a file system to organize it. That functionality requires a proper UI system, which hasn't been developed yet. The program needs expansion before validating the impact of it.

Introduction of the finished program should stabilize the wildly fluctuating misdiagnosis rates from recent decades and decrease the percentage of error steadily over time. The graph below exemplifies the predicted rate of misdiagnosis after the introduction of the program.

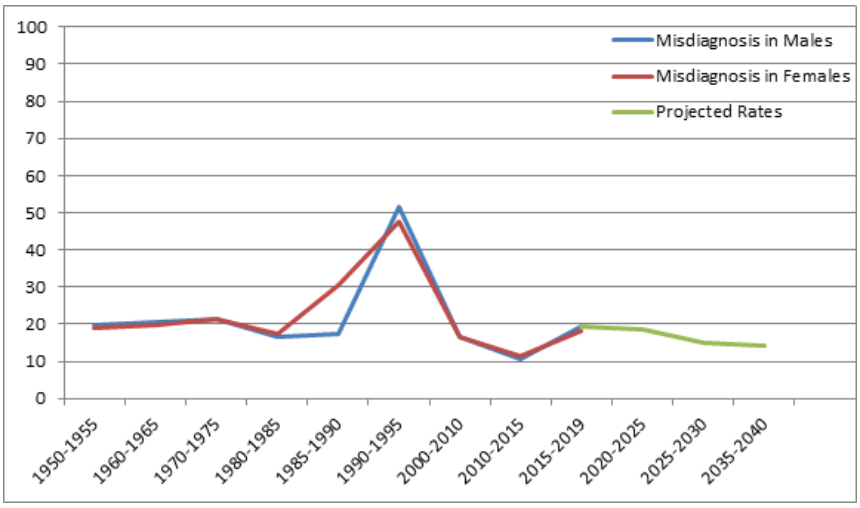

Fig.2

Introducing the program should have similar effects on the percentage of misdiagnosis. The percentage stabilizes and steadily decreases over time, showing a healthy growth in the medical field. The predictions do not take advances in medical science into account because we cannot determine how those advancements will affect medicine. The introduction of our program should still have a similar impact despite advances in medicine changing the misdiagnosis rate.

Results:

Our work gave great feedback for the functionality of implemented features of the program. The program can provide data on symptoms shared between symptom sets and can recommend ways to determine symptoms if the patient is unaware of a symptom affecting them. The symptom sharing determines if a shared symptom is true for every possible shared symptom. When the program detects a symptom that affects the patient it adds all possible symptoms together. The symptoms have an assigned numeric value based on the user input.

Ex:

A hypothetical patient tests negative for 1 symptom, however he tests positive for 3 symptoms. This is represented as this function, where 0 means “no” and 1 means “yes”:

Sympt1 = 0 Sympt2 = 1 Sympt3 = 1 Sympt4 = 1

According to the program's database, Ailment X displays symptoms 1, 2, 3, and 4, represented by this function:

Ailment X = Sympt1 + Sympt2 + Sympt3 + Sympt4

By using the information above and the program’s database, the program can also conclude that the patient may be suffering from Ailment Y rather than Ailment X, because the patient suffers from symptoms 3 and, and not symptoms 1 – 4. This is represented by the function:

If Sympt3 = 1: Ailment Y = Sympt3 + Sympt4

If Sympt4 == 1: Ailment Y = Sympt3 + Sympt4

Based on this example variable Ailment X should equal 3 of 4 possible symptoms and Ailment Y should have both possibly shared symptoms. The code will print the number of symptoms that are affecting the patient from the initial ailment and the print the number of matching symptoms for the second ailment. Ailment X should be 3 of 4 symptoms affecting the patient and 2 of those symptoms are shared with Ailment Y’s symptom set.

If patients don’t know if a symptom is affecting them the program will recommend a way to determine if that symptom is affecting them. For example, if the patient doesn’t know if they have a fever the program will print the proper procedure to test for that symptom. The program should print “Place a thermometer in your ear, point towards the opposite eyes and either wait or press button to take your temperature”. The function gives advice to patients to properly get the

input required for advising the doctor. If the patient doesn't have the time to determine if the symptom affects them, they can ask the program to skip testing. Skipping more than 3 short tests will warn the doctor that the patient is a possible hypochondriac but will never state a denial of care.

One of our team members recently obtained a possible ear infection. Below is the entry of symptoms and the output that would be presented to a doctor.

```
What do you believe you are suffering from? ear infection
Do either of your ears ache?  Y/N: y
Do either of your ears feel full?  Y/N: n
Do either of your ears give a sharp pain?  Y/N: y
Is your hearing muffled in either ear?  Y/N: y
Does either ear drain a liquid?  Y/N: n
Is there any other information or symptoms you would like to provide? Jaw Pain
Earache = y
Feeling of fullness in the ear = n
Sharp pain in the ear = y
Muffled hearing = y
Ear drainage = n
The patient believes they are suffering3/5symptoms of an Ear Infection
The patient provided these additional symptoms: Jaw Pain
```

Fig.3

The program reiterates which symptoms are affecting the patient for the doctor and gives a total out of the max value or X/5. Then the program prints the additional symptoms the patient provided which were not listed in the question series. The process allows a doctor to interpret with as much information as possible and make the most accurate initial diagnosis.

Conclusions:

These medical conclusions do not come from professional medical opinions.

Based on the test results in Figure 3 60 percent of the symptoms were labelled as affecting the patient, meaning there is a defined possibility of ear infection. The patient also listed Jaw Pain as an additional symptom for the doctor, stating there is another possible cause.

That cause could an arthritis in the jaw, causing an affect like an ear infection and potentially making a misdiagnosis.

Another fictional test could be someone suffering from Lower Respiratory Tract Infection. The patient scores 4 of 5 possible symptoms and includes coughing up blood and continued coughing for 2 weeks. The results suggest that the LRTI could instead be Tuberculosis even though the patient scored 80% of the possible symptoms. The potential of misdiagnosis is low because 2 symptoms are shared between the two symptom sets, making the diagnosis of Tuberculosis more likely to be the correct diagnosis. The potential of Tuberculosis being correct is because the additional symptoms provided are more severe than any symptoms within the LRTI list.

We have expected that our program will help stabilize the misdiagnoses rates and allow improved diagnostic conclusions. We were able to come to this conclusion based on the fact that our code results have shown us that given the same patient input information our code will always give that same diagnosis output information. If a more advanced version of our program was instituted in the medical field and became standard procedure for all patients to be run through the program. We are confident that misdiagnosis rate may not drop but will certainly stabilize and we will not see many more surges in the misdiagnose rates, like what appeared in Hong Kong in 1995. There is no need to say that stabilizing misdiagnoses rates in the medical field is a great net positive, and that this program at its apex has the potential to save millions of lives all over the world.

Software, references, tables, and other products of our work:

Figure 1: A pie chart referencing the chance of misdiagnosis in the US in 2017, see page 3

Figure 2: A graph referencing the misdiagnosis rate among men and women over the past 70 years, and the projected rates until 2045

Figure 3:

Most significant achievement:

The most significant achievement of the team is the program and its functionality. As the team continues to log more diseases into the program's library, the program's functionality expands, and can be further used in a practical setting. Currently the program is still being expanded to include new diseases, such as cardiac or pulmonary ailments. The team has added in an "unaware function" for patients that are unclear on a disease that they have. In most cases, this is the situation that would transpire, making the practical use of the program more appropriate in the "real world." The thought process was that most patients do not have medical degrees, so to make the program more accessible, this unaware function gives patients.

Acknowledgments of the people and organizations that helped you:

The team would like to thank their teacher Tracy Galligan for tolerating them through the year. The team appreciate her allowing them the opportunity to complete the project in her classroom during and after class. Without her patience and persistence, the project would not have been completed to an acceptable point. She is a great person and mentor and the team thank her for the effort she put in to organizing everyone's participation in the challenge this year.

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