



GRADUATION PROJECT

Faculty of Science Alexandria University
Software Industry & Multimedia program

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Cancer Fighters System



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Introduction

Motivation

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells that can result in death if not treated. Although the causes of cancer are not completely understood, numerous factors are known to increase risk, including many that are potentially modifiable (e.g., tobacco use and excess body weight) and others that are not (e.g., inherited genetic mutations). These risk factors may act simultaneously or in sequence to initiate and/or promote cancer growth.

More than 16.9 million Americans with a history of invasive cancer were alive on January 1, 2019, most of whom were diagnosed many years ago and have no current evidence of the disease.

New Cancer Cases—2021 Estimates



Female

Breast	281,550	30%
Lung & bronchus	116,660	13%
Colon & rectum	69,980	8%
Uterine corpus	66,570	7%
Melanoma of the skin	43,850	5%
Non-Hodgkin lymphoma	35,930	4%
Thyroid	32,130	3%
Pancreas	28,480	3%
Kidney & renal pelvis	27,300	3%
Leukemia	25,560	3%
All sites	927,910	

Due to American Cancer Society Breast Cancer new female cases in 2021 is 30% from the whole Cancer patients in that year, which comes in the first place in comparison with other Cancer new cases. Melanoma of the skin

comes in the fifth place of new female cases in 2021 which presents 5% from the whole Cancer patients in that year.

New Cancer Deaths – 2021 Estimates

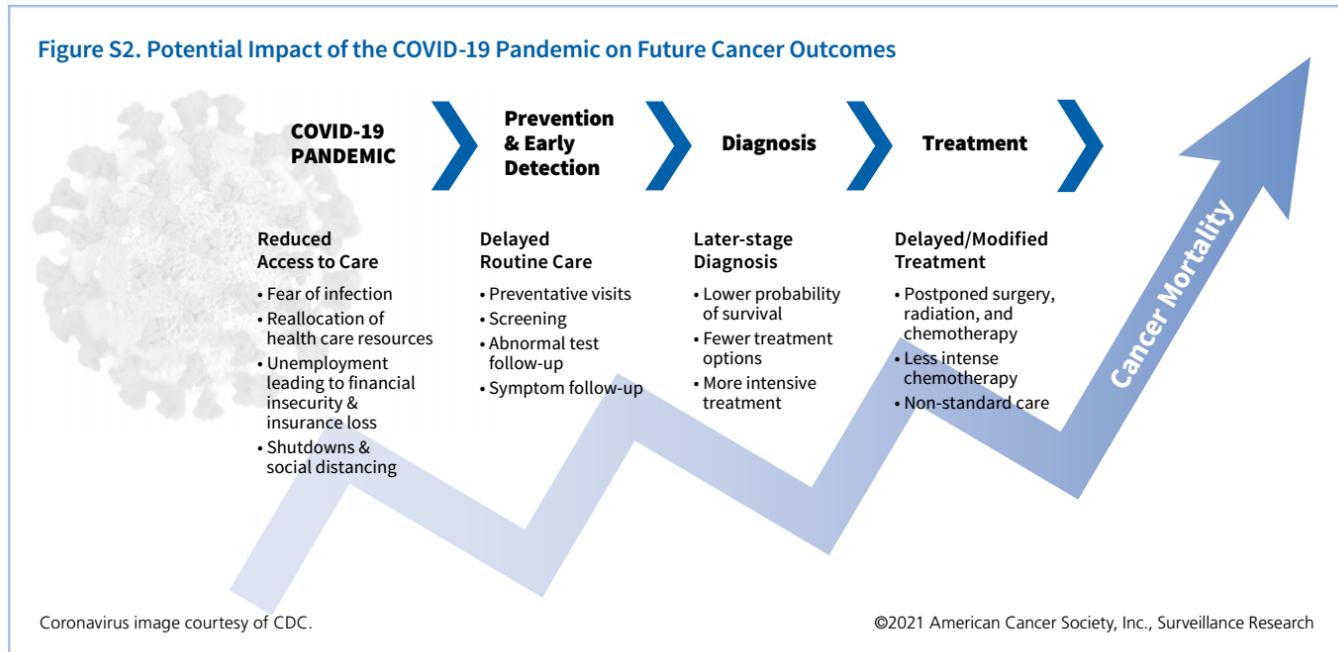


Female

Lung & bronchus	62,470	22%
Breast	43,600	15%
Colon & rectum	24,460	8%
Pancreas	22,950	8%
Ovary	13,770	5%
Uterine corpus	12,940	4%
Liver & intrahepatic bile duct	9,930	3%
Leukemia	9,760	3%
Non-Hodgkin lymphoma	8,550	3%
Brain & other nervous system	8,100	3%
All sites	289,150	

Due to American Cancer Society Breast Cancer new female deaths in 2021 is 15% from the whole Cancer patients in that year, which comes in the second

place in comparison with other Cancer new cases.



Due to the American Cancer Society, at the onset of the COVID-19 pandemic, the American Cancer Society and other organizations recommended that routine cancer screenings and other elective medical procedures be postponed in order to prioritize urgent medical needs and reduce the spread of COVID-19.

TABLE 9: Estimated number of cancer cases, Egypt 2013–2050.

	2013			2015			2020			2025			2050		
	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
Lip	135	126	262	146	135	281	178	164	342	206	202	408	438	427	866
Tongue	155	175	330	164	185	349	186	231	417	219	296	515	417	763	1180
Mouth	228	163	391	243	178	420	275	216	491	314	261	575	544	528	1071
Salivary glands	147	108	255	158	117	275	189	130	319	222	153	375	495	265	760
Tonsil	6	31	37	6	33	40	9	41	50	11	54	65	13	129	142
Other oropharynx	42	25	67	45	28	73	54	30	85	63	37	100	132	65	198
Naso pharynx	145	32	178	154	34	188	171	40	211	207	42	249	428	68	496
Hypopharynx	72	80	152	76	85	161	88	96	184	102	111	213	200	173	372
Pharynx unspec.	35	7	42	36	7	43	42	7	48	55	7	62	94	8	102
Oesophagus	699	485	1184	746	525	1271	897	644	1542	1065	762	1827	2249	1504	3752
Stomach	726	969	1695	772	1045	1816	922	1249	2171	1080	1484	2565	2185	2877	5062
Small intestine	98	179	277	106	194	300	120	229	349	134	274	408	223	507	730
Colon	1522	1339	2862	1618	1437	3055	1893	1715	3608	2225	2063	4287	4465	4120	8585
Rectum	464	406	871	490	432	922	568	502	1070	645	584	1230	1097	1052	2149
Anus	133	50	183	142	53	195	162	65	227	178	71	249	291	127	418
Liver	19646	8345	27991	20932	9043	29975	24420	10900	35320	28580	12933	41513	59047	26425	85471
Gallbladder and so forth	235	324	559	248	350	598	297	413	710	348	488	835	715	967	1682
Pancreas	1350	876	2226	1440	957	2397	1676	1160	2836	1961	1405	3366	3912	2971	6883
Nose, sinuses and so forth	98	136	234	104	144	247	124	170	294	154	186	340	340	322	661
Larynx	933	134	1067	993	142	1136	1194	173	1367	1428	201	1629	3094	395	3489
Trachea, Bronchus, Lung	3304	1586	4890	3530	1703	5233	4168	2031	6198	4889	2404	7293	10176	4895	15071
Other Thoracic organs	368	260	628	393	277	670	464	335	798	551	415	966	1149	897	2046
Bone	889	957	1846	935	1011	1946	1068	1174	2242	1216	1330	2546	2212	2401	4613
Melanoma of skin	60	59	119	66	66	132	82	84	166	95	105	200	181	207	388
Other skin	797	749	1547	853	813	1666	1018	973	1990	1205	1160	2365	2641	2306	4947
Mesothelioma	55	106	161	58	116	174	65	143	207	76	161	238	135	321	456
Kaposi sarcoma	60	8	68	63	9	72	72	10	82	81	13	95	159	28	187
Connective, Soft tissue	801	751	1552	846	787	1633	981	901	1882	1113	1026	2139	1924	1796	3720
Breast	287	17905	18192	306	19105	19411	362	22320	22682	422	25793	26215	807	45243	46050
Vulva	0	52	52	0	56	56	0	63	63	0	76	76	0	146	146
Vagina	0	95	95	0	103	103	0	126	126	0	147	147	0	305	305
Cervix Uteri	0	701	701	0	752	752	0	882	882	0	1039	1039	0	2039	2039
Corpus Uteri	0	392	392	0	426	426	0	502	502	0	600	600	0	1256	1256
Uterus unspec.	0	1353	1353	0	1456	1456	0	1758	1758	0	2055	2055	0	4143	4143
Ovary	0	2288	2288	0	2434	2434	0	2830	2830	0	3311	3311	0	5957	5957
Other female genital	0	30	30	0	34	34	0	44	44	0	55	55	0	134	134
Placenta	0	14	14	0	14	14	0	14	14	0	15	15	0	18	18
Penis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prostate	2544	0	2544	2747	0	2747	3398	0	3398	4295	0	4295	10785	0	10785
Testis	229	0	229	240	0	240	266	0	266	291	0	291	425	0	425
Other male genital	21	0	21	22	0	22	28	0	28	33	0	33	73	0	73
Kidney	877	561	1438	934	594	1528	1080	693	1774	1274	801	2076	2628	1487	4115
Renal pelvis	141	99	240	152	103	255	183	115	297	214	126	341	446	196	642

Due to Results of the National Population-Based Cancer Registry Program in Egypt, estimated number of cancer cases in Egypt 2013–2050:

Year/Cancer type	Breast	Melanoma of skin	Other skin
2020	22682	166	1990
2025	26215	200	2365
2050	46050	388	4947

Problem Statement

Access to health care and care delivery during the COVID-19 pandemic may be challenging for cancer patients. Several guidelines have been developed, which recommend treatment adjustments depending on the site of cancer, grade, and stage. However, few studies in India and across the globe have looked into the real challenges faced by cancer patients and assessed the effectiveness of the adopted interventions. This study was undertaken with the objective to study the challenges faced by cancer patients in India during the COVID-19 pandemic.

The various health care delivery issues as highlighted by the cancer patients responding to the survey are depicted in Table 3. Slot availability for teleconsultation was cited as an issue by 15 (41.7%) of the respondents, network issues was cited by 12 (33.3%) of the respondents, deferral of radiotherapy dates and long waiting hours beyond appointment time was a problem cited by 8 (22.2%) of the respondents, transportation problems from residence to hospital was faced by 28 (77.8%) of the respondents, restriction of visitors/attendants was cited as an issue by 26 (72.2%) of the respondents, deferral of surgery was a matter of concern for 5 (13.8%) respondents, deferral of tumor boards was cited as an issue by 7 (19.5%) of the respondents, delay and deferral of advice of the nutritionist was cited as an issue by 32 (88.9%) of the respondents, problems faced in extension of visa was cited as an issue by 4 (11.2%) of the respondents, unavailability of peer group support services and psychological counseling sessions was problematic for 34 (94.4%) of the respondents, difficulty in maintaining precautionary measures was cited as an issue by 12 (33.3%) of the respondents, availability of chemotherapy medications was cited as an issue by 8 (22.2%) respondents and availability of chemotherapy slots in day care was problematic for 20 (55.6%) of the respondents. Needless to mention there were multiple responses to this question, which means that

patients faced multiple problems concerning health care delivery. The average delay in surgery was 3.22 days (± 0.26), which was mainly due to the availability of COVID-19 results from throat or nasal swabs without which many hospitals that do not have dedicated operation theatres for COVID-19 positive cases are not allowing surgeries specially in patients coming from stamped containment zones. Surgeries are being allowed only if the results are negative. There was 1 patient, a follow-up case of laryngeal cancer after total laryngectomy, who had surgical delay due to delay in supply of the voice box.

Health Care Delivery Issues as Highlighted by the Cancer Patients Responding to the Survey.

^a Health care delivery issues	Percentage (n)
Unavailability of peer group support services and psychological counseling sessions	94.4 (34)
Delay and deferral of advice of the nutritionist	88.9 (32)
Transportation problems from residence to hospital	77.8 (28)
Restriction of visitors/attendants	72.2 (26)
Availability of chemotherapy slots in day care	55.6 (20)
Slot availability for teleconsultation	41.7 (15)
Network issues	33.3 (12)
Difficulty in maintaining precautionary measures	33.3 (12)
Deferral of radiotherapy dates and long waiting hours beyond appointment time	33.3 (12)
Availability of chemotherapy medications	22.2 (8)
Deferral of tumor boards	19.5 (7)
Deferral of surgery	13.8 (5)
Extension of visa	11.2 (4)

Among the study respondents, 33 (91.7%) mentioned an increase in their anxiety levels, 3(8.3%) mentioned their anxiety levels remained unaltered while none reported a reduction in their anxiety levels. Among the 3 patients who reported unaltered anxiety levels, 2 were

thyroid cancer patients and 1 was a laryngeal cancer patient declared cancer free for the past 1 year and on regular follow-up now.

The reasons for increased anxiety as highlighted by the study respondents are depicted in Table 4. Fear of infection with COVID-19 was the reason for increased anxiety in 33 (91.7%) of the respondents, fear of the inherent disease getting aggravated for treatment delay was the reason for 31 (86.1%) of the respondents, 20 (55.6%) of the respondents mentioned treatment not being optimum as the reason for their increased anxiety, 10 (27.8%) reported increased anxiety due to fear of death and 8 (22.2%) respondents mentioned fear of losing jobs and financial crisis for the family members as the cause of their increased anxiety.

Reasons for Increased Anxiety in Cancer Patients Responding to the Survey.

Reasons for increased anxiety in cancer patients	Percentage (n)
Fear of COVID-19 as there is increased chance of infection	91.7 (33)
Fear of the inherent disease getting aggravated for delay in treatment	86.1 (31)
Treatment not optimum	55.6 (20)
Fear of death	27.8 (10)
Fear of losing jobs and financial crisis for family members	22.2 (8)

Goals of the project

Main goal of the system is to provide many online services for cancer patients that was difficult to get quickly, provide a way to let Cancer survivors help Cancer patients, pave a highway for Cancer patients to the intensive care, patients get their medicaments in easiest and fastest way, provide a way for doctors to make surer from their breast and skin.

Currently Available Solutions

MBC Connect:

MBC Connect is an interactive patient experience registry designed specifically for people with stage IV or metastatic breast cancer (MBC) or advanced breast cancer. Patients or caregivers can enter health and medical information, which contributes to a powerful database that will help drive advances in MBC research. You'll also receive valuable feedback and insights about MBC.

Cancer.Net Mobile:

Cancer.Net Mobile is an award-winning free mobile application from the American Society of Clinical Oncology. Available on both iOS and Android devices, Cancer.Net Mobile provides a fully-featured set of tools to help manage your cancer care, as well as trusted, oncologist-approved information from Cancer.Net.

The app includes features that allow patients to get up to date information on more than 120 types of cancer, log and track their treatments, receive advice on how to manage side effects, provide cost of care information, and connect to links for cancer-related podcasts, videos, and blogs. This app is available for Spanish speakers as well and allows patients to track symptoms, log medication and facilitate communication between doctor and patient.

CareZone:

Free for iPhone or Android. This organizational app helps patients remember treatments, plan care notes, summarize drug administration protocols, deliver medication and doctors' visit reminders, and simplify treatment through taking and retaining pictures of medications, prescriptions, and supplements. The app also provides a journaling area for tracking appointments and keeping notes to discuss with doctors.

MoleScope:

This is a high resolution camera compatible with many different smartphones. This camera uses high magnification and special lighting to take more detailed and better quality photos than other skin cancer apps.

It also contains many features that other apps do, such as skin mapping, image management, and regular reminders.

Features Matrix

Features	Cancer Fighters	Cancer.NetMobile	MBC Connect	MoleScope	CareZone
Free	✓	✓	✓	✓	✓
Breast Detection	✓	X	X	X	X
Skin Detection	✓	X	X	✓	X
Provide treatment	✓	X	✓	X	✓
Buy medicaments	✓	X	X	X	X

Survivor can sell or denote their unused medicaments	✓	X	X	X	X
Book a bed	✓	X	X	X	X
Chat	✓	✓	X	✓	X
Take a researches	X	X	✓	X	X
Reminder	✓	✓	X	✓	✓
Language-enabled	X	✓	✓	X	X
Medical Consultant	✓	✓	X	X	✓
Track symptoms	X	✓	X	X	X
Image import/Export	✓	X	X	✓	X
3D body map	X	X	X	✓	X

Software Development Methodology Used

Agile iterations are usually between two and four weeks long, with a final completion date. The workflow of an Agile iteration will typically consist of five steps:



1. Plan requirements
2. Develop product
3. Test software
4. Deliver iteration
5. Incorporate feedback

We will use **Agile** software development methodology for this reasons:

1. Reduces Technical Debt

Technical debt refers to the maintenance tasks required to support the existing product. Those tasks include defect resolution, refactoring, and testing. In a traditional project methodology, this technical debt can

accumulate quickly as the team focuses on new feature development to keep pace with the project timeline.

Agile software development helps keep technical debt to a minimum. Any defects, feature changes or other maintenance tasks are added to what is known as a product backlog. The team reviews the backlog during each sprint planning session to determine what to address next. Thus, each sprint is a new opportunity to fix defects along with new feature development.

2. Easily and Quickly Adapt to Change

Teams not only adapt to change in Agile, they are encouraged to embrace the practice. Agile acknowledges that customer needs change and that teams must be able to adapt. Working in time-boxed iterations means the team does not need to wait on a lengthy requirement change, review and approval process. Any change or maintenance item is added to the backlog and allotted to an upcoming sprint based on priority and business need.

3. Using Agile for Mobile Application Development and Testing Creates Total Alignment and Transparency

An Agile software development process requires a level of collaboration and involvement that one would not find in a traditional waterfall project. In waterfall, each phase often only involves a specific set of individuals with expertise to accomplish the tasks for that phase. However, Agile is quite different.

Before each sprint, the entire team reviews, validates, and agrees on which user stories to assign to the sprint. The developers, analysts, testers, and product owner work together to accomplish the items assigned to the sprint. The team meets daily to keep everyone on the same page. Throughout the sprint, each team member verifies each feature and works closely with the developers to ensure it meets the customer's needs.

4. Agile Software Development and Test Minimize Risk

Although teams do their best to plan the phases of a waterfall project, there is often a level of uncertainty that isn't typically found in Agile software development. The traditional approach to software development leaves product testing and release to the end of the project. Waiting until the end leaves the team unsure if the product meets the customer's needs.

Using Agile for mobile application testing, teams get feedback almost daily and can act on that feedback immediately. Developing a product in sprints allows teams to quickly determine if they are on track and allows them to adjust almost immediately. Also, because sprints are customer-focused, the team can be sure they are producing value at every release.

5. Higher Quality Product

Waterfall methodology can negatively impact the quality of the product. In a waterfall methodology, project phases may be so full of features that developers must rush to complete them and little time is left for testing. As a result, they may not have the time needed for proper mobile application testing.

On an Agile project, the team does not attempt to develop all features at once. Instead, the team assigns a smaller subset of features to each sprint. That way, the developers have more time to perfect those items before release. Furthermore, Agile's reliance on continuous integration (merging all developers' working copies to a shared repository several times a day) gives developers the chance to test issues daily and address them immediately. Working on a product in small incremental releases ensures that each sprint results in a fully tested and working product.

6. Predictable Delivery Dates

Waterfall projects revolve around lengthy project cycles that make it difficult for teams to predict a release date accurately. Agile iterations happen in time-

boxed sprints that result in a working product at each release. Thus, the product owner knows that they will get new features at the end of every sprint.

7. Better Stakeholder Engagement

For Agile software development to be successful, it is important for the product owner to be engaged throughout the process. Unfortunately, that level of engagement doesn't happen in waterfall projects. In a waterfall project, stakeholders aren't inclined to participate past the requirements gathering phase and only re-engage during user acceptance testing (UAT). Unlike waterfall, product owners are very active participants in Agile sprints. This level of involvement gives them a sense of ownership that encourages further engagement.

8. User-Focused Testing

Agile is about more than just adapting to change. It is about delivering what is most important to the customer. As such, the product owner works closely with the team to help them gain a clear understanding of what is needed. In Agile software development, user requirements are represented as "user stories." These stories define an action that provides value to the customer. The concept of user stories is a stark contrast to the rather lengthy list of requirements developed in a traditional development methodology.

9. Greater Customer Satisfaction

The product owner actively participates in the sprints during the Agile development and testing process. Their participation in this manner ultimately fosters a level of engagement that ensures their needs are being met. Not only that, they get to see a working product at the end of each sprint and will be pleased that their team can deliver releases more quickly and frequently.

10. Better Project Control

Teams work together, along with the product owner, to determine what goes into each sprint. That way, the team is on the same page about what needs to be delivered. Also, there is less of a chance of surprises or unplanned features making it into the build.

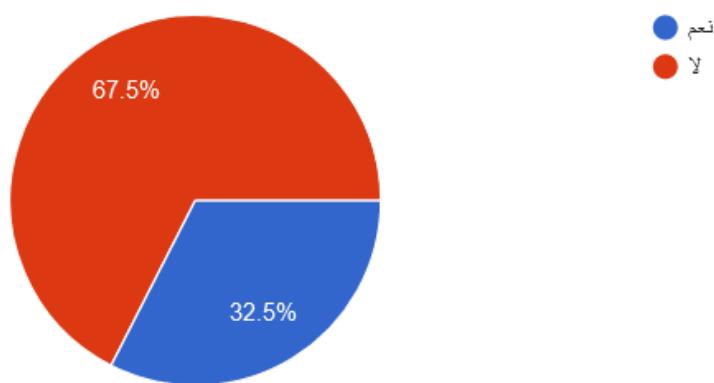
Requirement Analysis

Surveys and results

We made online surveys for patients, survivors and doctors.

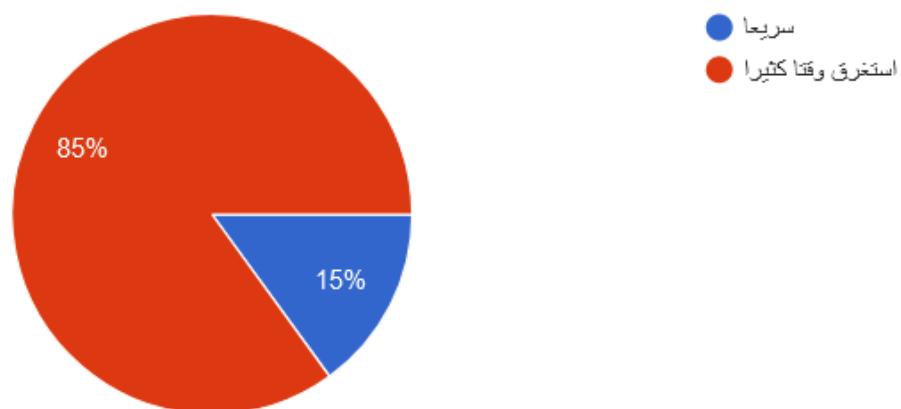
هل تجد العلاج الذي تريده بسهولة ؟

40 responses



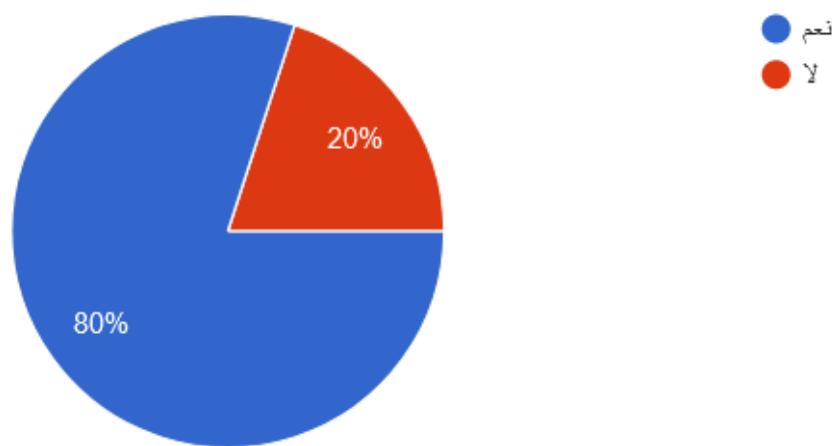
هل تستطيع حجز سرير بالعناية المركزة سريعاً أم تستغرق وقتاً كثيراً؟

40 responses



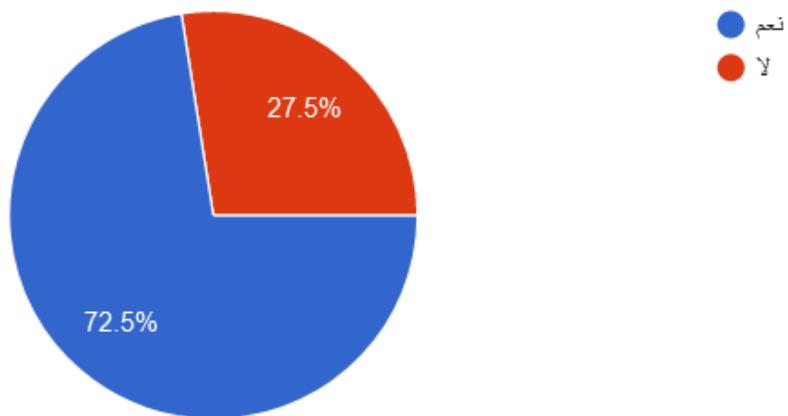
هل تفضل بيع الأدوية الغير المستخدمة على الموقع أو التبرع بها؟

40 responses



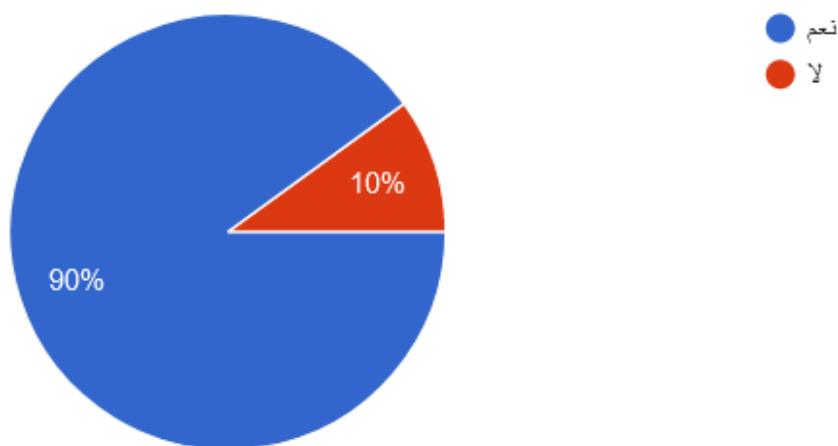
هل تجد صعوبة في الوثوق في الطبيب المعالج في التشخيص و رحلة العلاج؟

40 responses



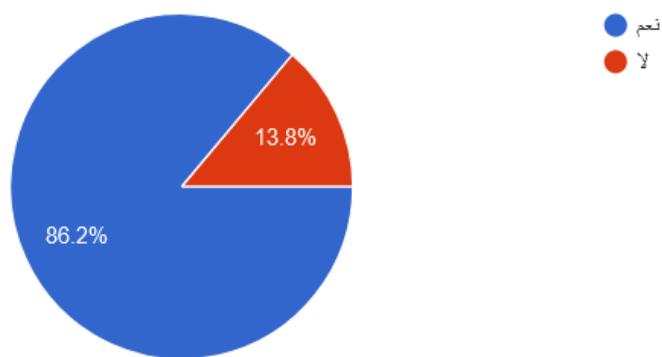
هل تجد عبئاً مادياً في الذهاب لأكثر من طبيب للتأكد من تشخيص حالتك؟

40 responses



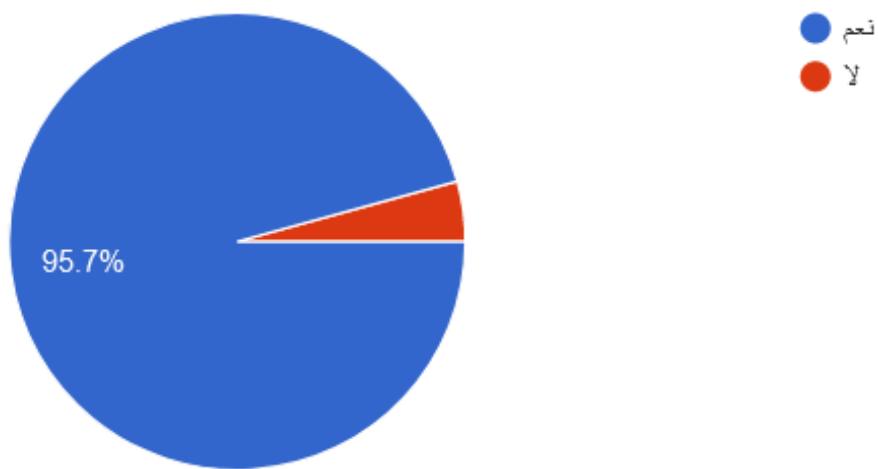
هل تفضل ان ترفع اشعة مقطعيه لمريض سرطان و يتم التشخيص عن طريق الذكاء الاصطناعي لتساعدك في التأكد من دقة التشخيص؟

94 responses



هل تفضل ان يكون حجز العيادات اونلاين ؟

94 responses



Discussion of results of survey

From the statistical analysis of the users' survey responses we get that:

- 67.5% of the patients don't find their medicaments easily.
- 85% of the patients take a long time to book a bed in the intensive care.
- 80% of the survivors prefer to sell or donate their unused medicaments on the website.
- 72.5% of the patients can't trust doctor's diagnosis.
- 90% of the patients find financial burden in going to many doctors to make sure from the diagnosis.
- 95.7% of the doctors prefer the online booking of clinics.
- 86.2% of the doctors prefer the diagnosis by ML models.
- 61.7% of the doctors prefer the treatment by ML models.
- 86.2% of the doctors prefer the prognosis by ML models.

Patients hope for online monthly check through their medical reports.

Patients hope that ML models could also help in telling them the side effects of the medicaments in their case.

Main Features

1. Breast cancer detection with deep learning models
2. Skin cancer detection with deep learning models
3. Patients can buy medicaments online from the website
4. Cancer survivors can sell or donate their unused medicaments
5. Patients can book a bed in intensive care
6. Chat rooms for survivors and patients (high scope)
7. Medical consultant (high scope)
8. Medicaments reminder (high scope)
9. Clinics online booking (high scope)

Functional requirements

Functional Requirements of patients

- They can register on the website.
- They can book for a clinic from the website and receive the reservation id and time.
- They can rate the doctors on the website.
- They can book a bed in the intensive care from the website and receive the reservation id and the doctor name.
- They can search for the needed medicament and order it online.
- They can enter the time of taking each medicament and the application will send a notification in the time.
- They can book for a clinic online.

Functional Requirements of survivors

- They can register on the website.
- They can book for a clinic from the website and receive the reservation id and time.
- They can rate the doctors on the website.
- They can book a bed in the intensive care from the website and receive the reservation id and the doctor name.

Functional Requirements of doctors

- They can register on the website.
- They can upload x-ray or medical reports on the website and get the medical diagnosis, prognosis and treatment.
- They can chat with the admin for complains and inquiries.
- They can make their profile on the website and show their clinics time for the patients to book.
- They will receive the information of the patients that book for clinics with them.

Functional Requirements of admin

- They can register on the website.
- They give the approval for doctors, hospitals and pharmacies registration on the website.
- They can manage data on the website.
- They can chat with doctors, hospitals and pharmacies to receive complains and inquiries.

Functional Requirements of hospitals

- They can register on the website.
- They can chat with the admin for complains and inquiries.

- They can make their profile to show for the patients.
- They can update the number of beds in their intensive care.
- They can receive and confirm the patient request for the bed in intensive care.

Functional Requirements of pharmacy

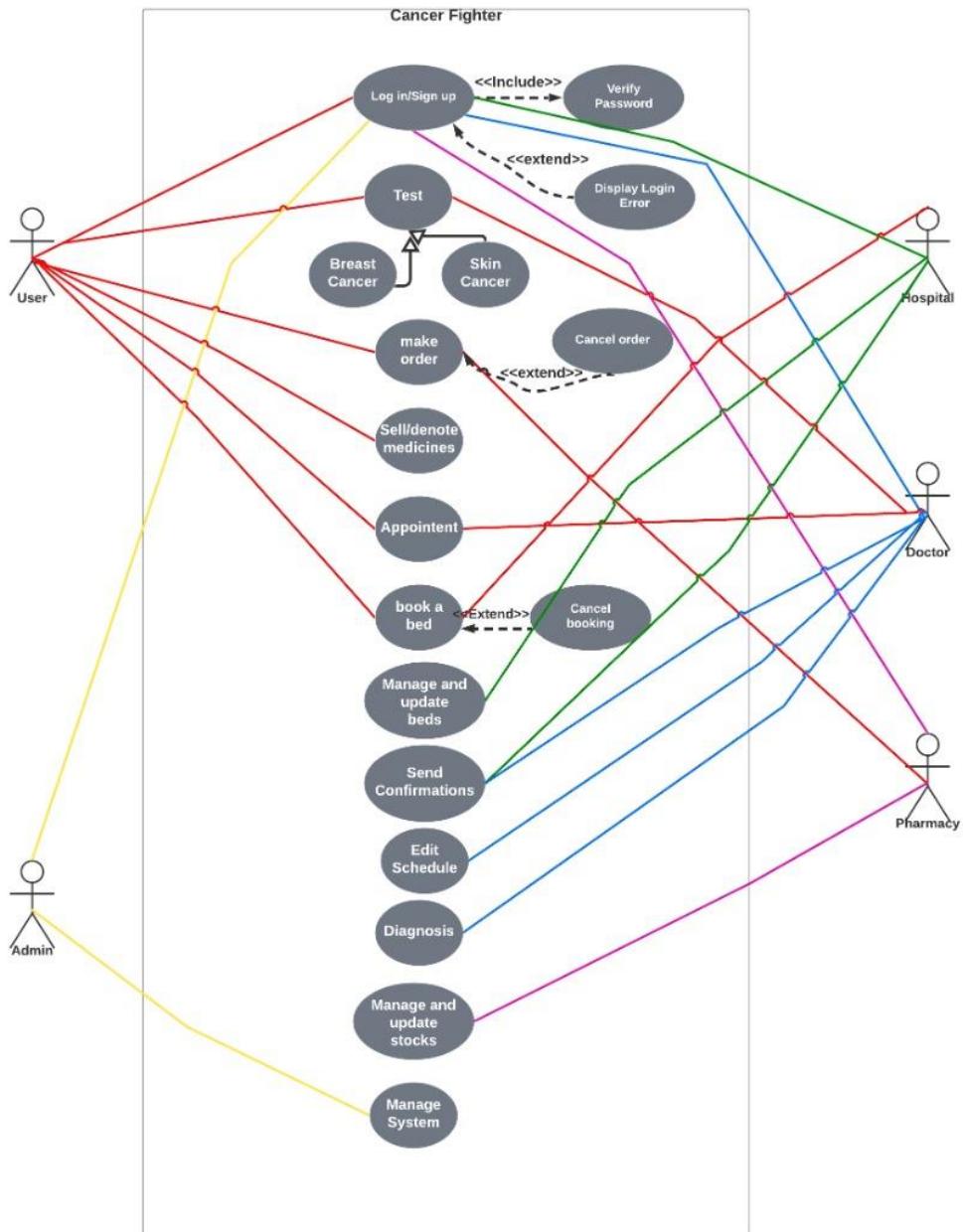
- They can register on the website.
- They can chat with the admin for complains and inquiries.
- They can add and update the stock data on the website.
- They can receive orders from patients.

Nonfunctional requirements

Usability	1- A simple responsive design should be used, so the application will be easy to learn. 2- Easy of remember: Any function of the application will be easy to be remembered. 3- It is possible to reach any given system from the main window in less than 3-4 clicks.
Portability	1- The mobile application will be available on iOS and Android devices.
Availability	1- The system shall meet 99% uptime. 2- The system shall not be unavailable for more than 1 hour. 3- Less than 30 seconds shall be needed to restart the system after a failure 95% of the time.
Maintainability	Installation of a new version shall leave all database content and all personal settings unchanged.

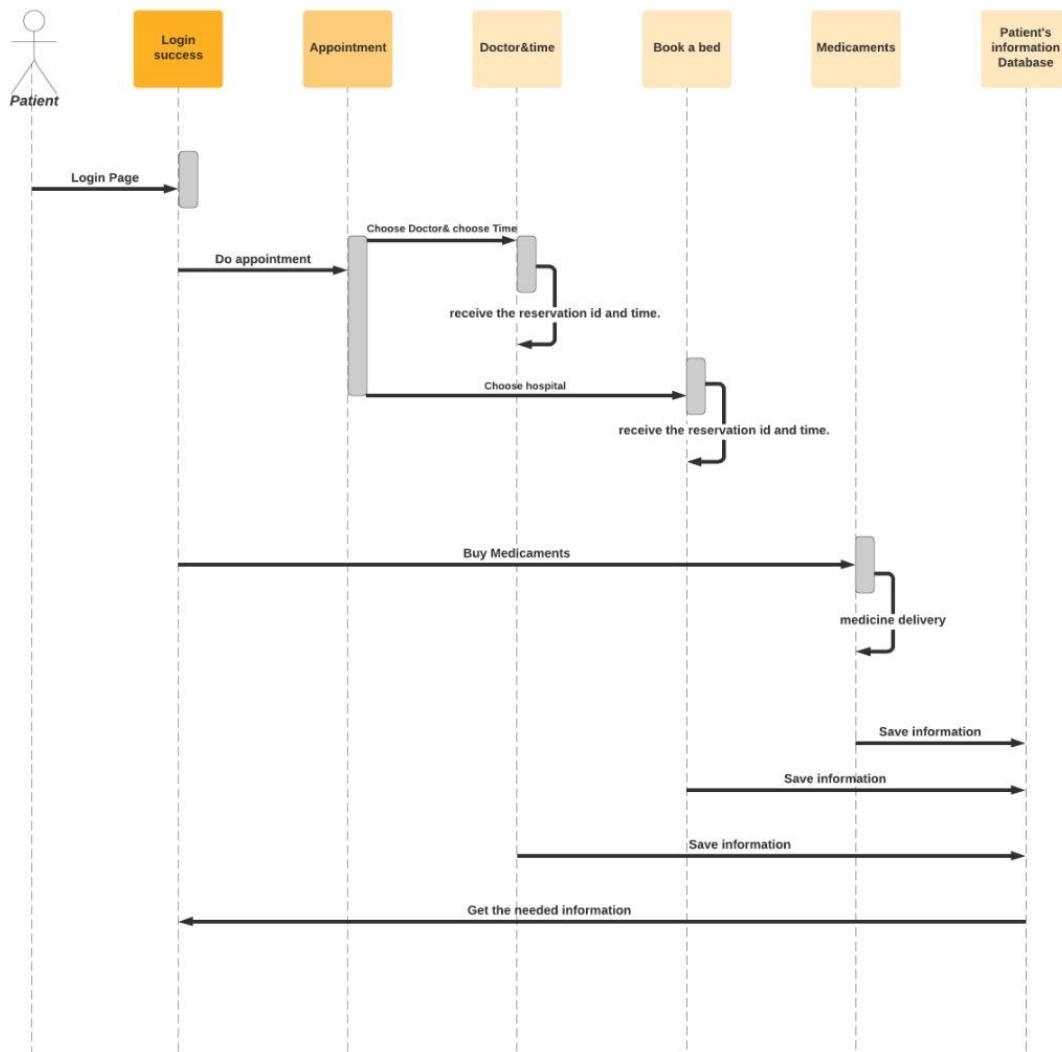
Performance	<p>1- The application performance should be optimized, and response time should be minimized.</p> <p>2- So in case of executing queries, this operation should be performed in less than 2 seconds.</p> <p>3- Every list retrieved from the database should be segmented into several pages, since it reduces server load.</p>
Reliability	The system defect rate shall be less than 1 failure per 1000 hours of operation.
Privacy	User's personal information shall be protected and will not be accessed by unauthorized sources or third parties.
Ethical	We ensure that the system will be for the benefit of society and will cause no harm to the users

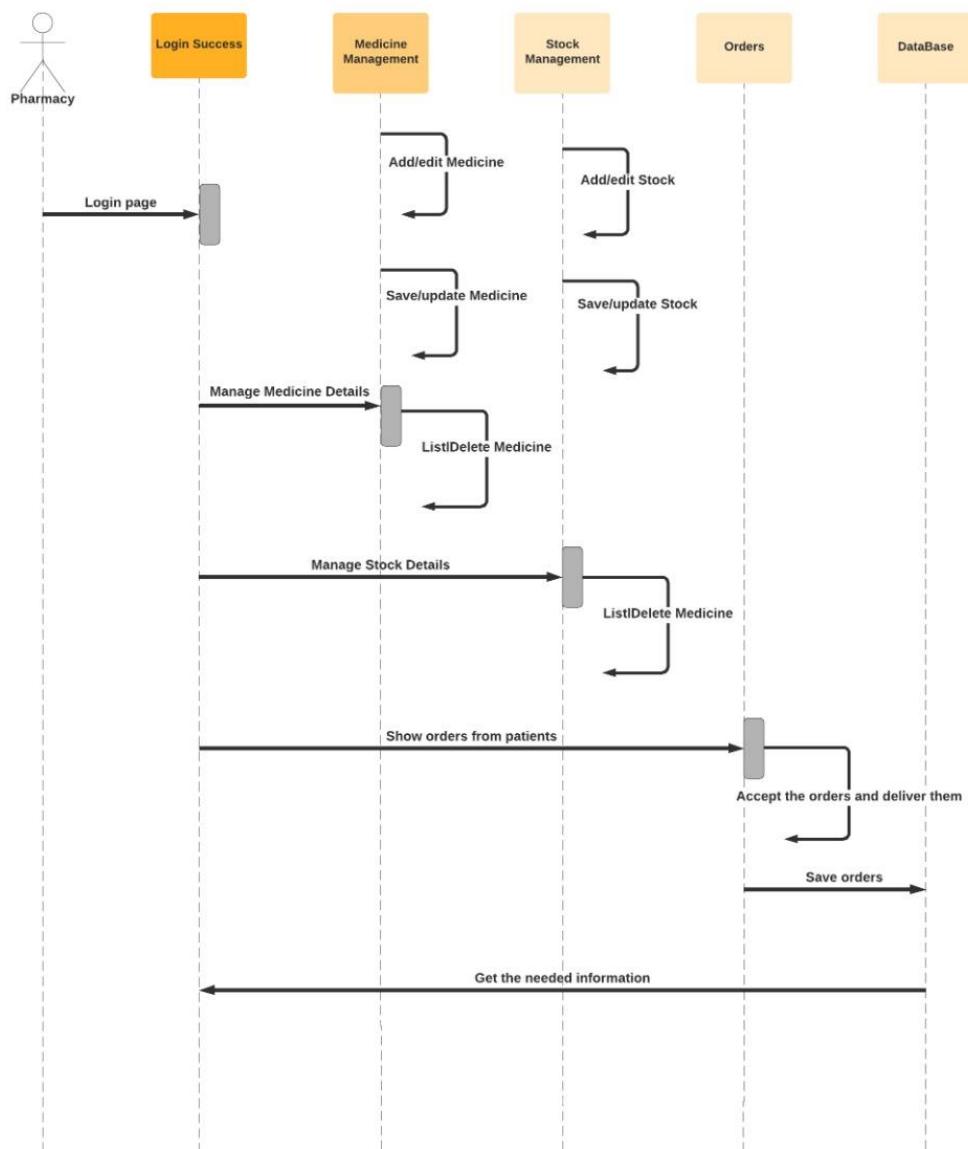
Use case diagram

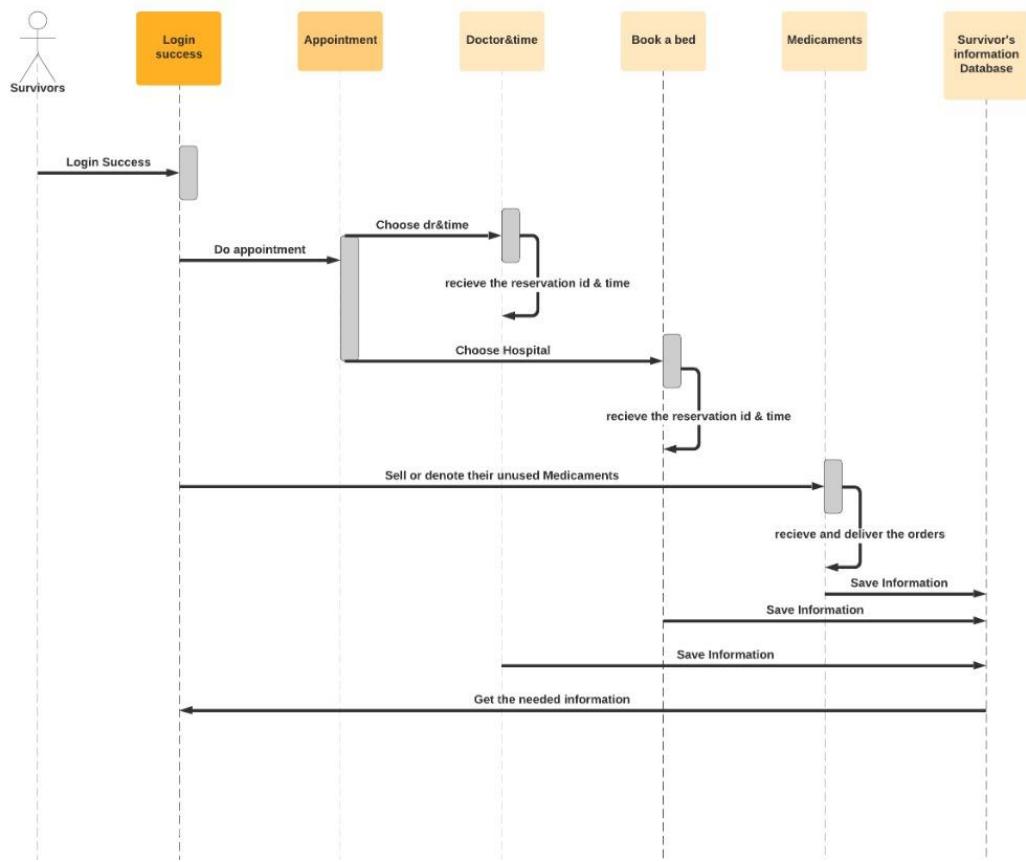


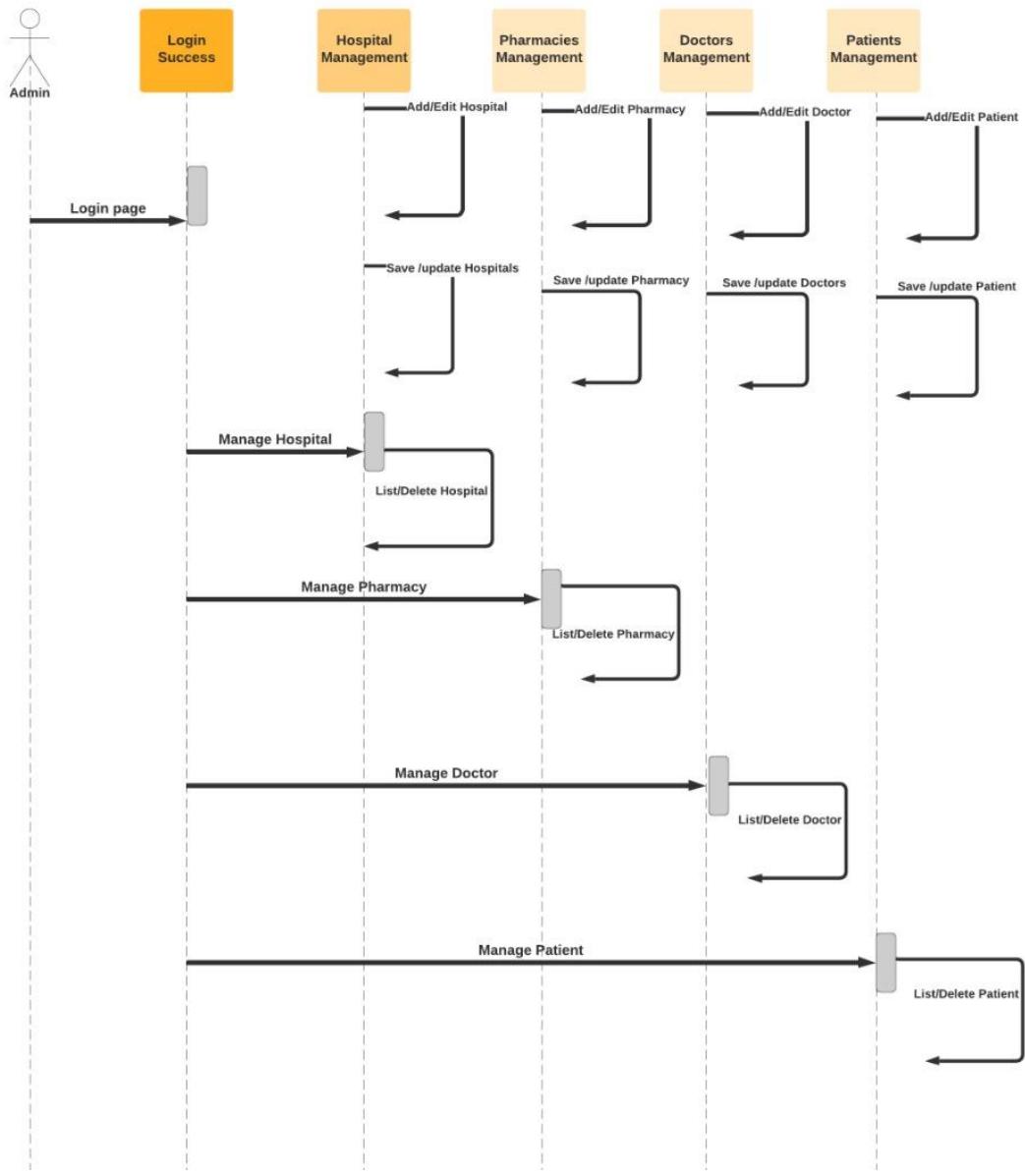
Design

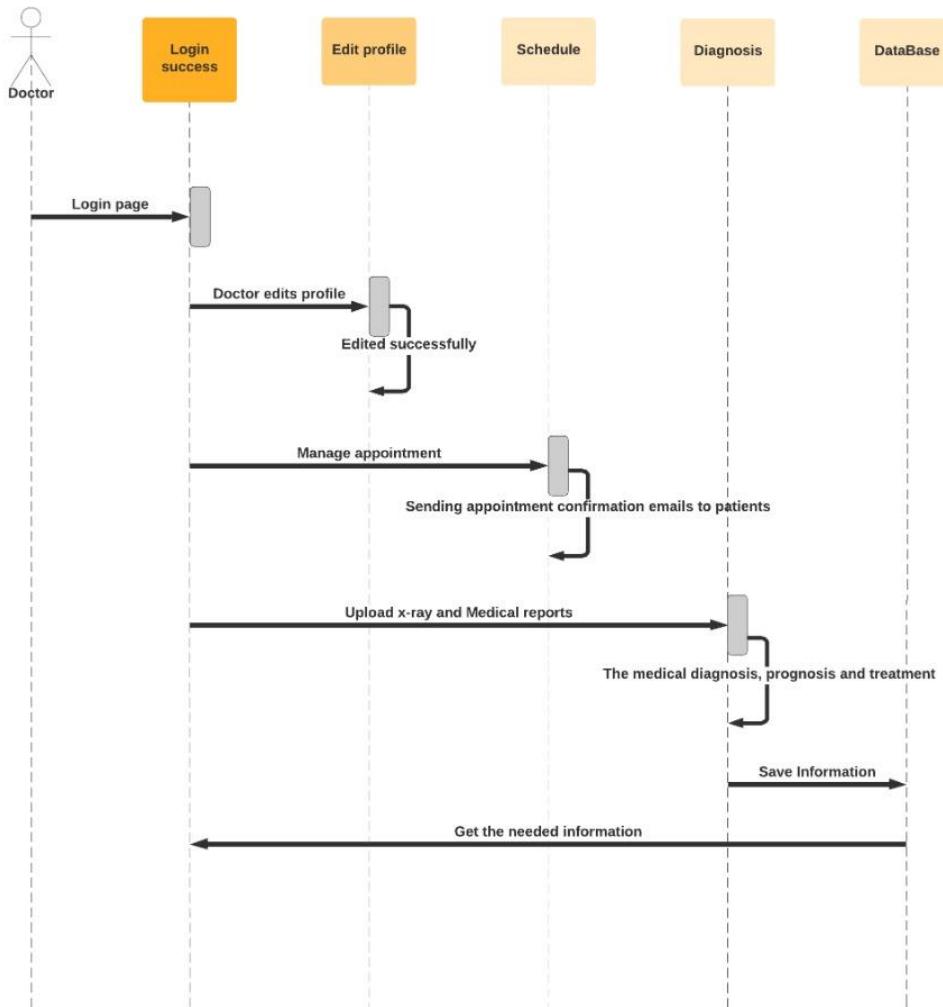
Sequence diagrams

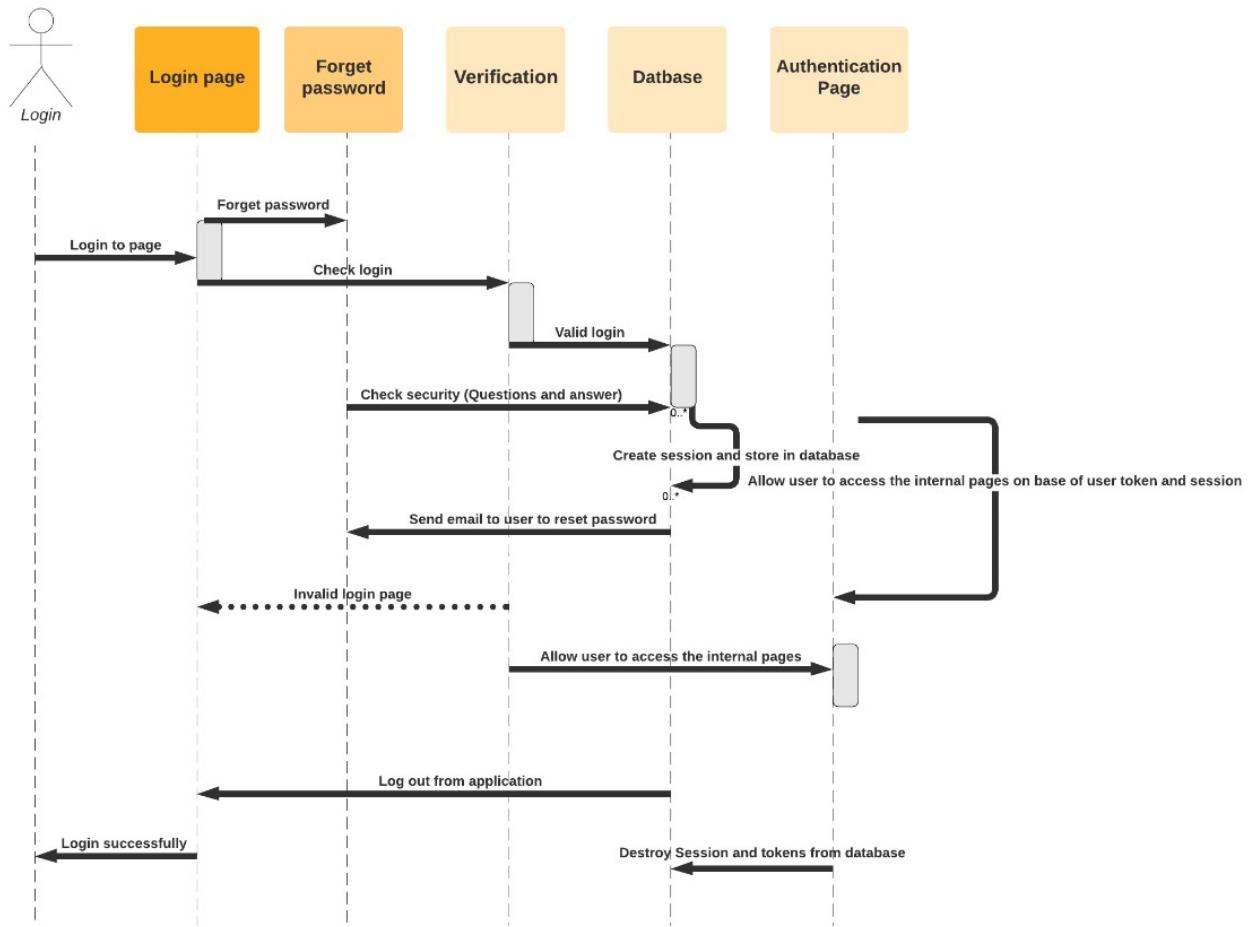




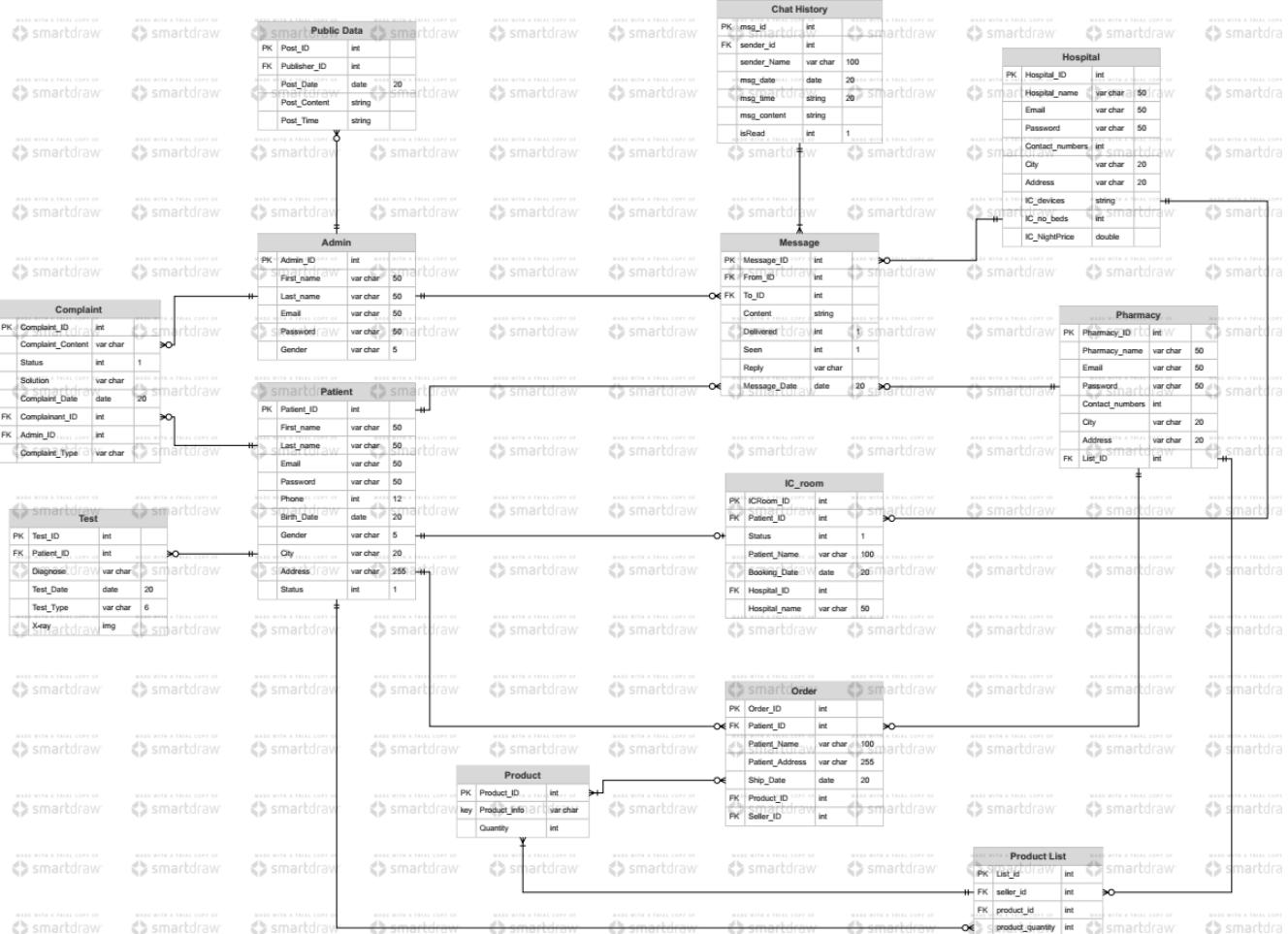


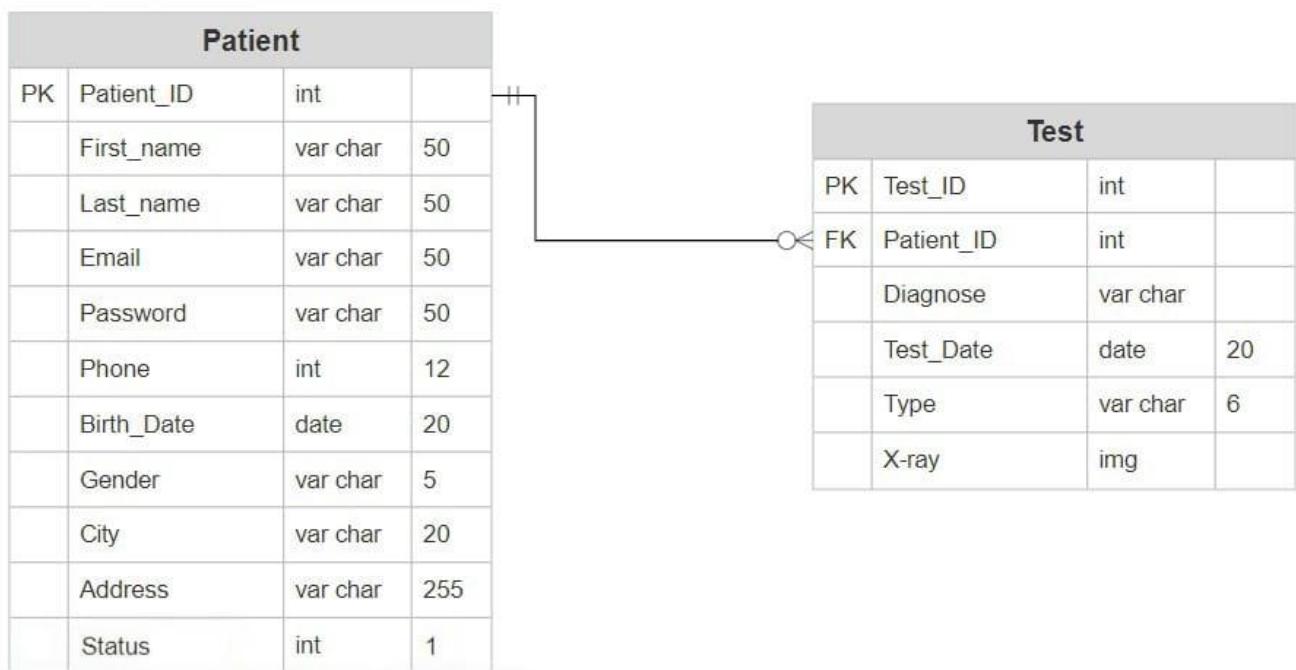
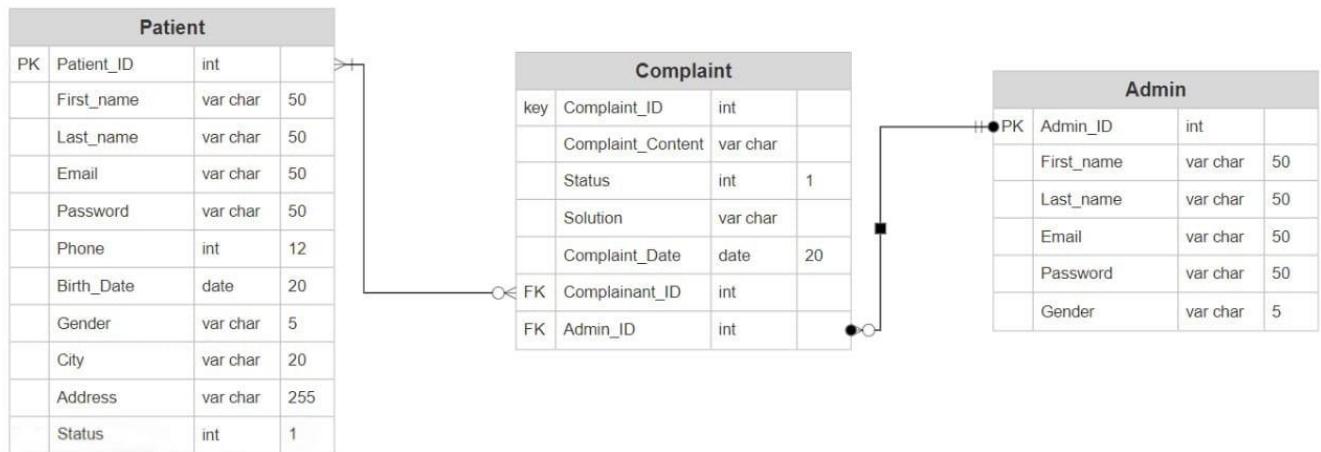


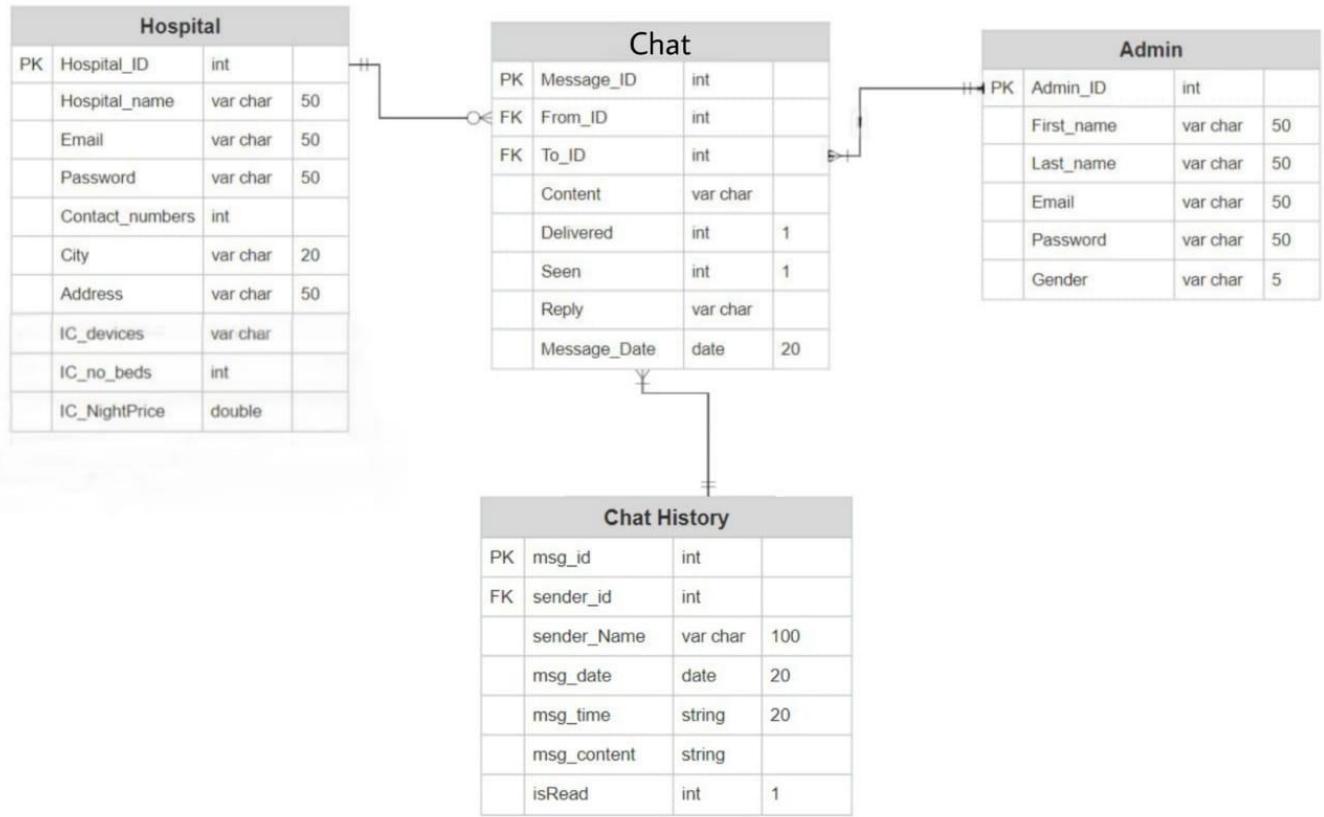


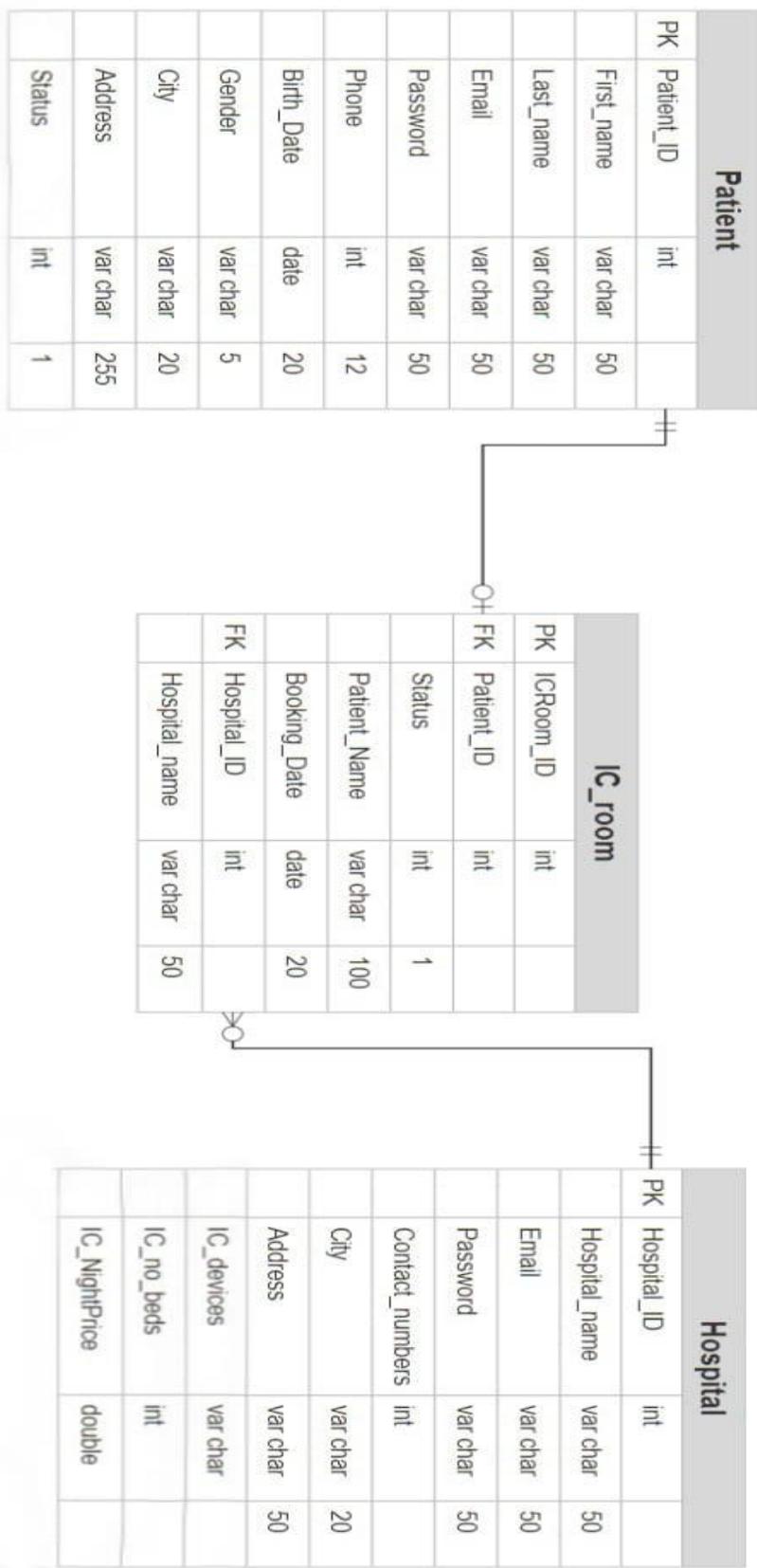


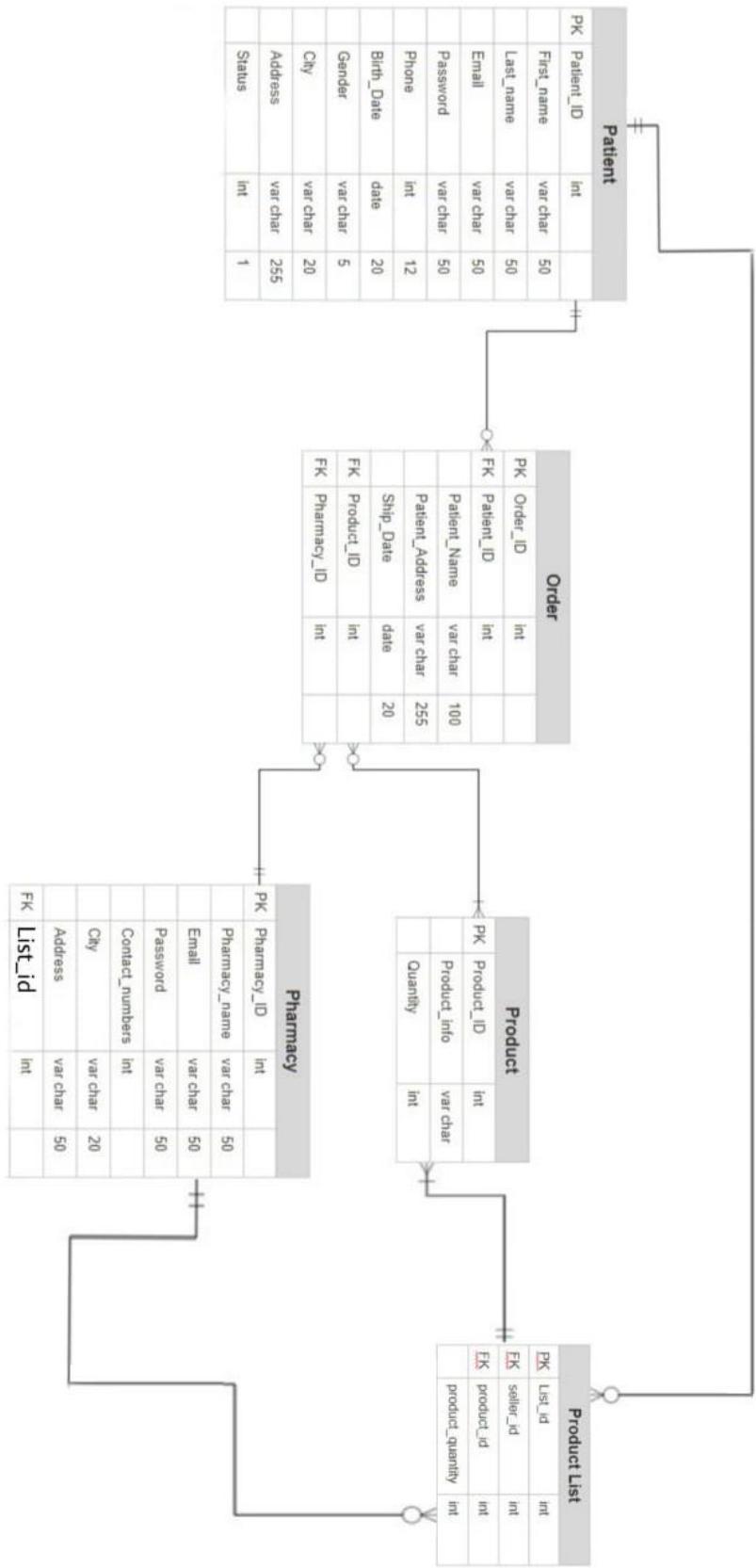
Entity relation diagram

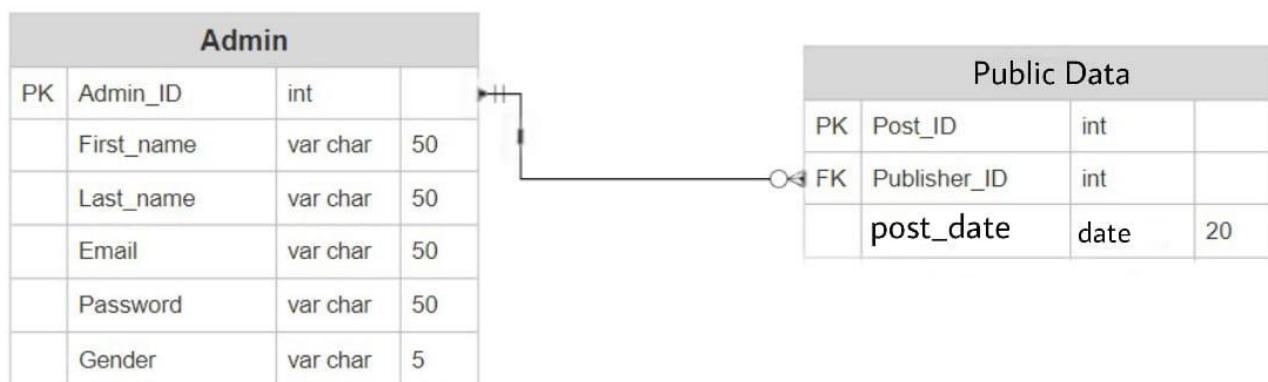
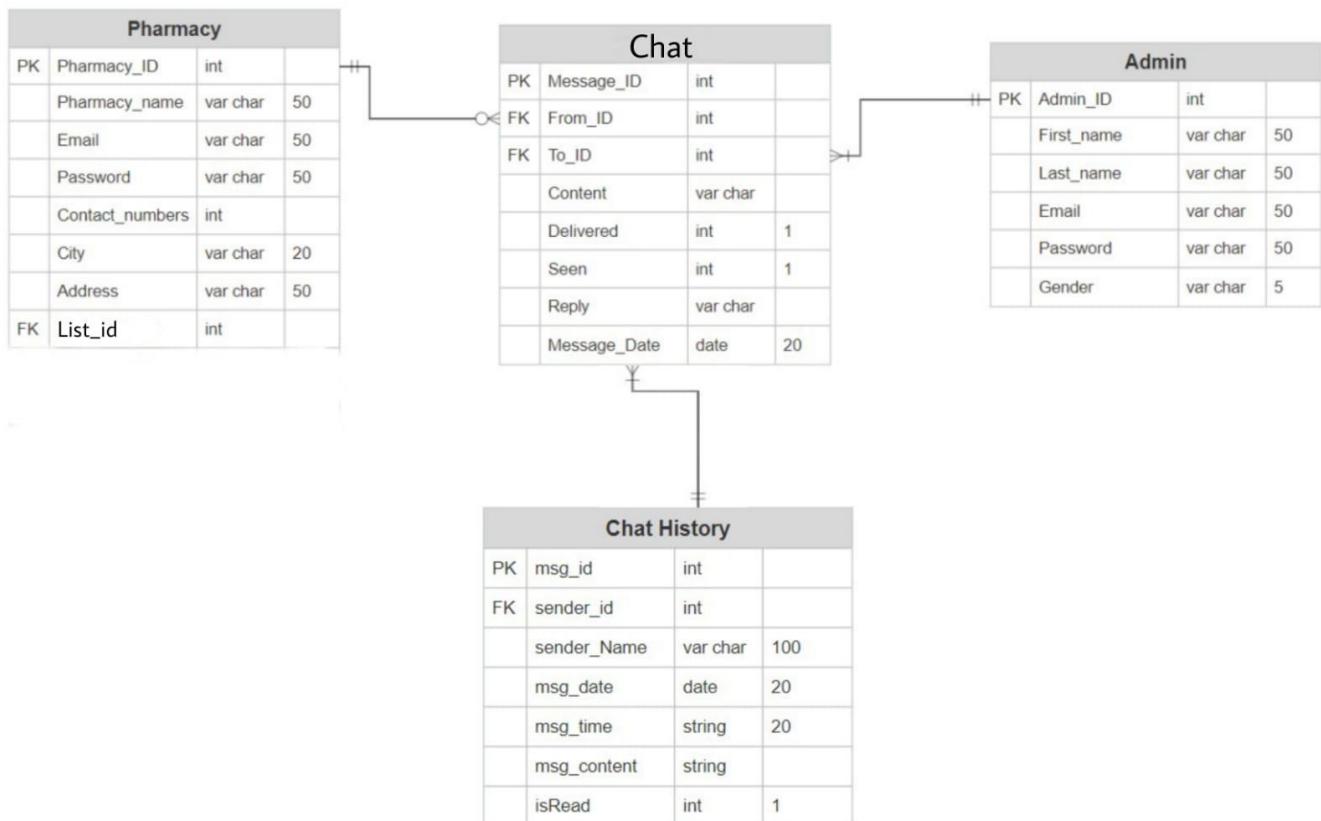


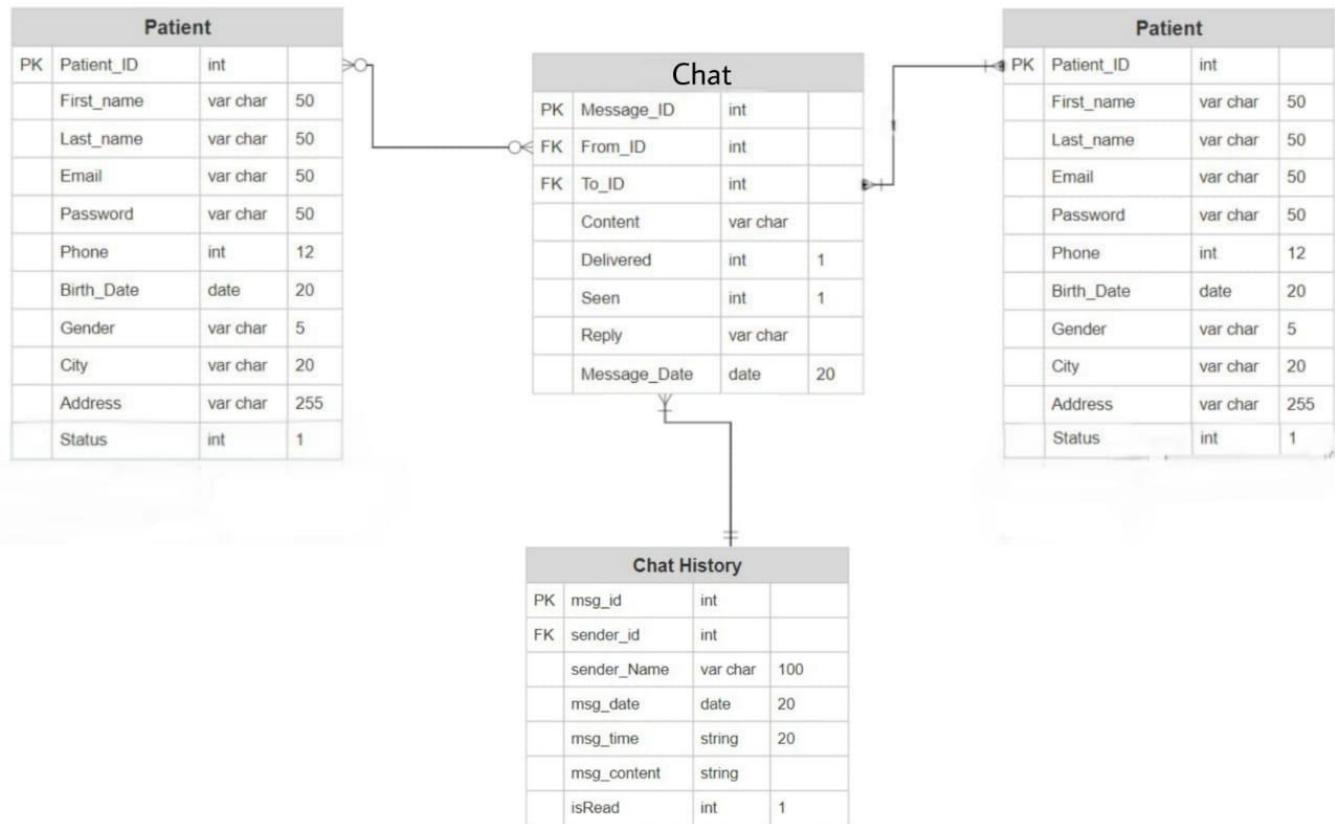






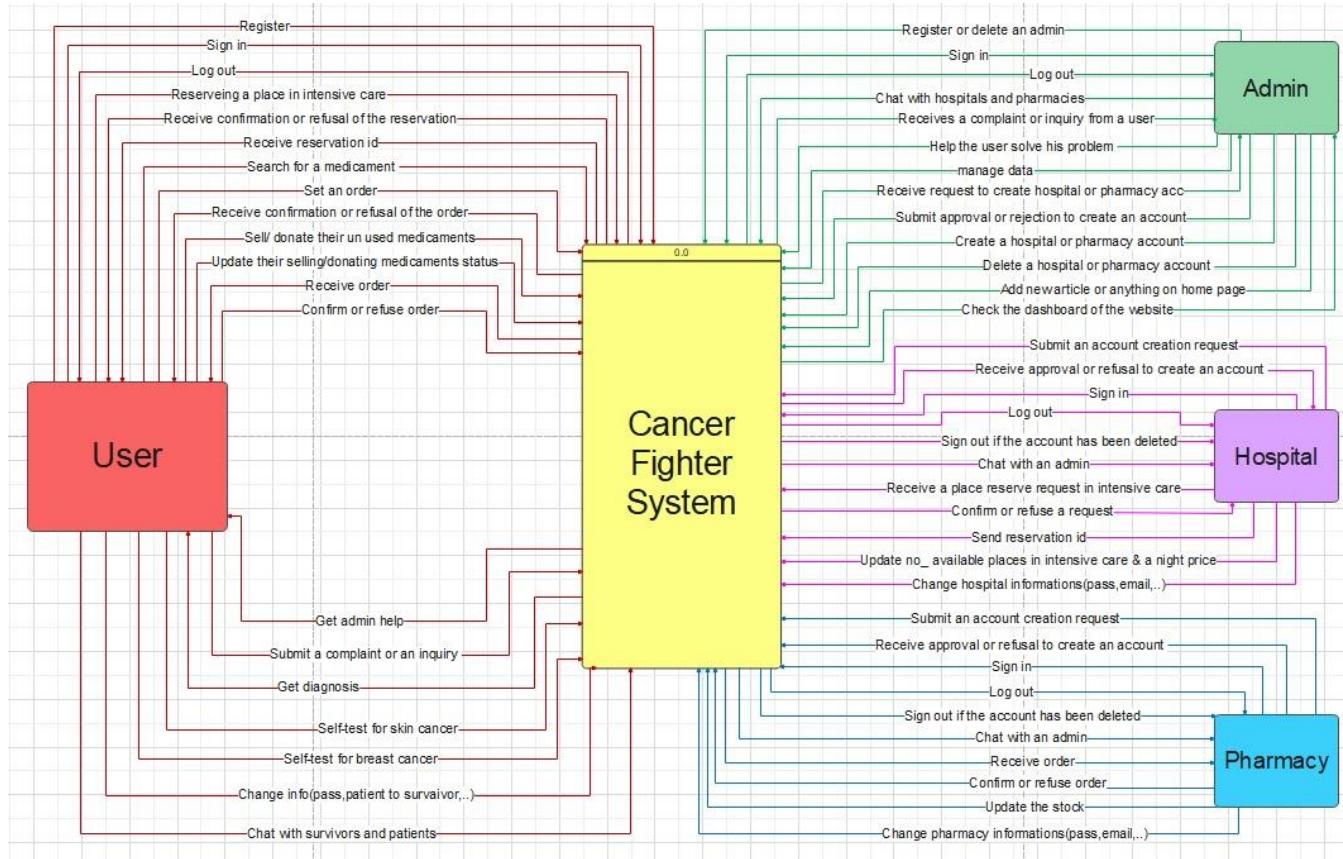




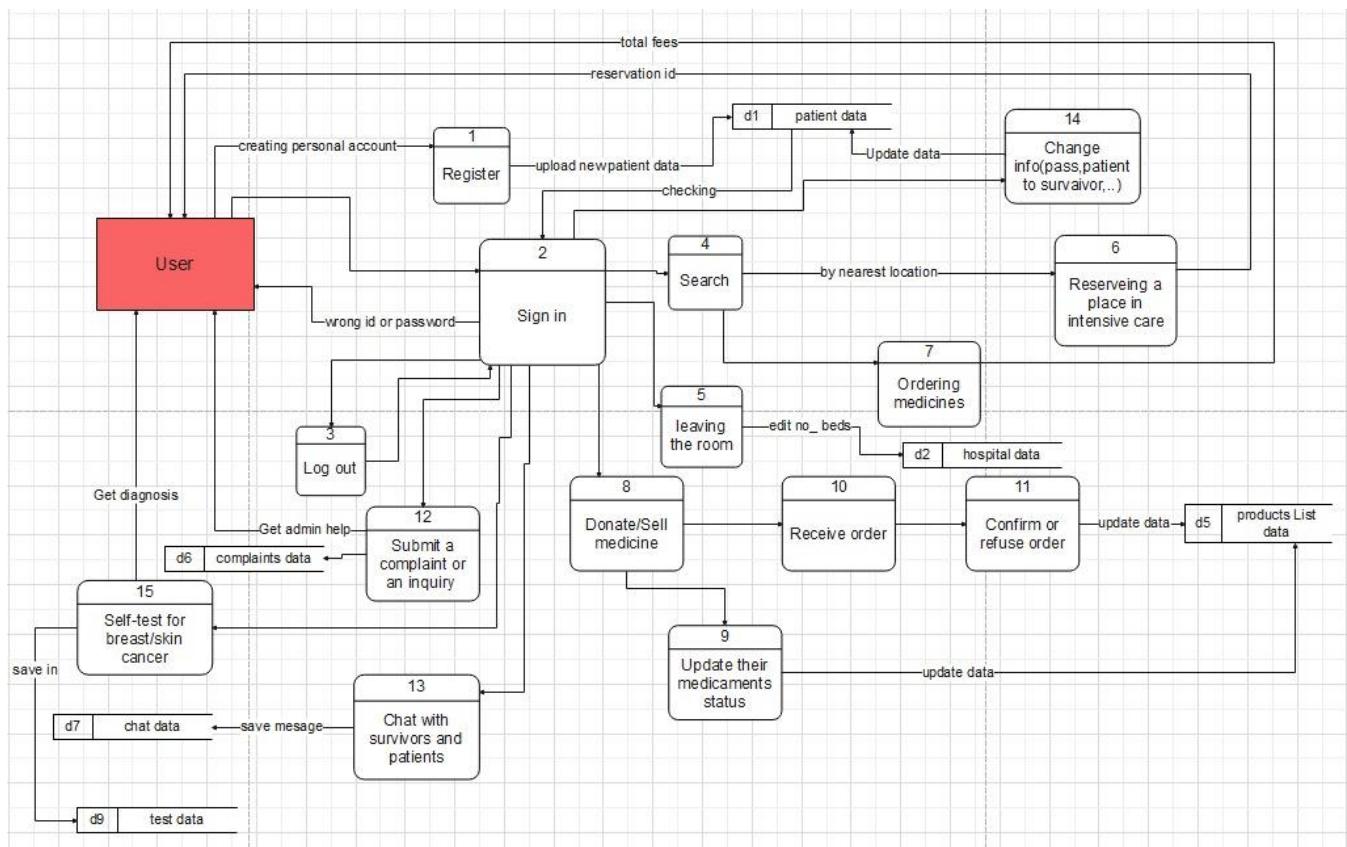
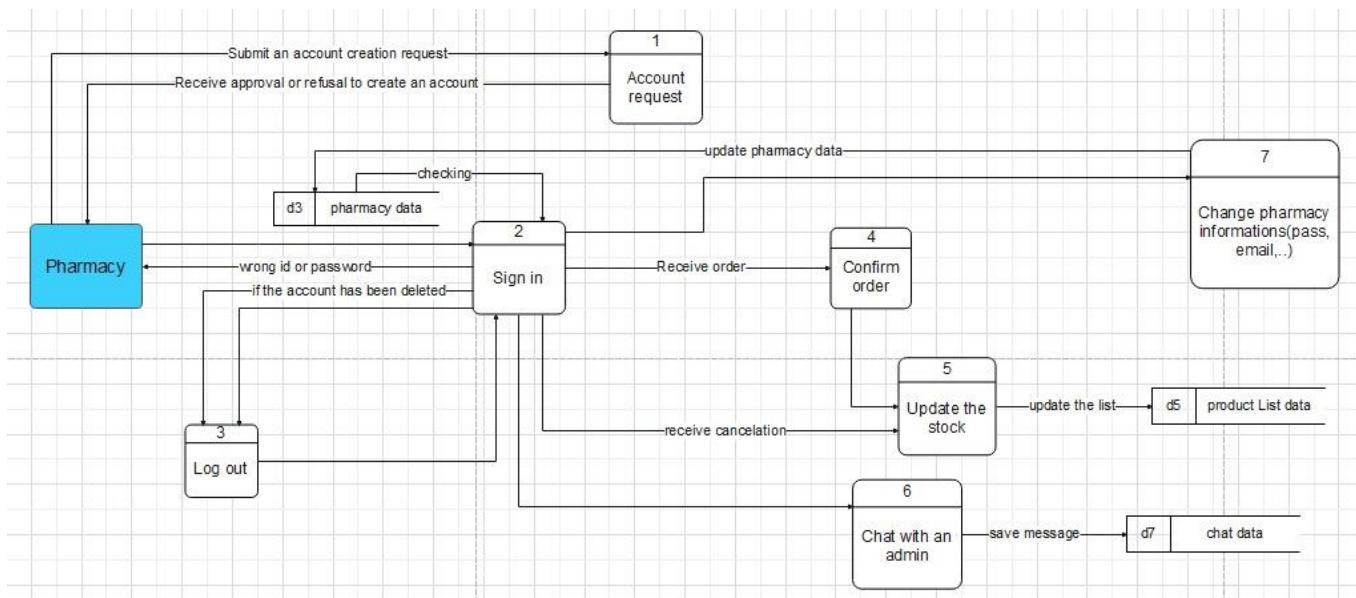


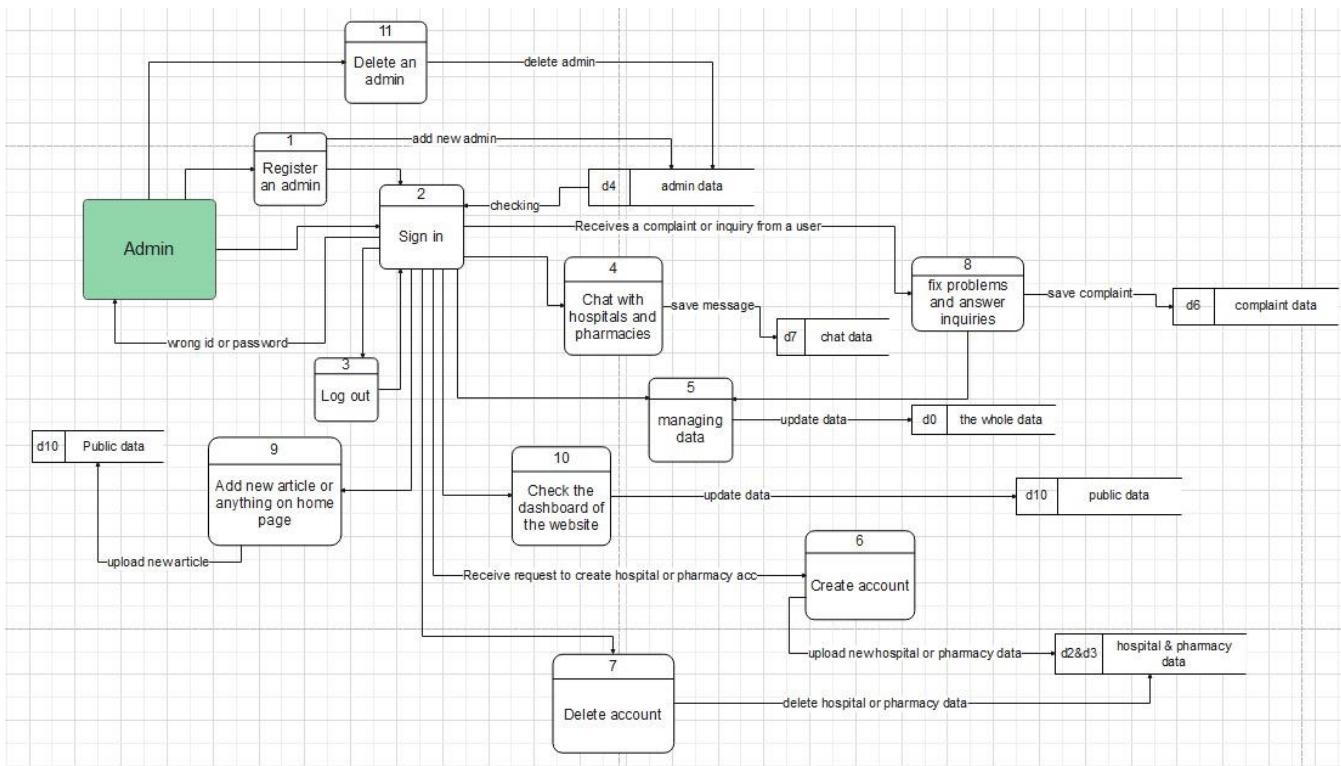
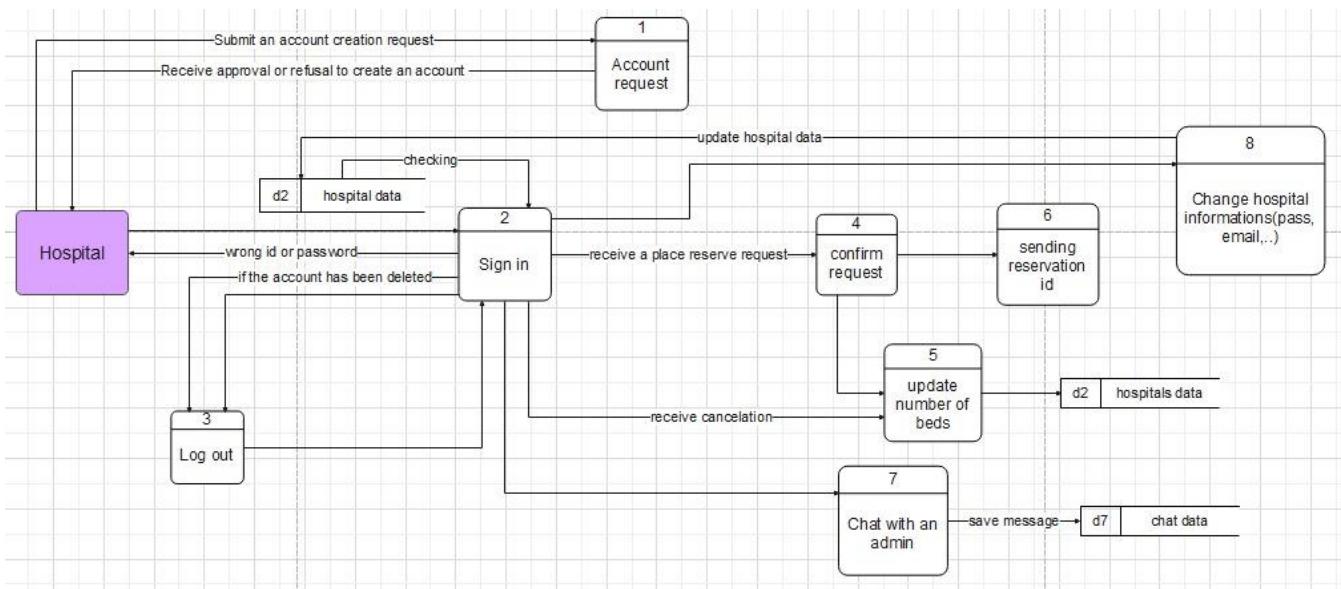
Data flow diagrams

DFD-Level 0



DFD-Level 1



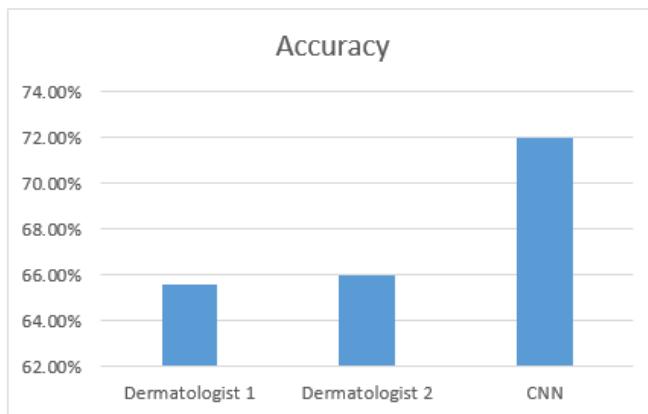


Algorithms

Skin cancer is the most prevalent type of cancer

Skin cancer is the growth of abnormal cells in the outermost layer of the skin epidermis, due to DNA damage that causes mutations Melanoma, specifically, is responsible for 75% of skin cancer deaths, despite being the least common skin cancer. Melanoma is the deadliest form of skin cancer, it is very dangerous because it's much more likely to spread to other parts of the body if not caught and treated early.

Deep learning can help in the early detection of skin cancer , it is more accurate than human detection



Classifier	Accuracy
Dermatologist 1	65.6%
Dermatologist 2	66.0%
CNN	72.0%

Models trained on ImageNet:

Model	Top-1 Accuracy	Top-5 Accuracy	Parameters	Time (ms) per inference step (CPU)	Time (ms) per inference step (GPU)
Xception	0.790	0.945	22,910,480	109.42	8.06

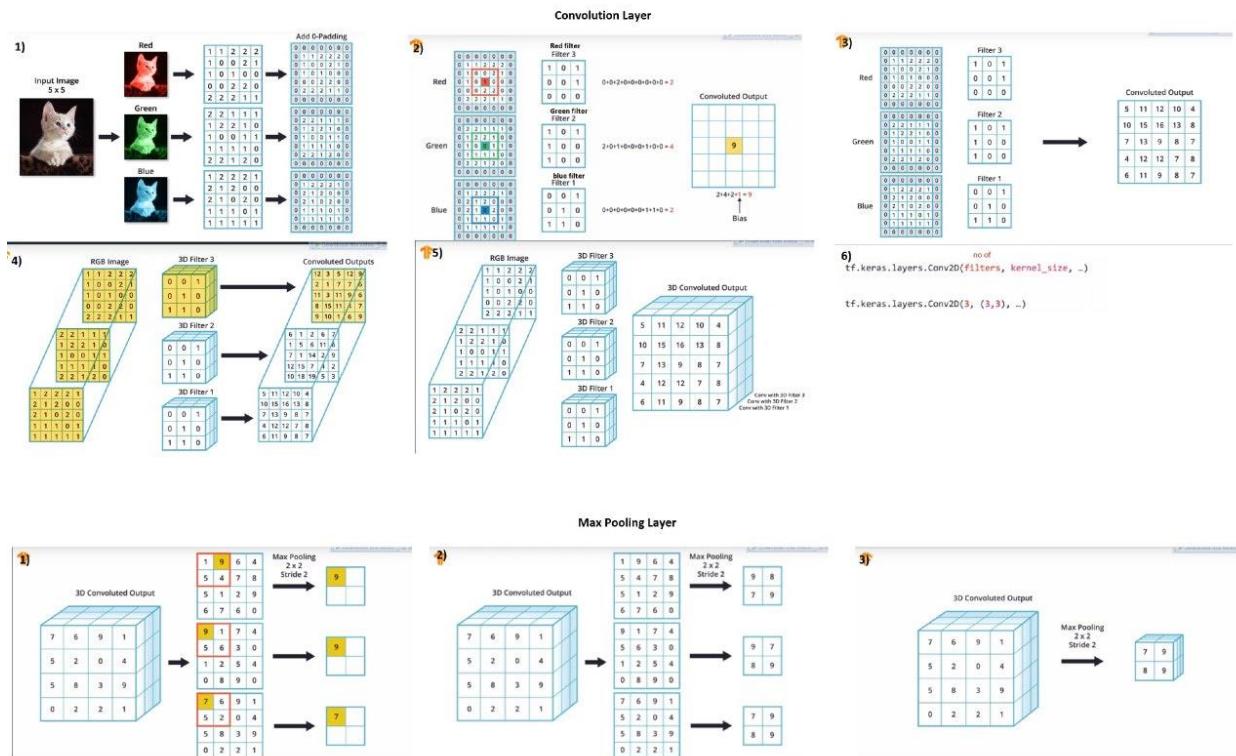
VGG16	0.713	0.901	138,357,544	69.50	4.16
VGG19	0.713	0.900	143,667,240	84.75	4.38
ResNet50	0.749	0.921	25,636,712	58.20	4.55
ResNet101	0.764	0.928	44,707,176	89.59	5.19
ResNet152	0.766	0.931	60,419,944	127.43	6.54
ResNet50V2	0.760	0.930	25,613,800	45.63	4.42
ResNet101V2	0.772	0.938	44,675,560	72.73	5.43
ResNet152V2	0.780	0.942	60,380,648	107.50	6.64
InceptionV3	0.779	0.937	23,851,784	42.25	6.86
InceptionResNetV2	0.803	0.953	55,873,736	130.19	10.02
MobileNet	0.704	0.895	4,253,864	22.60	3.44
MobileNetV2	0.713	0.901	3,538,984	25.90	3.83
DenseNet121	0.750	0.923	8,062,504	77.14	5.38
DenseNet169	0.762	0.932	14,307,880	96.40	6.28
DenseNet201	0.773	0.936	20,242,984	127.24	6.67

CNN:

Convolutional neural network (CNNs) is one of the main categories to do images recognition, images classifications. Objects detections, recognition faces

CNN image classifications take an input image, process it and classify it under certain categories (Dog, Cat, Tiger, Lion). Computers sees an input image as array of pixels and it depends on the image resolution. Based on the image resolution, it will see $h \times w \times d$ (h = Height, w = Width, d = Dimension). An image of $6 \times 6 \times 3$ array of matrix of RGB (3 refers to RGB values) and an image of $4 \times 4 \times 1$ array of matrix of grayscale image.

Deep learning CNN models to train and test, each input image will pass it through a series of convolution layers with filters (Kernels), Pooling, fully connected layers (FC) and apply SoftMax function to classify an object with probabilistic values



- Provide input image into convolution layer
- Choose parameters, apply filters with strides, padding if required.
- Perform convolution on the image and apply ReLU activation to the matrix. Perform pooling to reduce dimensionality size
- Add as many convolutional layers until satisfied
- Flatten the output and feed into a fully connected layer (FC Layer)

Transfer learning:

Transfer learning involves taking a pre-trained neural network and adapting the neural network to a new, different data set.

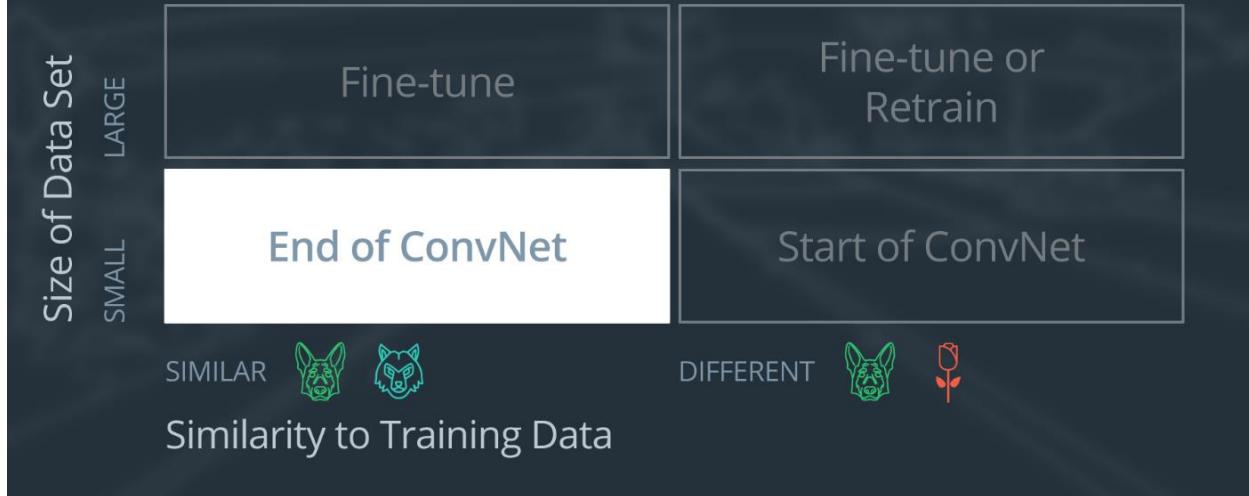
Depending on both:

- The size of the new data set, and
- The similarity of the new data set to the original data set

The approach for using transfer learning will be different. There are four main cases:

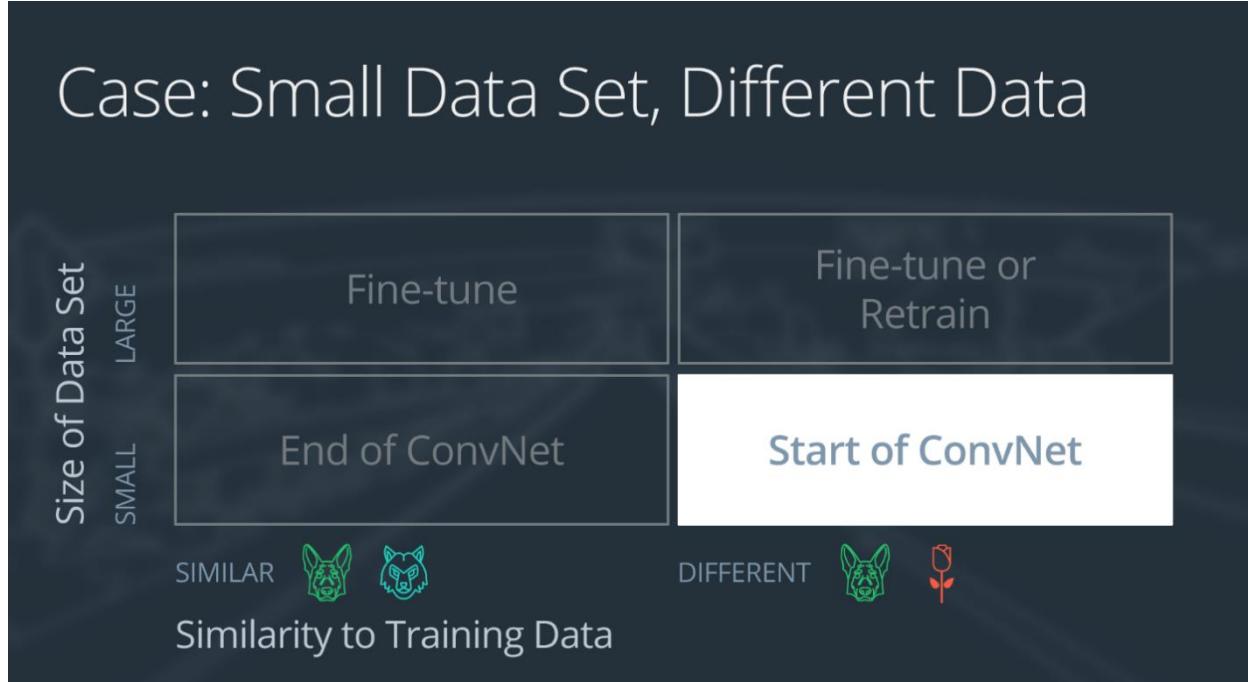
1. New data set is small, new data is similar to original training data.
 - a- slice off the end of the neural network
 - add a new fully connected layer

Case: Small Data Set, Similar Data

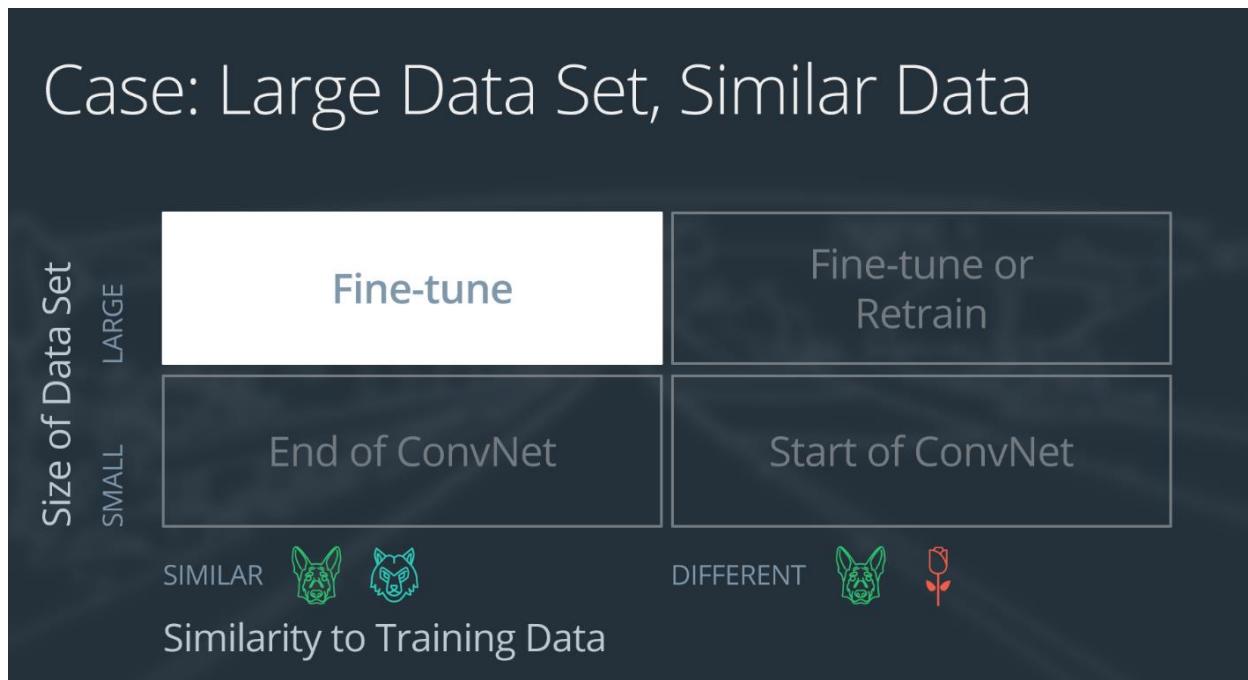


2. New data set is small, new data is different from original training data.
 - remove the last fully connected layer and replace with a layer matching the number of classes in the new data set
 - randomly initialize the weights in the new fully connected layer

Case: Small Data Set, Different Data



3. New data set is large, new data is similar to original training data.
 - remove the last fully connected layer and replace with a layer matching the number of classes in the new data set



- New data set is large, new data is different from original training data.
 - remove the last fully connected layer and replace with a layer matching the number of classes in the new data set
 - retrain the network from scratch with randomly initialized weights

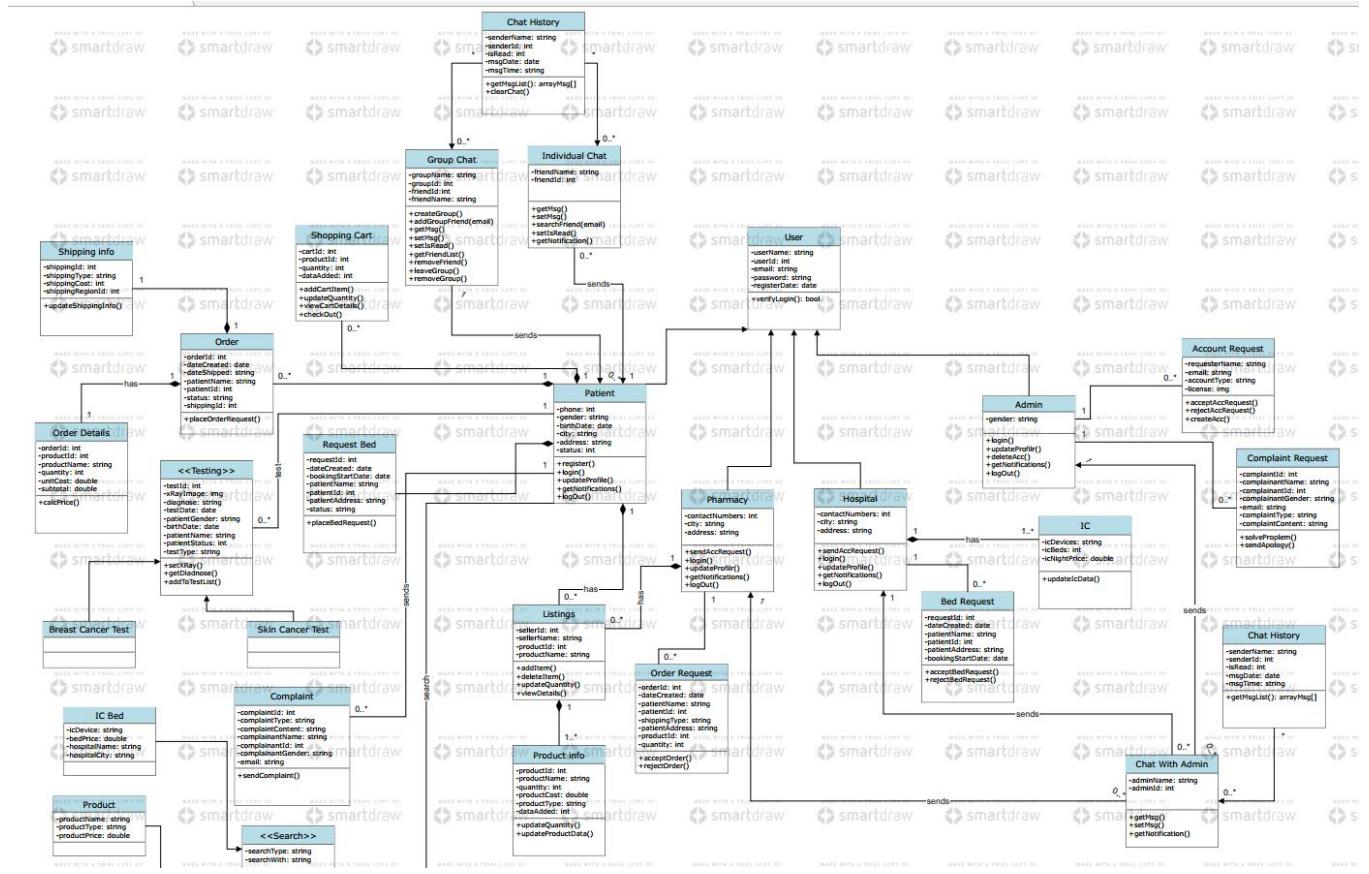


We demonstrate classification of skin cancer(melanoma) using dataset of 5.3 GB training data, 5.1 GB test data and 824.5 MB validation data

The data is pulled from the 2017 ISIC Challenge on Skin Lesion Analysis Towards Melanoma Detection.

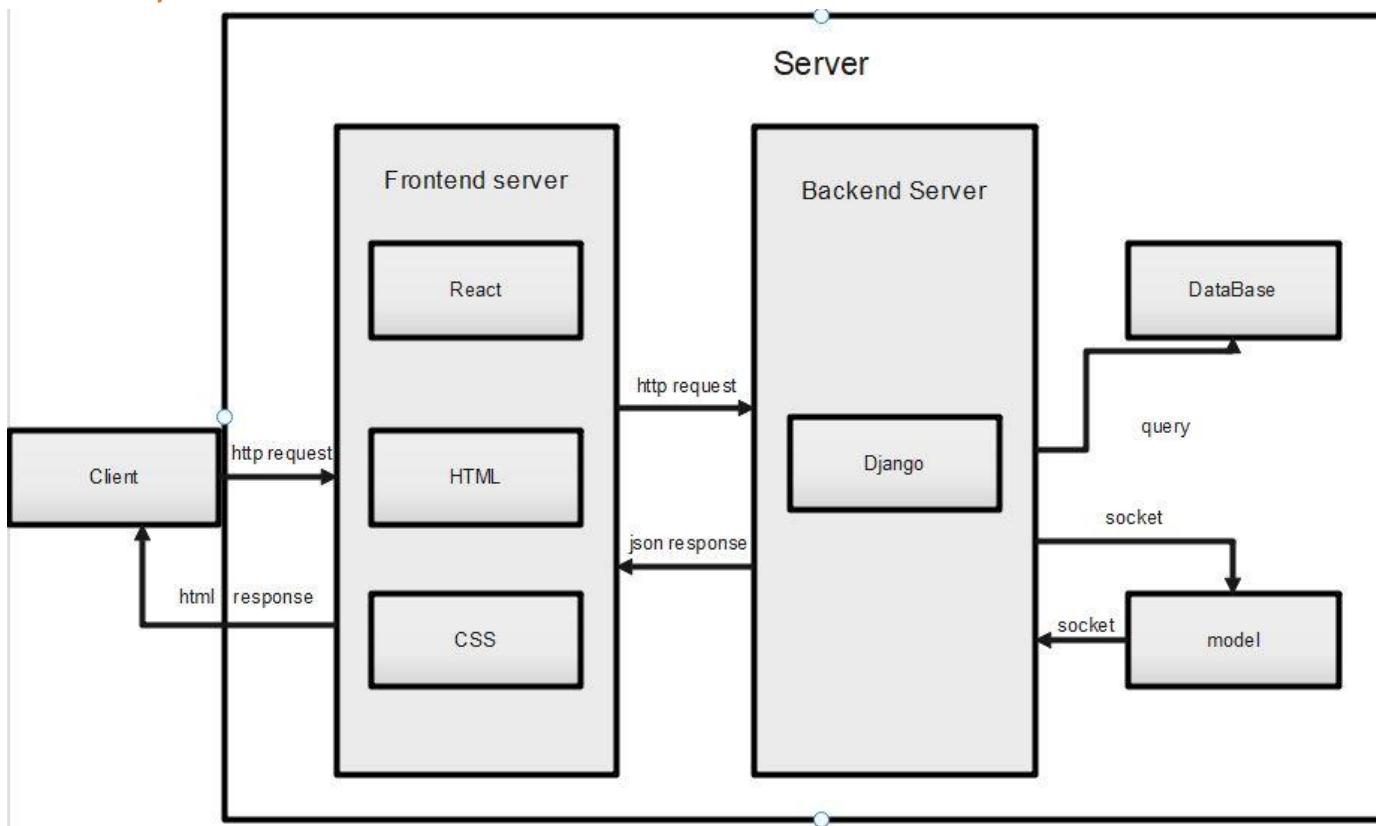
This algorithm is to diagnose melanoma and non-melanoma that help to increase the accuracy of the model

UML class diagrams



Implementation Aspects

Overall system architecture



Tool and technologies

For web development:

- Frontend → React js

1. Smooth Learning Curve

React is an elementary and lightweight library that only deals with the view layer of a web page. It has an easy learning curve, making it easier to start with than its counterpart Angular when using JavaScript.

If you have a functional understanding of HTML-CSS and a basic understanding of programming concepts, you can quickly start working

with React. If you are shifting from another framework or library, it might take some time to get used to React's innovative methods.

Apart from that, there is no concept or utility of React too hard to use. There are extensive documentation available online that will help you with everything related to ReactJS.

2. Large Community

Among the top 5 trending repositories on GitHub, React is an open-source library created by Jordan Walke. It has amassed a massive following of JavaScript developers who develop new solutions and tools regularly. A lot of user-developed applications have been included in the official library. Reusable Components

Components in ReactJS are independent, reusable bits of code. You may provide input if required (called **props**), and the component will return a rendered HTML element. You can use them as a primary JavaScript function or a class component, a JavaScript class that uses a render method. Virtual DOMS

Document Object Model or DOM is an interface that represents HTML and XML code into trees. A web browser creates a DOM-like model to render output, treating each object/element of the HTML code as a node in the DOM tree.

Whenever a change occurs in the HTML code, either by user interaction or value updates, the DOM tree has to be rendered again, leading to a lot of time and power consumption. ReactJS comes to our rescue here by use of Virtual DOMs.

React simply creates a copy of the DOM, maintaining a cache memory of sorts. Every time a change is made, it examines the Virtual DOM and

pinpoints exactly which tree nodes and components need to be updated.

With just a small change in the DOM, the tree can be updated quickly and efficiently. This saves developers a ton of time and makes the application remarkably fast and responsive.

3. JSX

JSX or JavaScript XML is a syntax extension for JavaScript. Facebook developed it to extend the functionalities of HTML structures into JavaScript. With JSX, there is no requirement for separate HTML and JS codes.

You can use the declarative HTML syntax directly in JavaScript code with ReactJS. Browsers decode HTML documents to display the UI.

They do so by creating DOM trees, and JavaScript enables us to modify this DOM to create interactive UI. JSX increases the efficiency of manipulating DOMs by manifolds.

Developers can pass HTML and ReactJS elements into the browser's tree structures and write clean, manageable codes.

JSX, along with the Virtual DOM, **increases the performance and efficiency** of ReactJS apps. JSX can be used with other frameworks and libraries too.

4. Unidirectional Data Flow

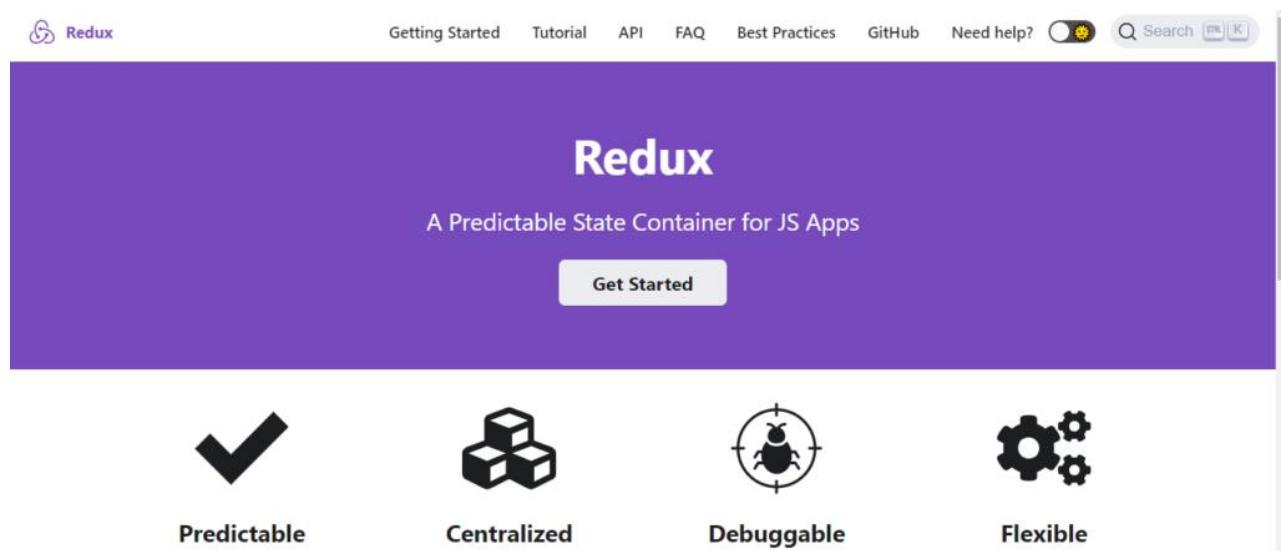
In React, information inherited from a parent component is called **props**. **Props** are immutable objects whose values can not be modified by the child components due to the unidirectional flow of data in React.

The downward directional binding makes the code stable and consistent as any child components' changes won't affect the siblings or parent components. To modify an object, you just have to update the state. ReactJS will automatically alter the valid details to maintain consistency.

Debugging and error-checking are much more efficient in React due to the unidirectional data binding providing higher control over data access of components.

It is, however, necessary to ensure that important values that need to be accessible and modifiable by a lot of components are declared as props in parent components to avoid access issues.

5. Redux



Redux is another JavaScript library used by React users to *extend React's state management ability*. Redux can be considered as the one official source of information for all components. It maintains data consistency across all components and keeps the View updated.

There is a central store in Redux where all the application data is kept. When a component takes action, Redux receives a message for state

change, and Redux uses reducers to change the state in the store and propagate that change for all connected components.

Redux avoids the hassle of passing down props through inheritance for updating states in components. With the central store, all components can directly access all required data.

6. React Hooks

There was a lot of debate when **React Hooks** was released whether it would replace Redux. The answer- No. Hooks is an independent feature introduced in ReactJS 16.8 that *enables JavaScript developers to write states and other features in function components*.

You don't need to deal with the complicated classes anymore. Using Hooks, you can easily manage state logic between components, colocate similar logic in a single component and share data with components without props and classes.

Redux and Hooks are used for optimizing different problems of React. Several developer tools such as [react-redux hooks API](#) and React's useReducer hook will let you use both together.

- Backend  Django

1. Built With Python So Easy to Learn

We all know that Python is simple, easy to read, and easy to learn. A lot of beginners choose this language as their first programming language for coding because of its simplicity and easy learning curve. Colleges and universities are using this language to teach coding to the students. Not just beginners but also tech experts are using this language for data science, machine learning, and in various other fields.

Python is a pretty much stable language and Django inherits a lot of key benefits of Python. If we look at the core stuff of Django all the exceptions files and codes are written in Python. So learning Django is also easy if you know how to code in Python.

2. Cross-Platform

Django is a portable framework and you can run its code on any platform including PC, Mac, Windows, Linux, etc. The cross-platform nature of this framework allows developers to support all the development and production environment. Django has a layer called ORM (object-relational mapper) between the developer and the database. With the help of this layer, you can migrate the whole project to other major databases with few lines of change in the code.

3. Open Source and Huge Community Support

Django is a free and open-source framework available on Github. There are almost 2k+ contributors and many more are joining every day. It is supported by the huge community of developers and the code is always updated by the developers who use it. A lot of new libraries are also introduced by the community to solve coding related issues that developers often face while building a project.

4. Batteries Included

Django is popular for “batteries included” which means you can find almost everything to develop a full-fledged application. These batteries include ORM, Authentication, HTML templating, session management support, URL routing, Middlewares, HTTP libraries, Multi-site support, i18n, template engine, forms, view layers, model layers, python compatibility, etc. The frameworks offer tons of libraries and tools for

common use cases. This kind of huge support allows developers to focus on the thing that matters most instead of reinventing the wheel for everything.

5. Security

One of the best things about Django is that you can build the application at a faster speed and deliver it without compromising the security of the application. Security features are enabled by default in this framework. It has built-in protection for some common security issues such as cross-site scripting, request forgery, clickjacking, and SQL injection. Django releases new security patches quite often and it immediately responds to the security vulnerabilities and alerts other frameworks.

6. Built-in Admin UI

In most of the frameworks you need to create the admin panel on your own and that takes a lot of time. Django offers a fully-featured web interface that is generated automatically for every app you build. The admin panel is well structured and it allows developers to create/update/delete users and any other database objects specific to the app. As per your need, you can customize or modify the admin panel user interface and add a dashboard using the third-party applications and wrappers.

7. ORM (Object-relational mapper)

Django offers a fully functional ORM, compatible with a number of databases. Basically ORM is a library that helps developers to interact with databases and allows them to transfer the data automatically from the databases (such as MySQL and PostgreSQL) to the objects. You can work with multiple databases at once.

Some technologies such as Eloquent, greenDAO, Yii AR, etc handle the basic queries very well but at some point, if the ORM fails to address the use case you will have to write the raw queries. This is not the case with Django. It is well built and it handles the database queries very well.

8. DRY (Don't Repeat Yourself)

In programming code-reusability or following the DRY principle is really important, especially when you are updating the code regularly. When you follow the DRY principle you just don't use the existing code, you also avoid the unnecessary lines of code, bugs, or errors in the application. With the DRY principle, you can get most out of very little code and that saves a lot of time of developers when it comes to making your code work or modifies the code for any reason.

9. Scalable and Reliable

Today every startup or company is concerned about the scaling of the application. What if the website hits scale and it needs to handle the heavy traffic and large volume of information? Surely you need to use the framework that can handle the huge amount of data. Well, Django is able to tackle the project of any size either it's a small scale web application or it's a high loaded web application.

10. Good Documentation

For quick reference, good documentation for any framework or language matters a lot especially when we get stuck somewhere during the development phase of any project. Django provides well-organized documentation with example code which is very helpful in building different kinds of real-world applications. The documentation is good

for quick reference if you are building some features in your application or you are stuck with some issues in your code.