# Smartphone App Concept for Medical Applications.

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July 31, 2016

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# Abstract

The market for smartphone based medical applications is a relatively new and growing quickly. The majority of medical apps are relatively simple health management and tracking applications that might remind a user to take his or her medicine or monitor blood pressure and heart rate data provided by accompanying devices. However, more sophisticated apps can directly provide diagnostic information by capturing and analysing data directly. Several apps exist that can asses the risk of skin cancer by tracking changes in the growth of skin lesions over time.

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# Introduction

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## 3.1 Data Gathering

### 3.1.1 Gathering Data from the Apple iTunes Store

Searching the Apple iTunes store is typically done manually via the iTunes Application from which text and data cannot be automatically extracted. Therefore, searching for and gathering data about IOS Applications is not easy. However, Apple does provide an rss feed that can be used to list Apps in specific categories and ordered according to how new, or how popular they are and if they are free or not. The rss feed is limited to 100 items per category. The data provided by the rss feed is minimal, not much more than title and a text description of the app. There are no sub-genres or tags than can be used to further differentiate the apps.

Using a python script data was gathered from the following rss feeds:

Top 100 Free Medical Apps Top 100 Grossing Medical Apps Top 100 Paid Medical Apps This combined results included data about 255 IOS apps. The title and description fields were imported into a database. Other information from the data such as price, right, or image link were ignored.

### 3.1.2 Gathering App Data from the Google Play Store

In order to gather data from the Goole app store a script was programmed that could extract lists of apps from a specific url. The following urls were scanned:

- Top Paid Medical Apps : https://play.google.com/store/apps/category/MEDICAL/collection/topselling_paid
- Top Free Medical Apps : https://play.google.com/store/apps/category/MEDICAL/collection/topselling_free

For each app listed the script would extract the url of the app's detail page. From the detail page more imformation would be gathered and stored in a database. The data set is similar to that of the itunes rss feed. The title and description text were imported, other fields such as pricing and copyright were ignored.

Data on 480 Medical Apps for Android was imported. However a significant percentage of the apps could not be classified because the description text was in a language other than English, German, or French.

## 3.2 Categorization

The term ”Medical App” is broad and neither the iTunes nor Google app stores offer any kind of sub categorization. In order to get a better overview of what sort of Medical Apps are available it was necessary to manually browse the gathered data and assign categories to the apps.

A database management tool was created using the python based Django Web Framework. Django provides many tools that makes constructing and interacting with databases very easy. The built-in backend administration tool can be configured to browse, edit, and filter data.

In order to quickly browse through and categorize over 700 apps. The Django backend admin was configured so apps could be categorized one after the other with a minimum of clicks or scrolling. The user was presented a list of uncategorized apps. The first one is clicked. The user is then presented with a page displaying the title and summary text of the app and a field from which a category can be selected. Once saved, the app is no longer presented on the list, the user can select the next app at the top of the list.

### 3.2.1 Description of Categories

- **Community** - provides some soft of social networking service through which the user can share data with her family or with a network of people suffering from similar disorders.
- **Fun / Entertainment** - These apps have to real medical purpose. They are for enjoyment only.
- **Alert / First Response** - Apps that assist first responders or that help users alert first responders that help is needed.
- **Health / Lifestyle** - Relaxation and meditation apps, or ovulation and fertility reminders
- **Resource Finder** - Apps that locate resources in the vicinitly, nearby pharmacies or care providers.
- **Reminder** - Apps with timer or calendar functionality that might remind a user of an appointment or manage medince consumption.
- **Algorithmic / Diagnostic** - These are apps that provide some sort of diagnositc information based on data that as been gathered by sensors or entered by the user. Examples are seizure detection apps, or stroke severity evalutaion apps.

- **Learning / Educational / Reference** - By far the largest category, this includes apps that provide reference information about diseases or education material like anatomy apps for example.
- **Organisational** - Apps in this category might help a user or practitioner organise, share or track data and documents. Examples are apps that help users track the status of their blood pressure or blood sugar levels, create health diaries, or manage clinical data and images.

## 3.3 Results

### 3.3.1 IOS Medical Apps

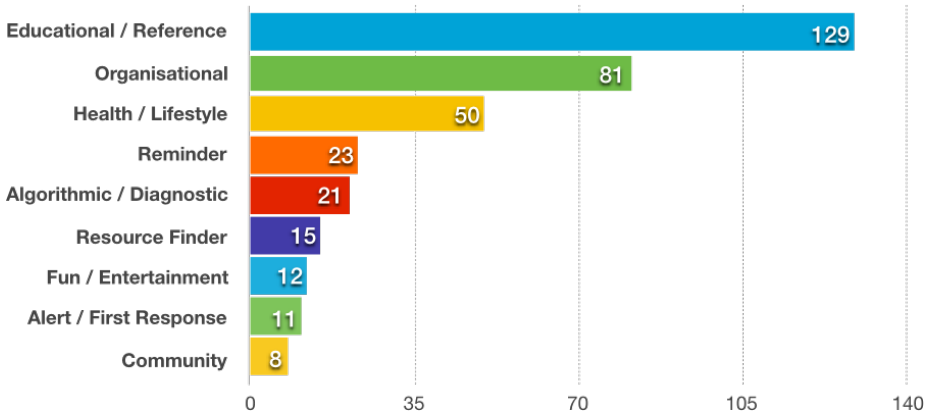


Figure 3.1: Medical Apps on the iTunes Apple Store, Search conducted on 17.05.2016

### 3.3.2 Android Medical Apps

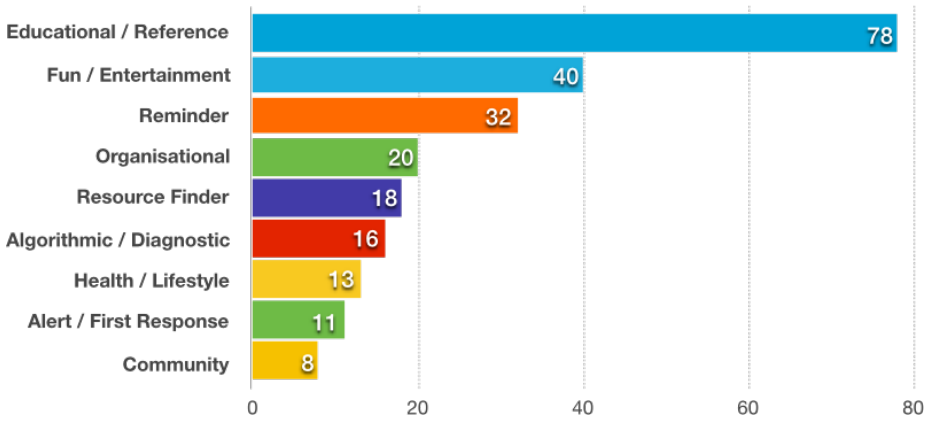


Figure 3.2: Medical Apps on the Goolge Play Store, Search conducted on 17.05.2016

### 3.3.3 Dermatology Apps 2013 vs 2016

Mobile apps are an especially good fit for dermatology-related care. Most dermatological conditions are by nature visible. The initial diagnosis and follow up monitoring is mostly done visually. A mobile device with a camera can aid patients and practitioners in the diagnosis of a dermatological condition and tracking it's development. The article Mobile Applications in Dermatology [1] in 2013 identified 229 dermatology-related apps across 5 app platforms ( Android, Apple, Blackberry, Nokia, and Windows ). These were grouped into categories based on their primary functionality. The "Self-surveillance/diagnosis" category was the second largest on the Android and Apple platforms, with 13 and 24 apps respectively.

Table 1. Total Applications

| Category | Android | Apple | Blackberry | Nokia | Windows | Total, No. (%) |
|---|---|---|---|---|---|---|
| Reference | 22 | 35 | 3 | 0 | 1 | 61 (26.6) |
| Self-surveillance/diagnosis | 13 | 24 | 1 | 0 | 3 | 41 (17.9) |
| Disease guide | 20 | 10 | 7 | 0 | 2 | 39 (17.0) |
| Educational aid | 7 | 11 | 2 | 0 | 0 | 20 (8.7) |
| Sunscreen/UV recommendation | 7 | 12 | 0 | 0 | 0 | 19 (8.3) |
| Calculator | 2 | 9 | 1 | 0 | 0 | 12 (5.2) |
| Teledermatology | 1 | 7[a] | 0 | 0 | 0 | 8 (3.5) |
| Conference | 2 | 3 | 0 | 1 | 0 | 6 (2.6) |
| Journal | 2 | 4 | 0 | 0 | 0 | 6 (2.6) |
| Photograph storage/sharing | 1 | 4 | 0 | 0 | 0 | 5 (2.2) |
| Dermoscopy | 0 | 2 | 0 | 0 | 0 | 2 (0.9) |
| Pathology | 0 | 2 | 0 | 0 | 0 | 2 (0.9) |
| Other | 1 | 6 | 0 | 1 | 0 | 8 (3.5) |
| Total applications, No. (%) | 78 (34.1) | 129 (56.3) | 14 (6.1) | 2 (0.1) | 6 (2.6) | 229 (100.0) |

[a] Two additional Apple iOS teledermatology applications were identified in a query of the term *teledermatology* during March 2013: HIV-Derm Algo Study (launched October 20, 2012) and SFGH Teledermatology pilot (launched November 12, 2012).

Figure 3.3: Total Applications, Brewer 2013

Using the same search criteria and categories from the article above indicates that the availability of dermatological apps is growing. Today there are 33 dermatological apps on the Apple platform that can be identified as having ”Self-surveillance/diagnostic” features. With the exception of the ”Reference” category, all other categories show significantly higher numbers of available apps.

| Category | Apple 2013 | Apple 2016 | Android 2013 | Android 2016 |
|---|---|---|---|---|
| Reference | 35 | 29 | 22 | 31 |
| Self-surveillance/diagnosis | 24 | 33 | 13 | 23 |
| Disease guide | 10 | 24 | 20 | 46 |
| Educational aid | 11 | 23 | 7 | 24 |
| Sunscreen/UV recommendation | 12 | 20 | 7 | 19 |
| Calculator | 9 | 4 | 2 | 10 |
| Teledermatology | 7 | 19 | 1 | 12 |
| Conference | 3 | 11 | 2 | 17 |
| Journal | 4 | 19 | 2 | 10 |
| Photograph storage/sharing | 4 | 3 | 1 | 1 |
| Dermoscopy | 2 | 7 | 0 | 3 |
| Pathology | 2 | 0 | 0 | 0 |
| Other | 6 | 8 | 1 | 4 |
| **Total** | 129 | 200 | 78 | 200 |

Figure 3.4: Demotological Apps by Category, July 2013(Brewer 2013) vs May 2016

It is important to note that the categories listed above are not defined in the stores. The apps must be manually assigned to a category based on an interpretation of the description text in the store and information obtainable on related websites. It is possible therefore that apps that were originally designated to the “Reference” category

might have been interpreted in this paper as a “Educational aid” app for example. The interpretation of the functionality of an app is fuzzy in many cases, and many apps have some crossover functionality. An app developed for self-surveillance will often contain information pertaining to symptoms and treatment ( reference ).

### 3.3.4 Dermatological Apps with Automatic Risk Assesment

Of the 55 apps identified belonging to the ”Self-surveillance/diagnosis” category, only 2 provided risk assesment features based on automatic analysis of captured images.

- SkinVision : https://skinvision.com
- mSkin Doctor https://play.google.com/store/apps/details?id=com.maleemtaufiq.mSkinDoctor

# Chapter 4

# Image Data Sources

## 4.1 Dermofit

## 4.2 DermQuest

## 4.3 PH2Dataset

# Chapter 5

# Image Feature Extraction

## 5.1 Preprocessing

## 5.2 Segmentation

## 5.3 Image Feature Extraction

## 5.4 Image Feature Extraction

# Chapter 6

# TDS Algorithm

## 6.1 Description of the Algorithm

## 6.2 Calculation of ABCD Values

### 6.2.1 Asymmetry

### 6.2.2 Border

### 6.2.3 Color

### 6.2.4 Differential

## 6.3 Two Examples

### 6.3.1 Postitiv Example

### 6.3.2 False Example

ABCD Values were calculated but classification result was false.

## 6.4 Results of Algorithm

Performance Evaluation
    Chapters 11.1, 11.2, maybe 11.3

# Chapter 7

# Machine Learning

## 7.1 Section Title

## 7.2 Results of Algorithm

Performance Evaluation

Chapters from book 11.1, 11.2, 11.3, 11.5, 11.6

# Chapter 8

# Implementaion of the Algorithm

## 8.1 Section Title

# Chapter 9

# Concept of the Application

## 9.1 Use Cases

| | |
|---|---|
| **ID** | Short Identifier |
| **Name** | Descriptive Title |
| **Description** | Use case in user story form |
| **Dependencies** | dependencies |
| **Trigger** | The event that starts the Use Case |
| **Preconditions** | The system state which must be active before the Use Case can occur |
| **Normal Flow** | Sequnce of events that occur during the use case. |
| **Alternate Flow** | Alternative sequence of events that might occur. |
| **Results** | triggers |
| **Comments** | Other infos |

Table 9.1: Use Case Template

| | |
|---|---|
| **ID** | UC-1 |
| **Name** | Capture Image |
| **Description** | As a user I can capture an image of the skin lesion that I would like to have analysed. |
| **Dependencies** | None |
| **Trigger** | The user activated the application and selected the ”image capture” navigation item. |
| **Preconditions** | The system state which must be active before the Use Case can occur |
| **Normal Flow** | **1.** Point the camera at the skin lesion.<br>**2.** Rotate and move the camera until the skin lesion is centered and optimally sized.<br>**3.** The user touches the screen to capture the image.<br>**4.** The user is notified ( beep ) that the image has been captured<br>**5.** The user can repeat from the begining |
| **Alternate Flow** | None |
| **Results** | The captured images are placed by the system in a processing queue to calculate the lesion’s border. |
| **Comments** | It is important that a user can capture the image with just one hand. If a lesion is located on a user’s hand or arm, it’s not possible to use two hands. |

Table 9.2: Use Case 1

| | |
|---|---|
| **ID** | UC-2 |
| **Name** | Confirm correct calculation of skin lesion's border |
| **Description** | As a user I want to confirm that the skin lesion's borders have been properly calculated. |
| **Dependencies** | UC-1 |
| **Trigger** | The user selected the "confirm border" navigation item. |
| **Preconditions** | At least one image has been queued for border calculation. |
| **Normal Flow** | **1.** The user is presented with a list of images.<br>**2.** The following step is repeated for each image in the list.<br>**3.** The user confirms that the border of the lesion has been precisely calculated. |
| **Alternate Flow** | **A1.** Border calculation for image has not completed.<br>**A1.3** The user can refresh the image preview until the results of the border are visible.<br>**A1.4** The user confirms that the border of the lesion has been precisely calculated.<br>**A2** Border calculation is not precise or has failed.<br>**A2.3** The user confirms that the border of the lesion has not been precisely calculated.<br>**A2.4** The image is deleted. |
| **Results** | After positiv confirmation, images are placed by the system in the risk assessment calculation queue. If no images can be positively confirmed, the user can recapture new images ( UC-1 ) |
| **Comments** | It is important that a user can capture the image with just one hand. If a lesion is located on a user's hand or arm, it's not possible to use two hands. |

Table 9.3: Use Case 2

## 9.2 Requirements

## 9.3 Prioritisation

## 9.4 Software Architecture

https://en.wikipedia.org/wiki/Architectural_pattern

# Bibliography

[1] Ann Chang Brewer, Dawnielle C. Endly, Jill Henley, Mahsa Amir, Blake P. Sampson, Jacqueline F. Moreau, and Robert P. Dellavalle. Mobile Applications in Dermatology. *JAMA Dermatol*, 149(11):1300, nov 2013.

# Chapter 10

# Appendix

# Chapter 11

# Notes

## 11.1 Notes

Research the medical app market:
itunes store search api:

- official api :
  https://affiliate.itunes.apple.com/resources/documentation/itunes-store-web-service-search-api/
  limited to 200 results, no posibility to get next 200.
- python wrapper
  https://github.com/ocelma/python-itunes
  too limited, better to use the python ”requests” library
  still depends on official api so same limitations
- rss feed with additional filters : https://rss.itunes.apple.com/us/?urlDesc=%2Fgenerator
  can filter free or paid applications, can rank by user feedback and gross

android seach api:

- no official api
- unofficial : https://github.com/egirault/googleplay-api
  hackey, pretends to be an android device

FDA (U.S. Food and Drug Administration) Mobile Medical App Submissions

- API : https://open.fda.gov/device/510k/ example : https://api.fda.gov/device/510k.json?limit=20&search=tumor%2
- reference : https://open.fda.gov/device/510k/reference/
  API is useable but might have too much information (not just for mobile apps).
  I need to reasearch if there are adequate filtering possibilities to narrow down results

- A
- B