AALBORG UNIVERSITY
STUDENT REPORT

Developing Complex Software Systems:

Piktotegner - A Pictogram Creation Tool

Bachelor Project by sw608f14

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AALBORG UNIVERSITY
STUDENT REPORT

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Abstract:

We develop an application for creating pictograms, *Piktotegner*, which is part of a larger software package called *GIRAF*. *GIRAF* is an autism communication software package developed for Android tablets by students at Aalborg University. The pictograms made in *Piktotegner* can be saved and used in the other applications of *GIRAF*.
We determine how to rotate and resize drawn objects as well as the thought process of designing an intuitive user interface.
Finally, a description of the collaboration we did with other groups of the *GIRAF* project is given, as well as the outcome and the experience gained thereof. This description includes working in a large system setting and collaborating with other groups to develop a shared library.

Foreword

This report was made at Aalborg University in the sixth semester of the Software Engineering study by sw608f14. When reading this report, the reader must know that the coordinate system in the application is mirrored in the abscissa axis. Furthermore, the drawn objects are henceforth referred to as entities. Experience with object oriented programming and Android development can be beneficial.

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1. Introduction

Disabled people need help and this help can nowadays be given through the use of technology. However, there are still some disabled people who are using non-technological solutions to aid their needs. Among these people, are people suffering from the mental disability known as autism. There are many different forms of autism, ranging from super intelligent to being unable to speak. A shared trait, though, is the inability to feel empathy. The result of this is that they cannot interpret emotions, causing them to have difficulties when interacting with other people in social contexts. The main focus is to help autistic people, primarily the ones who have trouble with speech. Currently, physical folders with pictograms are being used to communicate with the guardians. These folders are very cumbersome since they can grow very large in size. Furthermore, it can be very difficult to find the specific pictogram you are looking for. This is sought to be improved through technology by creating an application on a mobile device that fulfils the same functionality as the folders. By creating this application, it is possible to have the pictograms located at one place without having it grow in size. In addition to this, it could be easier for the people to find the specific pictogram by creating a search function in the application.

Currently this project is an ongoing development, which is built upon the work of previous students. Therefore, the project will primarily focus on getting the current features to work as intended, with potential for new functionality if there are no further improvements available to the current features. The development is done in four SCRUM sprints detailing the process of each.

2. Role in the Multi Project

Our role in the multi project environment is to improve on the foundations created by the previous developers. These improvements can be resolving bugs in the existing code, integration with other projects in the multi project, or adding new functionality to match the customers' requests and expectations. The goal of the multi project is to make a working application, which can be released to the customers, rather than optimal code that is not ready for the customers.

2.1 Analysis of Organisational Context

In the multi project, around 60 people are working together. To make this teamwork manageable, some organising is needed. Organising is done by utilising the SCRUM methodology, and since there are so many groups, a SCRUM of SCRUMS is used. This means that there are daily SCRUM meetings in the groups, weekly meetings between the SCRUM teams, and meeting with the customers at the end of each sprint. The goal is to create an application that aids autistic people and their guardians in communication. Each group gets a part of the application and further develops on it. The decisions involving parts of the application are put in the hands of the group responsible for said part, while decisions involving the overall application are discussed at the weekly meetings or at the sprint start meetings.

At the start of the development process, we had several meetings, with everyone present, where we did a transition with the previous development group to the current one. During these early meetings, we discussed how to organise the multi project and did decisions based on our own knowledge and the previous development group's experience.

Tools for managing the development were also decided at these meetings. *Git* [1] was chosen as our configuration management tool as this is easily available, a lot of developers have experience with it, and the previous group also worked with it which made the transition easier.

Redmine [2] was chosen as the main information sharing tool in regards to guides on how to use various parts, different standards such as the ones used for coding and meetings. *Redmine* was also chosen because it had a great issue tracker, allowing developers to easily check what was being developed on the other parts and to check their progress.

Another tool we used was *Jenkins* [3], which automatically build the project and alerts certain people when the build fails. *Jenkins* was also used to get the newest version of a part of the project, without the need to download the repository of the project and compile it.

The chosen IDE was *Android Studio* [4], which was suggested by the previous development group. *Android Studio* is an IDE designed specifically for Android devices making it a suitable choice.

Personnel from the development groups were chosen as being in charge of the tools, where each person had the responsibility of a single tool. It was also the responsibility of these people to be knowledgeable of their tool, in case the developers had questions.

As mentioned before, we had planned meetings with the customers at the end of each sprint, where some of the applications were presented with focus on the newly developed features. At the start of the sprint we had another meeting with all the developers present, where decisions were made regarding what parts each development group was to develop in the coming sprint.

3. First Sprint

The first sprint of this project is decided to run from 20th of February to the 19th of March. The primary focus of this sprint for all groups is to get the existing code to work. For this sprint, we choose *Croc* [5] to be the application which we develop on. *Croc* was developed in the spring of 2013 and is responsible for creating pictograms.

3.1 Croc

Croc is a part of the *GIRAF* software package. It is meant to support manual creation of pictograms. In that regard, to create a pictogram, the user can take pictures, record audio, and draw their own pictures. These options can then be used in any combination as the user sees fit for a given pictogram.

The target audience of *Croc* are guardians and parents, contrary to other parts of *GIRAF*. For that reason, the design focus is on usability for guardians as well as to make suitable pictograms, rather than educational or entertainment purposes.

Croc is developed as an application that may be launched from other applications in the *GIRAF* project. When a pictogram has been created in *Croc* it is meant to be stored in a database to make it accessible from other applications.

In order to achieve these goals, features are implemented, although not without issues.

Features

A lot of features of *Croc* are tied to the user interface, and for that reason it makes sense to present the *Croc* UI. In order to get an idea of how the *Croc* UI looks like, see Figure 3.1.

The UI is divided into two parts, the upper serving as a menu-bar allowing access to the camera, audio recorder, help view, closing the application, or saving the pictogram. The lower part changes depending on the mode chosen. In the figure, the lower part shows the UI for the following features.

- Selection tool
- Freehand, rectangle, line, and ellipsis drawing tool
- Choosing a colour
- Importing camera picture
- Preview of chosen colours
- Changing stroke width

Other features exists for the camera and audio recording, which include switching between black/white and colour pictures, take picture, and start/end recording. For an illustration of the camera and audio recorder, see Appendix A.

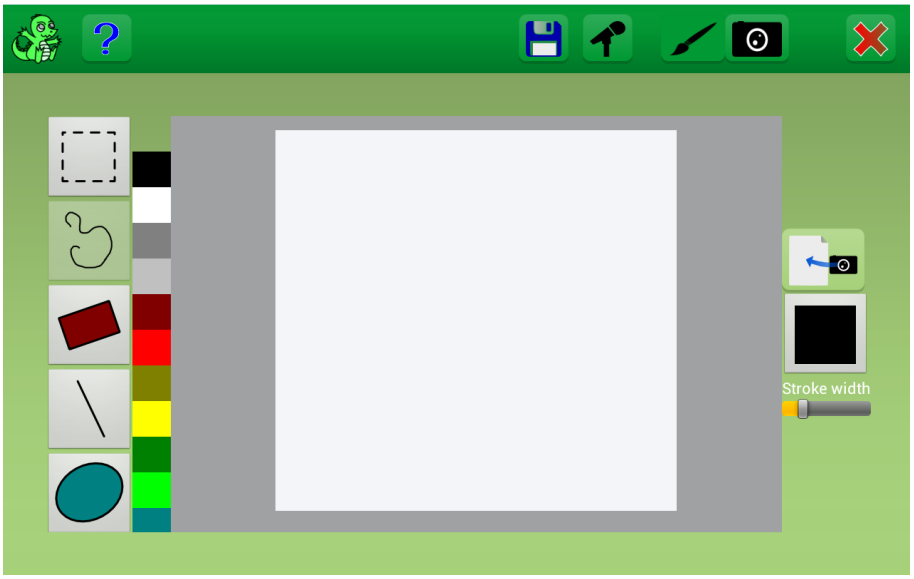


Figure 3.1: Screenshot of canvas UI.

3.2 Sprint Backlog

As mentioned before, in this sprint we add missing features and resolve bugs in the application we are assigned to. Some of these issues are found by the group working on the application last year, and the rest have been found by testing the functionality of the application. The different issues found are prioritised and estimated through planning poker. By this estimation and prioritisation, the following sprint backlog is constructed:

Change stroke width
: Be able to change the stroke width for freehand drawing.

Loading pictures from camera in suitable size
: Pictures loaded into the canvas are zoomed in too much, as the picture is larger than the canvas.

Colour swap
: The colour swap button does nothing at the moment. The fill and stroke colour should be able to be swapped by a click on the colour swap button.

Straight line colour
: Straight lines can only be drawn in black, it should be able to be drawn with the selected colour.

Icon changes
In general several icons do not represent their functionality, therefore they need to be changed.

Clear button
Implement a button in canvas to clear the canvas.

Collision detection for rotated entities
The collision detection only works when entities are not rotated. It needs to be changed to also work for rotated entities.

Save canvas state
Find a way to save the drawStack between uses. That is when switching to camera and back, or between app uses.

Record dialogue
Change dialogue box for recording, as the visuals does not match the expectations of how a sound recorder works.

Scale camera pictures
Pictures taken with the camera should be scalable in canvas.

3.3 Implementation

With issues assigned to the sprint backlog of sprint one, a description of the issues and their corresponding solutions follows hereafter. Some issues are added when found during the sprint as they surfaced after the functionality is added.

Change Stroke Width

Changing the stroke width was not possible for a freehand line. The other entities already had the feature implemented in its *updateBuffer* function, which was called when the entity was created and assigned the stroke width to be that of the current handlers stroke width. To resolve this issue, we update the stroke width in the *updateBuffer* function.

Loading Pictures from Camera in Suitable Size

In order to fix this issue, it is necessary to look at the function that loads the pictures into canvas. Previously, the function took the picture as it was and loaded it into canvas. Therefore it was imported in a too large scale, which could not fit into canvas. The issue is fixed by implementing a new constructor when creating a picture. The new constructor, seen in List 3.1, is similar to the old constructor but with the option of including a scale factor as input that is used to change the width and height of the picture by this factor.

Colour Swap

To resolve this issue, the class diagram is used to identify a connection between the preview button and the draw view, which can be seen Figure 3.2. Two connections are found between *DrawView* and *PreviewButton*, which is *ColorButton* and *DrawFragment*. *ColorButton* is used when picking a new colour, and assigns the new colour to *PreviewButton*. However, when pressing the *PreviewButton*, no connection existed. In order to correct this issue, the

```
1 public BitmapEntity(Bitmap src, int size) {
2   internalBitmap = Bitmap.createScaledBitmap(src,
        src.getWidth() * size / 100,
3       src.getHeight() * size / 100, true);
4
5   setHeight(internalBitmap.getHeight());
6   setWidth(internalBitmap.getWidth());
7 }
```

Listing 3.1: New Constructor for *BitmapEntity*

event for touching *PreviewButton* could be accessed from *DrawFragment* and was already implemented for the other buttons.

In order to correct this issue, the *onTouch* event is moved from *PreviewButton* to *DrawFragment*, since *DrawFragment* has access to both *DrawView* and *PreviewButton*. *DrawFragment* was already subscribed to the other buttons, thus it is a logical change to move the touch event of *PreviewButton* to *DrawFragment*. The event implemented in *DrawFragment* can be seen in List 3.2.

```
1 private final OnClickListener onPreviewButtonClick = new
      OnClickListener() {
2     @Override
3     public void onClick(View v) {
4         previewButton.swapColors();
5         drawView.setFillColor(previewButton.getFillColor());
6         drawView.setStrokeColor(previewButton.getStrokeColor());
7     }
8 };
```

Listing 3.2: onPreviewButtonClick event

Freehand Drawing Colour

Before the colour swap functionality was implemented, it was not possible to change the colour of the freehand drawing. However, with that feature implemented, a bug occurred when using the preview button to swap colours after drawing a freehand drawing. By using the button it resulted in swapping the colour of the latest freehand drawing. The bug happened since the latest drawn freehand entity was not released after being drawn. It was not released for the freehand entity, since it overrode that functionality from the superclass, and as of such it had to be added.

Straight Line Colour

The straight line colour is changed to be that of the fill colour instead of the stroke colour. The problem was that when picking a colour and then drawing a line, the colour of the line would be that of the stroke colour, instead of the picked colour. This is deemed non-intuitive, and thus the colour used to draw the line is changed to the fill colour. The issue is resolved by changing a method call to take the fill colour instead of the stroke colour.

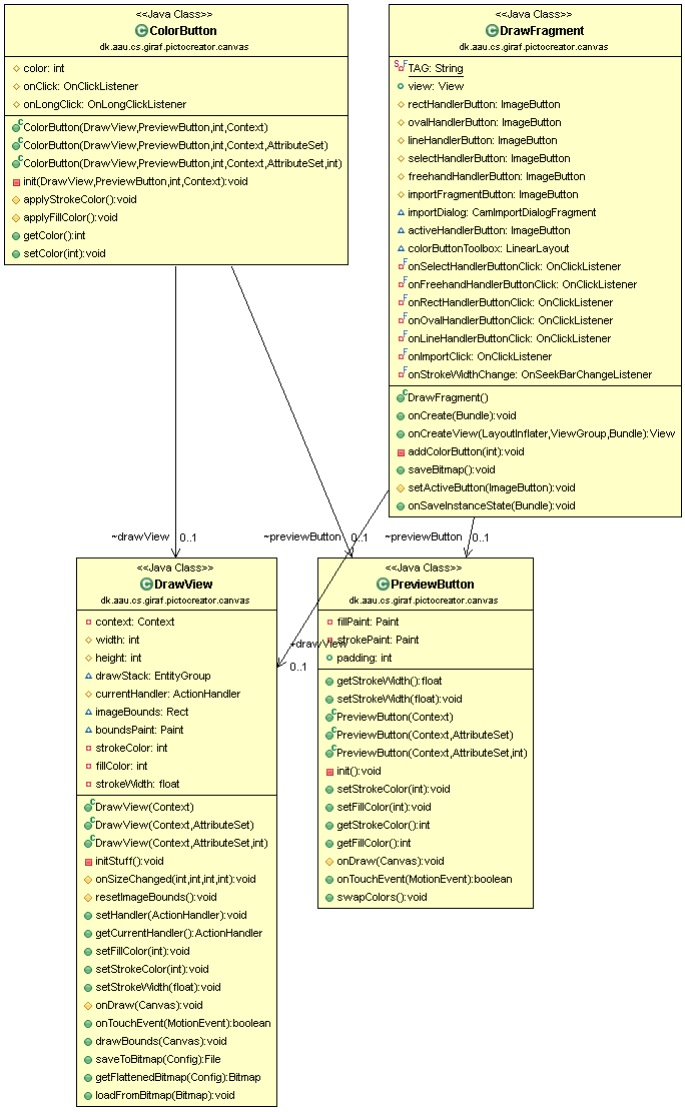


Figure 3.2: Part of the class diagram.

Icon changes

The previous development group working on this application [5] performed usability tests and through these, found that some of the icons were not intuitive to the users and thus needed changing. When changing the icons, the focus is to make the icons easier to associate with the functionality of their buttons. The idea behind the new choice of freehand drawing icon is what people associate with this functionality and how it is represented in similar applications. In such similar applications the standard representation of a freehand drawing is a pencil. Due to this standard the icon in Figure 3.3a is replaced by Figure 3.3b.

The previous icon for the selection tool could give a misleading impression

(a) Old freehand drawing icon.

(b) New freehand drawing icon.

Figure 3.3: Freehand drawing icons

of the functionality. The icon, seen in Figure 3.4a, looks much like a tool that marks an area, but the tool selects a single entity. To make the icon represent the functionality of the feature a new icon is deemed necessary. The new icon looks like a hand, see Figure 3.4b, as this gives a clear representation of being able to select a single entity at a time.

(a) Old selection icon

(b) New selection icon

Figure 3.4: Selection icons

Clear Button

Before adding the clear button, to clear the canvas you had to either delete each entity individually or to restart the application. As this was highly undesired, we decide a clear button is necessary. It is decided that the icon of a trash bin is the most fitting as it is our understanding that most people associate the trash bin icon with throwing something away.

In order to clear the canvas it is a matter of clearing the *drawStack*, deselecting the selected entity, and redrawing the canvas through the *Invalidate()* method, which is performed when the clearing action is accepted. *drawStack* is an *ArrayList* consisting of entities, which conceptually functions as a stack, with entities drawn on top of each other.

An unintentional click of the clear button would be of great nuisance to ones work. Thus, a dialogue box is added, requesting final confirmation for the clear operation.

Collision Detection for Rotated Entities

The user should be able to select the entity by clicking inside of the hitbox, even when the entity is rotated. This gave an issue, as when rotating an entity the hitbox did not follow and to click on the entity you had to click inside the misplaced hitbox. Originally before we changed the hitbox, when rotating an

entity, the hitbox would move out of the canvas, and thus not targetable. As the previous implementation was out of the question, its code is scrapped and the hitbox location remains stationary.

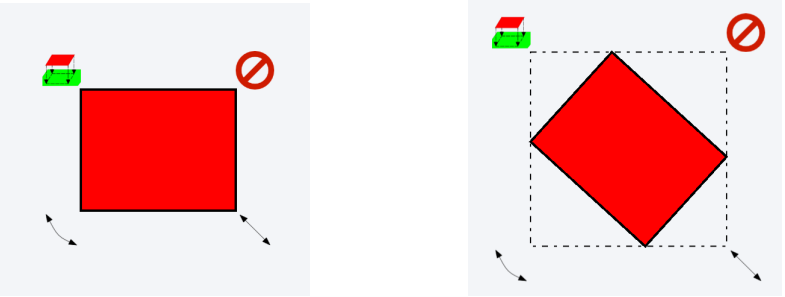
The reason for this is that when the entity was created the hitbox was set but never changed after rotating the entity. Therefore, a change is made to the hitbox property such that the top left corner of the hitbox is set to the minimum x and y value of coordinates of an entity.

To find the new points of the rotated entity we use the rotation matrix to rotate the current corners of the entity. As seen in List 3.3 the minimum x and y values of these corners are then found, and used to find the top left corner of the hitbox. Once this corner is found, the width and height can be calculated by using the corner and the centre of the entity.

In Figure 3.5, the hitbox can be seen around the hitbox both when rotated and not rotated.

```
1  protected void changeHitbox(){
2          FloatPoint one = rotationMatrix( -(getWidth()/2),
               -(getHeight()/2));
3          FloatPoint two = rotationMatrix((getWidth()/2),
               -(getHeight()/2));
4          FloatPoint three = rotationMatrix((getWidth()/2),
               (getHeight()/2));
5          FloatPoint four = rotationMatrix( -(getWidth()/2),
               (getHeight()/2));
6
7          hitboxTopLeft = new FloatPoint(
8              findMin(one.x, two.x, three.x, four.x),
9              findMin(one.y, two.y, three.y, four.y));
10         hitboxWidth = (getCenter().x - hitboxTopLeft.x)*2;
11         hitboxHeigth = (getCenter().y - hitboxTopLeft.y)*2;
12 }
```

Listing 3.3: Method to change the hitbox



(a) Hitbox for a un-rotated rectangle. (b) Hitbox for a rotated rectangle.

Figure 3.5: The different hitboxes.

A new issue that emerged was that the collision detection for the entity was now larger than the entity. When an entity was behind a rotated entity, and the user clicked in the top left corner of the hitbox, the rotated entity would be selected instead of the entity behind. To resolve this issue, an implementation

is done to give a precise collision detection on the entity, which is described below.

Precise Collision Detection for Rotated Rectangles

To understand the mathematics behind the precise collision detection for rotated rectangles, an illustration of the problem can be seen in Figure 3.6.

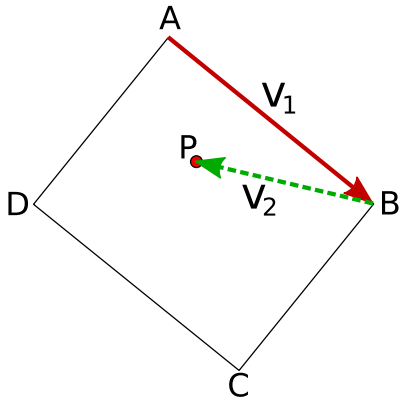


Figure 3.6: Vectors showing a right rotation.

The idea behind the mathematical formula is to see whether the vector to the point is a right rotation of all the rectangle's sides. To determine this, we compare the slope of the vectors. The formula to determine a right rotation is:

$$\frac{B_x - A_x}{B_y - A_y} \geq \frac{P_x - B_x}{P_y - B_y} \tag{3.1}$$

The formula is changed to avoid divide by zero errors, and is therefore changed to the following formula:

$$(B_x - A_x) * (P_y - B_y) \geq (P_x - B_x) * (B_y - A_y) \tag{3.2}$$

Formula (3.2) is then used with all four vectors of neighbouring corners of the rectangle to determine whether a point is inside the rectangle or not.

Precise Collision Detection for Rotated Ellipses

To get a precise collision detection for rotated ellipses, we use the formula of an ellipse in standard form with the clicked point as input to check whether it is inside of the ellipsis. If the clicked point is inside of the ellipse, the formula of an ellipse in standard form is smaller than or equal to one as seen in Formula (3.3).

$$\frac{P_x^2}{a^2} + \frac{P_y^2}{b^2} \leq 1 \tag{3.3}$$

To use Formula (3.3), we first have to accommodate for the rotation of the ellipse. If the ellipse is rotated, we rotate the clicked point around the centre of the ellipse and compare it with an un-rotated version of the ellipse. The rotation of the clicked point is done by use of the rotation matrix, as seen in Formula (3.4). An ellipse has two radii which are used in the formula and illustrated as a and b, as seen in Figure 3.7.

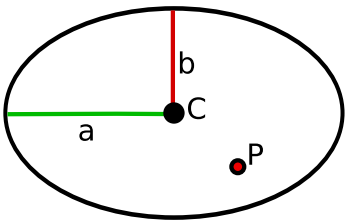


Figure 3.7: Ellipsis with its two radii, centre point, and the clicked point.

$$\begin{aligned} P'_x &= P''_x * cos(\alpha) - P''_y * sin(\alpha) \\ P'_x &= P''_x * sin(\alpha) - P''_y * cos(\alpha) \end{aligned} \tag{3.4}$$

P'' is the vector from the centre of the ellipse to the clicked point. This formula can now replace the coordinate in the standard formula, which results in Formula (3.5).

$$\begin{gathered} \frac{{P'_x}^2}{a^2} + \frac{{P'_y}^2}{b^2} \leq 1 \\ \Downarrow \\ \frac{(P''_x * cos(\alpha) - P''_y * sin(\alpha))^2}{a^2} + \frac{(P''_x * sin(\alpha) - P''_y * cos(\alpha))^2}{b^2} \leq 1 \end{gathered} \tag{3.5}$$

With this final formula derived, we can use it in the application to check if the user has clicked on an ellipse or not.

Precise Collision Detection for Rotated Lines

The last collision detection issue is a precise detection of a click on a line. We discuss how to click on a line and agree that the click is allowed to be slightly off the line, since it otherwise is hard to click on. An idea is to calculate the distance from a point to the line and add a click range in order to determine if the click is meant to target the line.

To find this distance we use the formula for finding the area of a triangle, since the three points, clicked point, start point, and end point of the line, form a triangle. The distance is determined by the height of the triangle, from the base to the clicked point as seen in Figure 3.8.

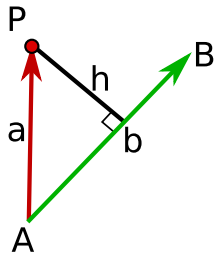


Figure 3.8: Drawing showing the idea behind the mathematical formula.

There are two equations for finding the area of a triangle, as seen in Equation (3.6) and Equation (3.7).

$$A = \frac{1}{2} * h * b \tag{3.6}$$

$$A = \frac{1}{2} * |\vec{a} \times \vec{b}| \tag{3.7}$$

We combine these two formulas since we are not interested in the area but the height h. Once combined, we isolate the height h and find a final equation for the height, as seen in Equation (3.8).

$$\begin{gathered} \frac{1}{2} * h * b = \frac{1}{2} * |\vec{a} \times \vec{b}| \\ \Downarrow \\ h = \frac{|\vec{a} \times \vec{b}|}{b} \end{gathered} \tag{3.8}$$

Another note to mention, is that the length of the vector $\vec{b}$ is the same as the base b.

$$|\vec{b}| = b$$

Since Equation (3.8) is based on given vectors and lengths, and the variables given in the application are coordinates, we change the formula to calculate the vectors and lengths from the coordinates. As can be seen in Equation (3.9), the vector $\vec{a}$ is equal to the difference in the clicked point P and the start point A.

$$|\vec{a} \times \vec{b}| = \left| \begin{bmatrix} P_x - A_x \\ P_y - A_y \end{bmatrix} \times \begin{bmatrix} B_x - A_x \\ B_y - A_y \end{bmatrix} \right| \tag{3.9}$$

From Equation (3.9), we can see how the cross product of the two vectors is determined, given the three coordinates. We can now replace that with the cross product in Equation (3.8), and add the equation for finding the length of the vector $\vec{b}$ in the denominator, as seen in Equation (3.10). By expanding the brackets in the numerator, we get a final equation for finding the distance from a point to a line that goes through two points.

$$\begin{aligned} h &= \frac{|\vec{a} \times \vec{b}|}{|\vec{b}|} \\ &= \frac{|(P_x - A_x)(B_y - A_y) - (P_y - A_y)(B_x - A_x)|}{\sqrt{b_x^2 + b_y^2}} \\ &= \frac{|P_x B_y - P_x A_y - A_x B_y - P_y B_x + P_y A_x + A_y B_x|}{\sqrt{b_x^2 + b_y^2}} \end{aligned} \tag{3.10}$$

Since the equation finds the distance from the clicked point and a line that goes through two known points, we have to limit the line so it does not pass the two points. To do this limitation, we use the hitbox of the line so that the click also has to be inside of the hitbox.

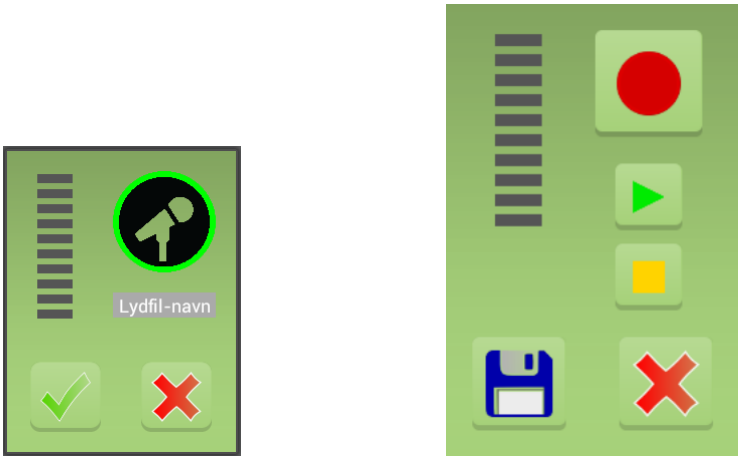
Save Canvas State

To fix the issue, the *drawStack* is saved as a singleton, which makes a single *drawStack* instance available across modes, such that even when the canvas is restarted, the *drawStack* can be reloaded. The canvas is still be cleared if the process is terminated, however, for the given issue the singleton will suffice.

Record Dialogue

The record dialogue contains two issues, the UI of the dialogue and the functionality to hear your recording.

For the UI, the main issue was an unintuitive icon for recording, discovered by usability tests performed by the previous development group on this application [5]. To solve this issue, we decide to make a red circle icon, similar to the look of other recording buttons. Furthermore, the record button changes to a darker colour when recording.



(a) The old record dialogue design. (b) The new record dialogue design.

Figure 3.9: Comparison of the record dialogues.

To get an idea of the dialogue box look, see Figure 3.9. As can be seen in the dialogue box, a play and stop button are also added to preview ones recording, which is a feature that was non-existent in the application before this sprint. The functionality of these buttons are implemented with the *SoundPool* Android library, which allows for playing of audio.

Scale Camera Pictures

When a picture in the canvas is selected, it shows the resize button, and when the resize functionality is accessed, it resizes the hitbox, but it does not change the size of the picture. In order to make this resizing possible, a new method is created. This method takes a width and length as input, and recreates the picture based on this information.

3.4 Sprint Closure

To conclude, the sprint has been successful, as the issues for the sprint have been resolved, but an additional issue is found. The stroke width of an entity

was not taken into account when determining collision detection, resulting in squashed boxes with a large stroke not being selectable, and should be resolved in the next sprint. In addition to this, the application also shows a tendency to crash when a large amount of entities are drawn, as it runs out of memory to store the entities. Furthermore, issues from the product backlog which is not in the sprint backlog should be considered for future sprints. Another thing to note, is that the UI changes that are made require usability tests in order to verify that the assumptions made regarding what is intuitive, actually correspond to the users' understanding.

4. Second Sprint

The second sprint of this project is decided to run from 20th of March to the 14th of April. The primary focus of this sprint is to resolve issues in the running application. *Croc* is still the application being worked on and is renamed to *Pictocreator* as the customers did not understand the applications purpose from the name.

4.1 Sprint Backlog

For the second sprint, the sprint backlog consists of the following.

Load existing audio file to the record dialogue
: After recording an audio file and exiting the record dialogue, the recorded file can not be played when you enter the record dialogue again, which it should.

***playButton* press before no recording is performed**
: The play button should be deactivated when no recording exists.

Change *Pictocreator* icon
: Needs to be changed to a pencil drawing on a paper, as requested by the customer.

Record dialogue GUI change
: Needs to be changed to one record button that switches icon to a stop icon when recording. In addition have a single toggle button for playing and stopping of audio. This was a request from the customers.

Use colour settings from *Launcher* in *Pictocreator*
: Apply colour settings parsed from *Launcher* in *Pictocreator*.

Update to *gComponent*
: Update GUI such that it uses *gComponents*, developed by another group in the *GIRAF* project.

Save pictogram
: Save pictogram in database and its associated sound.

Load pictogram from database
: Load a pictogram from the database into the canvas.

Flatten Button
: Give flatten button the functionality to move selected entity to back of the canvas.

Pictogram title in text on pictogram
Customers have expressed interest in having the title of the pictogram written on the pictogram on either the top or the bottom.

Tags for save dialogue
Be able to add tags to ones pictogram when saving it and support this in the GUI.

Rotation of Freehand Entities
Freehand entities are rotating around their start point, but should rotate around the centre of the entity.

Collision detection for large stroke width entities
The current collision detection does not take the stroke width into account. This means that entities with a large stroke width are very hard to hit, if their centre area is very small.

Freehand collision detection
The collision detection should work so if you click the freehand drawing it should be marked.

Freehand hitbox
The hitbox has to follow the rotation, so it encapsulates the freehand entity.

Preview Pictogram
A bug occurs when trying to save a pictogram as the preview sometimes does not load.

4.2 Implementation

With the sprint backlog for the second sprint specified, here follows a description of how the main issues are resolved.

Load Existing Audio File to the Record Dialogue

A pictogram can have a single sound file associated. As of such it is reasonable to make the saved sound file path static.

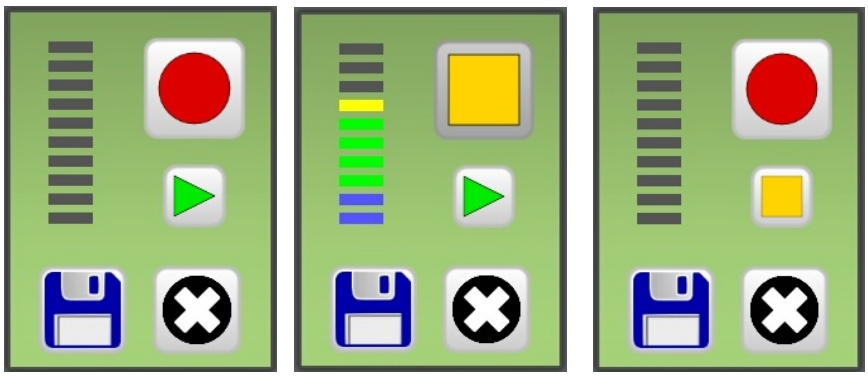
As the sound file path is made static, it just needs to get assigned a path the first time the record dialogue is added. Else you replace that file each time you save a new recording.

One issue occurred, which is associated with a play button press before no recording is performed. This issue is fixed by checking if a recording already exists at the static path. If a recording exists at the path the recording is played, if not, a toast is made telling the users that there is no recording.

Record Dialogue GUI Change

By satisfiability testing it is found that the record dialogue should be changed again.

The record dialogue GUI to be changed is the one seen in Figure 3.9. However, the customers desires fewer buttons, and point out that the play and stop button can be combined into one button, as they are mutually exclusive and are causing confusion.



(a) Idle mode (b) Recording mode (c) Playing mode

Figure 4.1: Record Dialogue GUI.

To support this change, the audio player is changed to the Android *MediaPlayer* instead of *SoundPool*, as *MediaPlayer* supports an event for registering when a sound is finished playing. The new GUI can be seen in Figure 4.1. It was shown to the customers and they found it reflected their requirements.

Use Colour Settings from *Launcher* in *Pictocreator*

The colour settings originally parsed from the *Launcher* application can be applied to the layout with a gradient effect by use of the HSV colour encoding. Later, the *Launcher* group decided that this colour schema from the *Launcher* should not be applied after all, but the following description serves as a documentation of how it was implemented.

We make a gradient colour with use of the HSV encoding format with adjustment of the value parameter, to give a better depth to the background layout. If the application is not opened from *Launcher*, or the *Launcher* does not parse a colour value, a default colour scheme is applied.

Update to *gComponent*

This issue is a general issue for all the applications in the multi project. A group was assigned to create a GUI framework to the multi project such that the GUI has the same look in all applications.

To implement this framework, we have to add the path for the *gComponent* such that they can be used in the XML-files that define the GUI. Each existing button is changed to a matching *gComponent* and its functionality changed to work with the new framework. This implementation resulted in deletion of several XML-files that were used to create the previous buttons and their functionality is now taken care of by the framework.

The clear dialogue changed more drastically than the rest of the interface, as the framework also contains a method to create simple confirmation dialogue. This change results in removal of the clear dialogue XML-file, as it is no longer needed.

Save Pictogram

A pictogram has some needed attributes that have to be saved together with the pictogram. These attributes can be assigned in the save dialogue and include the publicity of the pictogram, public or private, the tags following the pictogram, the inline text, and the name of the pictogram.

To save the pictogram, we first create a pictogram object and assign the needed attributes to it. The sound is saved in the cache of the tablet in another dialogue, but now it is assigned to the pictogram object so it can be saved in the database. Furthermore, the author's ID is added as well as the bitmap from the canvas. Once the attributes have been assigned, the pictogram is stored in the database via the provided methods from the database. The database gives the pictogram an ID and returns it back, so it can be used to create the relation between tags and pictogram.

Load Pictogram from Database

The application should be able to load existing pictograms, so they can be modified to accommodate desired changes. To do this we decide to use *Pictosearch*, which is an application that is also under development in the *GIRAF* project. *Pictosearch* is a search tool that can find pictograms stored in the database. The chosen pictogram ID is then sent to the calling application, which in this case is *Pictocreator*.

The call to start *Pictosearch* also sends the guardian's ID, to allow access to their private pictograms, as well as the purpose of the call which is *single* meaning *Pictosearch* can return at most one pictogram ID, as seen in lines 5 – 9 in List 4.1. If *Pictosearch* is not installed, a message will inform the user about it.

```
1  private void callPictosearch(){
2      Intent intent = new Intent();
3
4      try{
5          intent.setComponent(new ComponentName(
               "dk.aau.cs.giraf.pictosearch",
               "dk.aau.cs.giraf.pictosearch.PictoAdminMain"));
6          intent.putExtra("currentGuardianID", author);
7          intent.putExtra("purpose", "single");
8
9          startActivityForResult(intent, RESULT_FIRST_USER);
10     } catch (Exception e){
11         Toast.makeText( this, "Pictosearch er ikke
               installeret.", Toast.LENGTH_LONG).show();
12     }
13 }
```

Listing 4.1: Method used to launch *Pictosearch*.

An event to receive the pictogram is created, called *onActivityResult*, which checks whether it returns a results or not. If there is a result, another function is called which loads the pictogram bitmap from the database using the pictogram ID returned from *Pictosearch*, as seen in line 5 in List 4.2. The bitmap is then loaded into the canvas in the original scale.

```
1  private void loadPictogram(Intent data){
2      try{
3          int pictogramID =
               data.getExtras().getIntArray("checkoutIds")[0];
4
5          Bitmap pictogram = (PictoFactory.getPictogram(this,
               pictogramID).getImageData());
6
7          drawFragment.drawView.loadFromBitmap(pictogram);
8      }catch(Exception e){
9          Log.e(TAG, e + ": No pictogram returned.");
10     }
11 }
```

Listing 4.2: Method to load a pictogram from Id received from *Pictosearch*.

Flatten Button

The flatten button functionality is implemented as seen in List 4.3.

```
1 public void moveToBack(Entity entity){
2    int index = entities.indexOf(entity);
3    entities.remove(index);
4    entities.add(entities.size(), entity);
5 }
```

Listing 4.3: Flatten Button functionality.

As the entities are already stored in a list, it is a matter of moving the entity to the end of the list. With the flatten button functionality implemented, the order in which a user draws entities can be disregarded, as the order can be changed.

Pictogram Title in Text on Pictogram

When talking with the customers, a need for adding text to pictograms was proposed. Different options for adding text was discussed, which included adding text to the pictograms themselves or in the dialogue in which the pictogram is saved. The customers agreed that adding text in the save dialogue made the most sense, and thus text on the pictogram itself was discarded.

The customers want the title of the pictograms to be in changeable positions. This issue is deemed as not being the responsibility of *Pictocreator*, as the text is merely stored together with the pictogram and can be placed wherever users of the pictogram want it. The issue of placing the text is the responsibility of the applications showing the pictogram and its text.

Tags for Save Dialogue

Tags were partially added in the GUI but you could not add tags and they could not be stored in the database. To resolve this, tags are stored in an *ArrayList* and displayed in a *ListView*, such that when modifying the *Arraylist* the GUI is updated as well. Implementing the tags gives the opportunity of specifying keywords for the created pictogram, which can be searched for to find the pictogram later. Assigning the tags to a pictogram is done with use of a database helper provided in the developed *Oasis* database library.

Freehand Collision Detection

This issue is resolved by using the collision detection method used for a line. A collision with the freehand entity should occur when the clicked point is close to the drawn part of the freehand entity. To do this, each of the line segments have to be compared with the clicked point using the method for line collision detection which is presented in Section 3.3. However, the freehand entity only contains points, so these points are used to create the line segments.

Preview Pictogram

Previously when loading the preview, it was handled in the *drawView* and was saved on the cache. This proved to be a problem, as it was unclear how the timing of saving to the cache worked, and using that storage was vulnerable to sudden cache clearings. In order to solve this issue, the Bitmap encoding of the pictogram is parsed to the save dialogue instead, which makes the preview unaffected by sudden cache clearings.

4.3 Sprint Closure

The issues for the second sprint have been resolved. In addition, contact was established with the customers, where they expressed an opinion on the current UI, which they wanted to have changed. This opens for a new issue for following sprints to change the UI of the application. Additionally, the customers expressed the requirement of loading old pictograms for editing, where the pictograms should not be overwritten, but save an extra modified version instead.

Another application, *Pictosearch*, worked on by another group, is needed to search for pictograms. However, *Pictosearch* at its current state crashes at startup, and needs to be resolved before further work regarding loading of pictograms can be pursued. *Pictocreator* still crashes, but seems to have been reduced to memory issues. It is believed that this can be minimise by reducing the amount of camera images stored to the ones taken for a specific pictogram. Furthermore, tests are believed to be crucial in future sprints to minimise bugs before a final release is published to the customers.

5. Third Sprint

It is decided that the third sprint should run from the 15th of April to the 5th of May. The primary focus of this sprint is a major GUI overhaul. The secondary focus is adding of a few missing functionalities. In addition to this, it is also decided that the application needs to be renamed once again, from *Pictocreator* to *Piktotegner*, since the customers are Danish, the name should also be in Danish.

5.1 Sprint Backlog

The sprint backlog for the third sprint is as follows.

New text for title and name in save dialogue
: The name of the title and name in the save dialogue have to be changed so it is more understandable for the customers.

Resize rotated entities
: Have an intuitive resizing of entities after they have been rotated.

Camera dialogue
: The way import pictures worked through the camera is deemed illogical by the customers. They desired something more akin to *Instagram* [6] that does not require them to go into another dialogue, but rather open a dialogue box instead.

GUI changes
: Rearrange all buttons in accordance with customer expectation.

Load drawstack
: Change load functionality to load drawstack if the pictogram is created in *Piktotegner*. This is only possible after the database has been updated to accommodate this change.

Text on buttons
: There has to be text below the icon of every button as requested by the customers.

Radio button for "public" save dialogue
: Make two radio buttons for the save dialogue. The first should be for the private setting and the other for the public setting.

Custom Colour button
: Need a button to choose a custom colour.

5.2 User Interface

A meeting was established with two of the customers, Drazenko and Pernille [7, 8]. From the meeting it was found that the general drawing interface seemed suitable. However, after they tried to use the application, some flaws were found. The flaws were mainly how you take pictures, which is deemed unintuitive, as you have to take multiple pictures and then later choose which one to load into the pictogram.

Furthermore, a new position ordering of the drawing tools was requested. This was mainly a request from Pernille, as she found that options for the drawing tools should be located near each other. Additionally, the colour theme of the application is changed such that the graphical components developed by the *gComponents* group is used.

The chosen version can be seen in Figure 5.1, keep in that the colour of the buttons are from *gComponent* whereas the background at this stage is not changed to match this colour. This version of the UI is not yet tested, and as of such can not be determined as final yet. Future sprints have to focus on presenting the UI to the customers and perform usability tests to ensure that a good quality of the application is achieved.

Figure 5.1: The implemented user interface.

Prototypes

Before the user interface (UI) changes are performed in the application, paper prototypes are created to get a first intuition of how the UI should look. These prototypes are based upon the talk with the customers [7, 8].

Rearrange UI Components

Based on the request from the customers, the UI components of the drawing surface should be rearranged. Two prototypes are drawn for this, which can be seen in Figure 5.2 and Figure 5.3. The idea of Figure 5.2 is to move the components that had to do with the creation of a pictogram down in the

drawFragment. Furthermore, to arrange the options for the drawing tools near the tools themselves. However, it is deemed that the application would become asymmetrical due to this change.

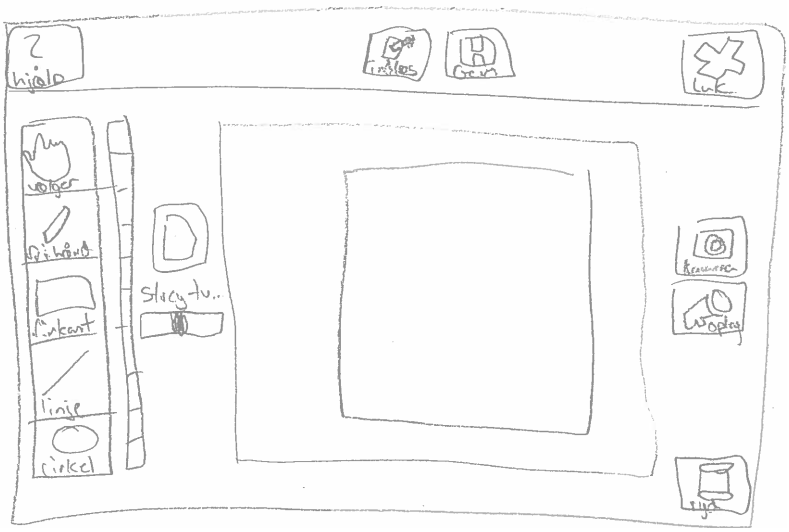


Figure 5.2: Version 1 drawfragment.

The idea of Figure 5.3 is to keep everything drawing related in the *drawFragment* and additional features in the top bar. In addition, the options of the drawing tools are separated from the tools themselves, to regain symmetry.

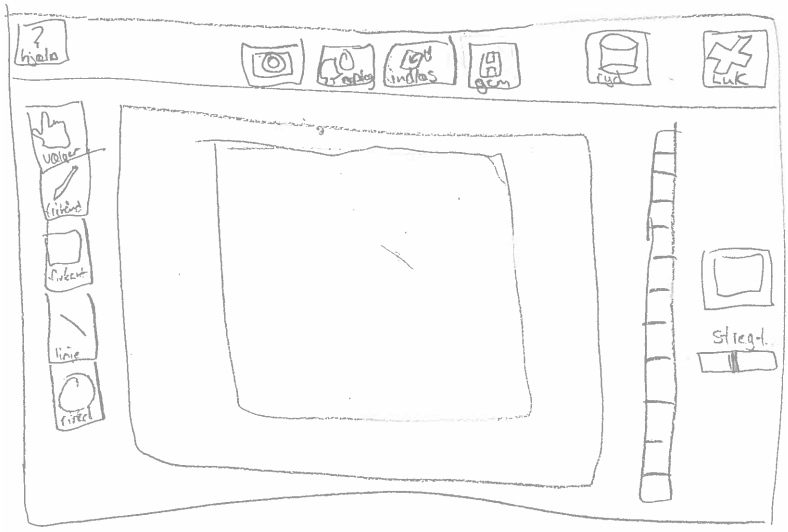


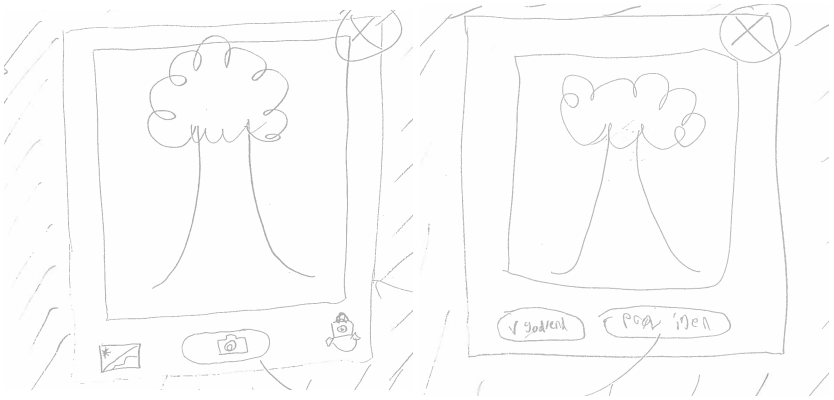
Figure 5.3: Version 2 drawfragment.

Parts of the two prototypes are found satisfactory, and as of such a combination of the UI is performed. It results in still having the separation of tools

and their options, but making the *drawFragment* being a more general layout, featuring the creation of pictograms instead of the drawing part solely.

Camera Dialogue

The customers found it unintuitive to be able to take multiple pictures at a time and then later use some of the pictures for a pictogram. For that reason, the camera dialogue should be changed to only be able to take one picture at a time. When the picture is taken it can be verified, and then added to the pictogram, or discarded.



(a) Take Picture. (b) Verify Picture.

Figure 5.4: Camera Dialogue.

Figure 5.4 shows a prototype of the camera dialogue, where inspiration has come from popular image applications such as the inbuilt *iOS* [9] camera and *Instagram* [6]. Seen in Figure 5.4a is the dialogue as it should look like when preparing to take a picture of a tree. The button to the lower left is to swap between colour and black-white mode, which is a request of the customers. In the lower right corner, a button to swap between front and back camera can be seen. Finally, in the lower center, a button to take the picture can be seen.

When the picture is taken, you are transferred to the UI seen in Figure 5.4b, where you have the option to accept the taken picture or to decline it, and return to the previous UI to take a new picture.

In the whole camera dialogue you always have the option to quit the dialogue by pressing the button in the upper right corner.

5.3 Implementation

In this section, the important issues from the sprint backlog of the third sprint are detailed and explained.

New Text for Title and Name in Save Dialogue

These two fields need to have the text changed, as both the customers as well as colleagues had trouble understanding the difference between information contained in the two fields. The previous text in Danish, "titel på pictogram" and "pictogram navn", is changed to "tekst på piktogram" and "piktogram navn". The reason it is such a slight change is that the main confusion seemed to be

the use of the word “titel”, Danish for title, and we think that by replacing it with the word “tekst”, Danish for text, the meaning becomes more clear. It is not yet known if this is the case, as this change has not yet been checked with the customers, so there is a risk it changes nothing, but is checked in the next meeting with the customers.

Resize Rotates Entities

Resizing an already rotated entity would result in an odd and unintuitive behaviour. The problem was that the dragged vector just added its dimensions to the rectangles width and height. However, if the rectangle is rotated, the dragged vector would still add its dimensions to the rectangle as if the rectangle was not rotated. This issue would for example have a opposite resizing if the rectangle was rotated 90°, as can be seen in Figure 5.5. To change this

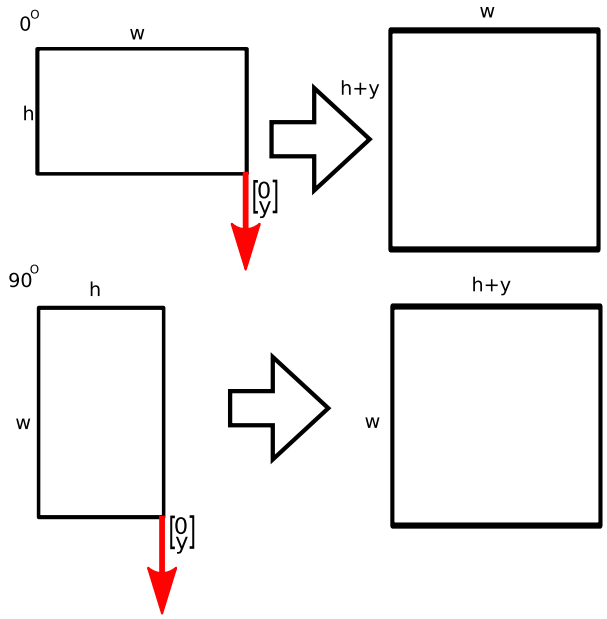


Figure 5.5: Example showing previous resize rotate combination

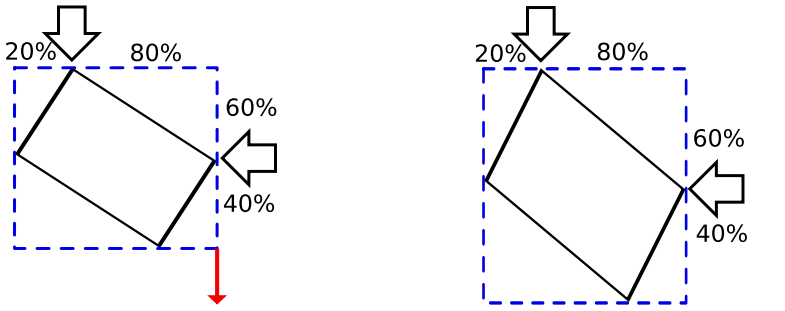
behaviour we tried some different ideas, which resulted in failure but will still be documented to show our effort towards this issue.

The initial approach was to rotate the vector with the same angle as the rectangle is rotated and then apply the dimensions as previously. However, this approach was mathematically flawed as the vector could end up with negative dimensions after rotation and decrease the size of the rectangle where the motion of the user intuitively should increase the size of the rectangle.

In an attempt to reuse the idea in the previous approach, we observe that the vector should be rotated somehow. An example to show this idea can be shown using $\vec{a} = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$, and let us say the rectangle is rotated by 90°. This means the resulting vector should be $\begin{bmatrix} 3 \\ 2 \end{bmatrix}$. The problem with this approach is that we could not mathematically express how to rotate the vector.

Since we can not determine that rotation, we take another approach and instead of looking at the drag vector, we look at how the hitbox changes. The drag vector was now applied to the hitbox and we looked at how much the hitbox would change in size. This size change would then be applied to the rectangle inside the hitbox, but had the same problems as in the original problem as when the rectangle is rotated above 90° its height should be changed when the hitbox width was changed.

Next approach expanded upon the idea of using the hitbox. We look at where the edges of the rectangle connected with the hitbox and when the dimensions of the hitbox change, we place these edges at the same ratios. For example, assume that the an edge of the rectangle connected with the side of a hitbox at a ratio of $20\% - 80\%$, it should keep that ratio after the hitbox is resized. However, this approach will conceptually stretch the rectangle instead of resizing it, resulting in it no longer being a rectangle. This result can not be represented with the implementation of the Android rectangle shape as the entity is considered a rectangle at all times, and due to this, it is not implemented. Yet again we take the idea in another direction, and look at the



(a) The rectangle without resizing. (b) The rectangle after resizing.

Figure 5.6: Example showing 4th resize approach.

width and height of the rectangle as vectors. The angle of these vectors can be divided by the angle of the drag vector, to find a factor of how much each side has to be affected. For example, let us assume that the width vector has an angle of 60°, the height vector an angle of 150°, and the drag vector 30°. The factor can then be found as follows:

$$\begin{aligned} w' &= v/w \\ h' &= 1 - w' \end{aligned} \tag{5.1}$$

where,

w is the angle of the width vector.

v is the angle of the drag vector.

w' is the factor of much the width should be affected.

h' is the factor of how much the height should be affected.

The equation is opposite when the angle of the width vector is above 90°. With the above example the factors would be $w' = 0.5$ and $h' = 0.5$, which means

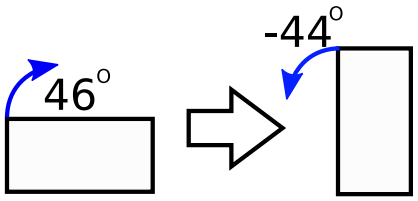


Figure 5.7: Example showing the current and possibly final resize approach.

half the length of the drag vector is added to the width and height. A problem occurs when the angle of the width vector would be a lot smaller or larger than the drag vector angle and for example add twice the length of the drag vector.

The current and possibly final approach is to reset the starting point of the rectangle and swap its width and height. This happens when the rotation angle of the rectangle is between 45° and 315°, which corresponds to the possible angles to be between 45° and −45°. We implement this approach since we observe that the resizing is reasonably accurate as long as the rotation angle is below 45°. As an example, let the rotation of the rectangle be 46°, this means the dimensions of the rectangles are swapped and the rotation angle is set to −44°, as can be seen in Figure 5.7.

Custom Colour Button

The colour choices available in the application were unchangeable as they had hard coded values. Due to this, a need for additional colour choices would arise, if a customer needed a specific colour that was not available. This functionality is added by using an already created implementation of a colour picker created by the group responsible for graphical components in the *GIRAF* project. The colour picker has a full spectrum of colours, once a colour is chosen it can be shaded. In addition to the colour picker, we create a button to allow for quick reselection of the last colour chosen in the colour picker. This button is added because we believe that having to go into the colour picker to reselect would be a nuisance.

DrawStack

After a pictogram is created and saved with *Piktotegner*, the customers want to be able to load it again, without loss of pictogram information. This information consists of the *drawStack* of a pictogram, such that different painting entities can be edited individually and not a singular bitmap. If the pictogram is saved in the database from some other source that is not *Piktotegner*, it is the singular bitmap you load. The *drawStack* issue consists of saving and loading the *drawStack*, and is described hereafter.

Saving the DrawStack

The idea to save the *drawStack* on the database is to convert the *drawStack* into a byte array. Java provides this service if you implement the *Serializable* interface, which is a keyword where you do not need any implementation if the data types of the fields are all *Serializable*. However, *RectF* and *Paint* from the Android Graphics Library do not implement the *Serializable* interface.

At first this is tried to be solved by making *Serializable* versions of those classes, which then extends *RectF* and *Paint* respectively but implement the

Serializable interface. This method resulted in the *drawStack* being able to be converted to a byte array, however, the information of the stroke width and colour of entities is lost. This is due to the *Paint* and *RectF* classes again including fields that are not *Serializable*. As of such, integers are introduced to contain the information of those objects, in order to bypass the usage of those objects as fields and thereby be able to convert the *drawStack*tack to a byte array. *Paint* and *RectF* can be solved in this way, but when containing a camera picture represented as a bitmap in the *drawStack*, difficulties arise when converting to a byte array.

If the *drawStack* contains a bitmap, a solution is not as easy as introducing integers to hold information. A library is instead tried to manually convert the bitmap to a byte array and back again. However, for the current sprint, a satisfying solution is not found, because if the bitmap has to retain a certain quality, the conversion is too resource demanding. As of such, for future work, a way to save the *drawStack*, when a bitmap is an element thereof, is needed. At present, the *drawStack* gets saved if there is no bitmap for the pictogram, else the singular bitmap saving and loading is performed.

Loading the DrawStack

For loading a *drawStack*, it is not a problem, as the *drawStack* has already been saved as a byte array and the classes have been made *Serializable*. Then it is a matter of using the developed method to convert the byte array to a *drawStack*, see List 5.1.

```
1 public static Object deserialize(byte[] data) throws
      IOException, ClassNotFoundException {
2         ByteArrayInputStream in = new
              ByteArrayInputStream(data);
3         ObjectInputStream is = new ObjectInputStream(in);
4         return is.readObject();
5 }
```

Listing 5.1: Method for converting byte array to object

5.4 Sprint Closure

The issues of the third sprint are resolved, but some are still missing a usability test to be approved and closed. Additionally, the camera dialogue still needs some development, as a bug occur that results in stretching of the dialogue unintentionally.

The application was presented to the customers at the sprint end meeting, where general positive feedback was received. A few requests were proposed, such as the possibility of assigning pictograms to specific citizens instead of the whole institution. In relation to this, it was found that there is only a need of one guardian profile per institution, which is why the distinction between guardians is not necessary, but is kept as it is resolved in the guardians using a shared profile. This sharing of a profile is, however, a temporary solution, as the guardians should have their own profile with their private settings.

Furthermore, it was found that resizing of camera pictures should be changed to scaling, such that its aspect ratio is kept.

For the next sprint, these issues are focused on in addition to usability tests to ensure a good application quality.

6. Fourth Sprint

It is decided that the fourth sprint should run from the 6th of May to the 20th of May. The main focus for this sprint is to implement the final important issues that are left or were introduced during the sprint end. Another focus for this sprint is to make the application ready to be deployed to the customers. Finally, to make sure that the customers can use the application, a usability test is performed.

6.1 Sprint Backlog

For sprint 4, the sprint backlog consists of the following.

Negative width and height during resize
: Allowing negative width and height during resize gives volatile behaviour and should thus be constrained.

Bug in the camera dialogue
: A bug occurs when a picture is taken after the camera has been swapped between front and back camera, and when the camera dialogue is accessed again there is no camera feed.

Change help pictures
: Make new help pictures illustrating tutorials with the new user interface.

Changes to accessibility settings
: Change the settings from private and public to be for citizen specific or available to whole institution.

Pictures should fill whole canvas
: Pictures taken with the camera should fill the canvas.

Resizing camera pictures
: Resizing camera pictures should be limited to scaling, such that the aspect ratio is kept.

Preview button with suitable display
: Make the preview button show the selected tool instead of always a rectangle.

6.2 Implementation

In this section the main problems from the sprint backlog are detailed and explained.

Negative width and height during resize

Entities could be resized to negative sizes resulting in odd behaviours. To resolve this issue, we constrain the width and height of the entities to not go below zero. If that happens they are set to zero.

Bug in the Camera Dialogue

When using the camera to take pictures after the camera is swapped between back and front camera, a bug is found. The bug is that the next time the camera dialogue is accessed, the camera is not available. It is found that the camera is not released when the camera dialogue is closed. Two surfaces are used in the camera dialogue, so the releasing of camera can not only be performed in the *onPause* method, but has to be added to the *surfaceDestroyed* method.

Change Help Pictures

Piktotegner has grown to be an application with numerous features for creating pictograms. As of such, due to the scale of the application, people may be confused when using the application the first time. The help pictures come as a possible solution to this, where the user can open the help menu and look at help pictures to get a better understanding of how the application works. Help pictures already exists from the previous development group, but have become outdated due to UI and functionality changes, which also gives a reason for this update.

The help pictures are structured as a mini sequence, such that each help picture contains two images, aligned top and bottom. The top image shows where to press to perform some action and the bottom image shows the result of performing that action. In total, 24 help pictures have been made and to view them you browse through them with a left and right arrow button. An example of such a help picture can be seen in Figure 6.1.

Changes to accessibility settings

A customer request was made to create a feature which could add a pictogram to specific users in the system. Previously, we have the option of assigning the pictogram to the user, as private, or available to everyone, as public.

We change the public to be institution wide, meaning the pictogram is available to all the guardians and citizens of the institution. The private option is changed to be available for specific citizens, chosen from a list which contains the citizens assigned to the currently logged in guardian. To avoid confusion, it is decided that the button to add citizens and the list with the citizens is hidden until the user checks the citizen radio button.

This change require a significant overhaul in the GUI of the save dialogue, the resulting GUI can be seen in Figure 6.2, where the citizen button is checked and two citizens are chosen.

When the button *Tilføj Borger* is clicked a new dialogue will show up where the citizens can be clicked, as seen in Figure 6.3, where the darker fields are chosen whereas the light is not. The dialogue is a component from the *gComponent* library created by the GUI group in the multi-project. The text colour on the radio buttons are white due to the library, but should have been black as they are not clearly visible.

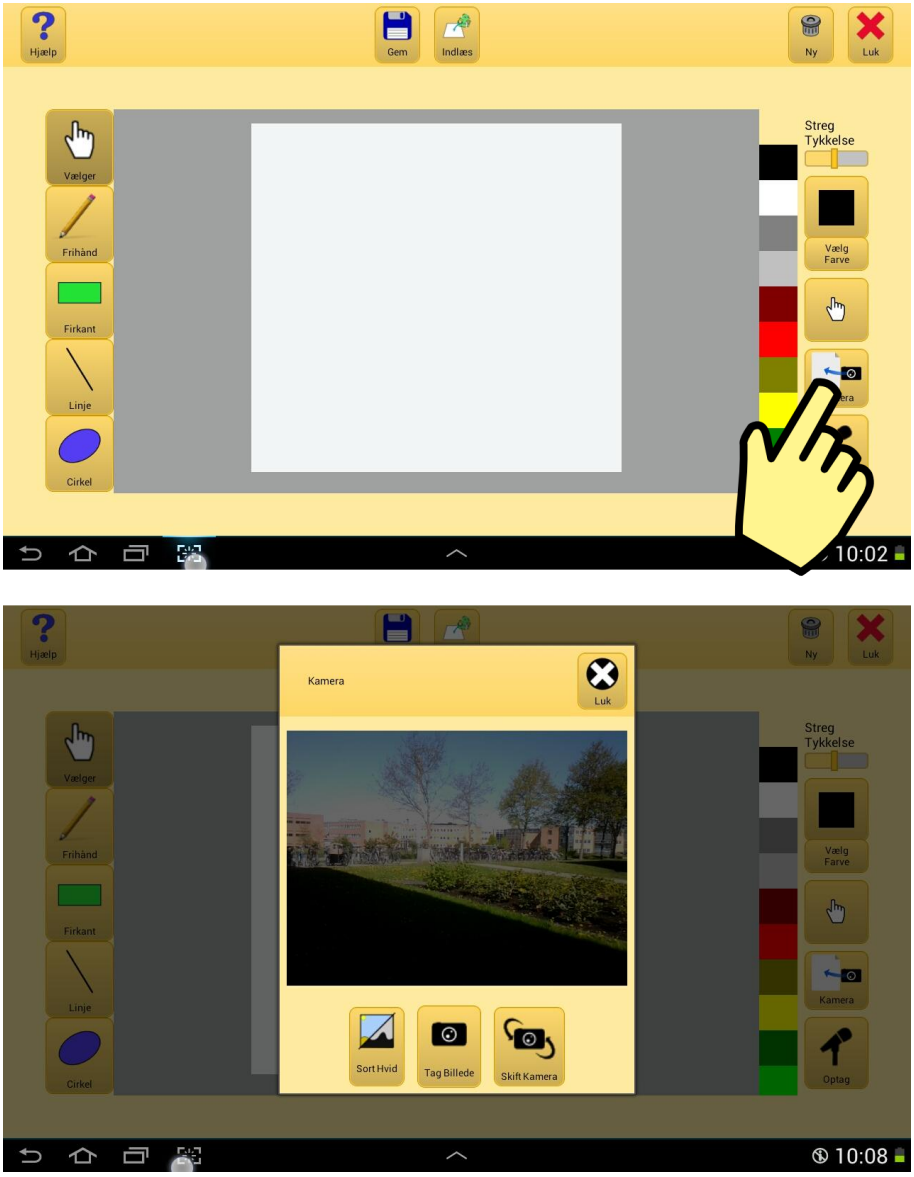


Figure 6.1: Help picture for opening camera dialogue.

Pictures should fill canvas

A request was made by the customers that once a picture is taken with the camera it should fill the drawing field. To do this we look at the width and height of the drawing field and find the relation between the picture and the drawing field, and create a new bitmap where the bitmap is scaled with this relation in a proper aspect ratio. This scaling makes the picture fit the drawing field in size. The placement of the picture is determined from the picture's centre, which is assigned to the drawing fields centre. The code implementation for this can be seen in List 6.1.

Figure 6.2: The dialogue showing the button where citizens can be given access to a pictogram.

```
1 private void loadPicture(Bitmap bitmap){
2   int sizeHeightPercentage =
        (int)(((double)(this.getBitmap().getHeight()) /
        (double)(bitmap).getHeight())*100.0) + 1;
3   int sizeWidthPercentage =
        (int)(((double)(this.getBitmap().getWidth()) /
        (double)(bitmap).getWidth())*100.0);
4
5   BitmapEntity tempEntity = new BitmapEntity(bitmap,
        Math.max(sizeHeightPercentage, sizeWidthPercentage));
6   tempEntity.setCenter(
        drawFragment.drawView.getMeasuredWidth()/2,
        drawFragment.drawView.getMeasuredHeight()/2 - 4.0f);
7   DrawStackSingleton.getInstance().mySavedData.addEntity(
        tempEntity);
8   drawFragment.drawView.invalidate();
9 }
```

Listing 6.1: Method which scales the picture

Resizing camera pictures

A request from the customer was that the pictures from the camera should scale instead of resizing its dimensions independently such that the picture would retain its quality. To constrain the resizing of pictures we find the ratio between its width and height and multiply the drag vector by this ratio.

The ratio is found by dividing the width with the height, when the height of the pictures from the camera is smaller than the width, otherwise it is vice

Figure 6.3: The dialogue where citizen are chosen for access.

versa. The new dimension is then found by finding the length from the top-left corner of the picture to where the user clicks. The x-component of the drag vector is assigned to the width of the picture, and the height is assigned to the y-component of the drag vector multiplied by the ratio.

Changing Preview Button

The current preview button always displayed a square with the fill and stroke colour matching the currently selected colours. This preview of a square can cause confusion regarding what type of drawing tool the user has selected.

To try to avoid this confusion, we change the button's display to match the user's selected drawing tool. When the user selected the freehand or line tool, the button's display changes to a line with the fill colour as its colour. The rectangle tool is displayed as it did previously, and the ellipsis tool displays an ellipsis figure with the same colour structure as in the rectangle. Selection tool is also a tool available for the user, and when chosen, the *previewButton* displays the icon of the selection tool.

The button also has the feature of swapping colours as mentioned in Section 3.3, but this feature is unavailable when the freehand, line, and selection tool are chosen, as it is not intuitive to swap to a colour that is not visible.

6.3 Usability Test

To ensure that the customers are able to use the application and that it is easy to understand, a usability test is performed. The application should be easy to understand since the customers are not used to Android tablets. Moreover, the customers are receiving a tablet with the application installed and are therefore not told how to use the application beforehand.

To make a usability test, several tasks are constructed which makes the testees try all parts of the application. The testees then have to try to complete these tasks without help. If they are unable to complete the tasks without help, they can ask the tester for help. Problems are then described and put into categories depending on how the testees complete the tasks.

The problems are categorised into three categories, which are cosmetic, serious, and critical. Problems that are categorised as cosmetic are defined as tasks that are slowing the testees down by a few seconds. When a problem is categorised as serious, the testees are unable to solve the problem without any help or are stuck for several seconds. The worst type of problem is critical, this problem occurs when the testees are unable to solve the problem and the person sitting next to the testees has to show them how to perform the task.

The usability test is performed in the end of this sprint and the issues found are therefore not resolved in this sprint. The tests are performed with the help of two testees, who are also customers.

Problems	Description	Category
P1	Change camera picture to black and white	Cosmetic
P2	Clear canvas	Cosmetic
P3	Drawing entities	Serious
P4	Move entities behind another entity	Critical
P5	Swap colours	Critical
P6	Add tag	Cosmetic
P7	Delete entity	Serious
P8	Colour picker	Cosmetic
P9	Play sound	Cosmetic

Table 6.1: Discovered usability problems.

P1 - Change Camera Picture to Black and White

A problem occurred when the testees had to take a picture of their chair in black and white. The problem was that one of the teestees took the picture and thought that they could change the colour of the picture afterwards. The other testee did not read the tasks well enough and therefore forgot to pick black and white.

The reason why this is a cosmetic problem is that the first testee had some problems finding out how to change the colour of the picture. However, the second testee found the colour changer right when the testee was told that it should be in black and white.

P2 - Clear Canvas

When the testees had to clear the canvas, after drawing, they had problems finding the button to do so. However, after looking for a few seconds the testees were able to locate the button, which is why the problem is cosmetic.

P3 - Drawing Entities

Drawing entities is done by swiping the screen. The start position of the swipe is then the first corner and the end of the swipe is the opposite corner, the entity is then drawn using these corners. What the testees did when trying to

draw an entity was that they pressed the screen and believed that the entity would be created.

This problem is a serious problem since the testees used several seconds figuring how to draw an entity. However, none of the testees needed help to be able to draw an entity, and for that reason it is not deemed a critical problem.

P4 - Move Entities Behind Another Entity

Moving an entity behind another entity was a problem for one of the testees, since the testee was unable to understand where the button to do this was. When told which button pushed an entity back, the testee felt that the icon was not understandable. Furthermore, the testee thought that the button would push an entity in front of another instead of behind an entity. Therefore, the testee needed help figuring out how to use this functionality. Since the testee had so many problems with this task, it is deemed a critical problem.

P5 - Swap Colours

The button to swap colours was not understandable by the testees. Furthermore, none of the testees figured out how the button worked even after getting told how it works. For that reason this problem is a critical problem and should be fixed in the next sprint of *Piktotegner*.

P6 - Add Tag

The problem occurred when one of the testees should add a tag to the tag list. The testee did, however, only need a little help to figure out how to add the tag to the list. As just one of the testees were not able to add it to the list and had few problems doing this, the problem is deemed to be a cosmetic problem.

P7 - Delete Entity

When deleting an entity, the user have to select the selection tool and then select the entity that has to be removed. However, none of the testees understood that they had to select the selection tool to do this. Both of the testees thought that there would be an eraser to remove entities. Furthermore, both of the testees tried to double press the entity because they thought that would select the entity. However, after few seconds and a bit of help they were both able to see that selecting an entity would allow them to delete it. Therefore the problem is deemed to be a serious problem.

P8 - Colour Picker

One of the testees had a problem with the colour picker. The problem was that the testee thought that pressing the button that picks the last picked colour would open the colour picker. However, after several seconds the testee figured out that pressing the colour picker would lead them to picking the colour. Since only one of the testees had problems, it is deemed to be a cosmetic problem.

P9 - Play Sound

To play the sound of a pictogram, the user has to go into the recording dialogue, which happens by pressing the record button. The testees did not find this understandable as the record button should be for recording sound only. However, the testees, after a few seconds, found that the record dialogue

would be able to play the sound of a pictogram, which is why the problem is a cosmetic problem.

6.4 Sprint Closure

The issues mentioned in the sprint backlog have been solved but new issues have also been discovered through the usability test as mentioned in Section 6.3. Replacement of pictograms in the database was not implemented in the sprint, but is recommended to consider for future groups that are further developing *Piktotegner*.

We also refactored the code such that it is easier to understand for future developers. The refactored code was also shown to another development group as part of a code review and gave us feedback. The feedback was taken into consideration and changes were performed when they were deemed reasonable. The resulting code should now be easier for the next development group to expand upon if further development of this application is performed.

After the presentation of the application during the sprint end meeting, new issues were mentioned which are added to the product backlog. An example of an issue was that the audience were slightly confused of what the preview button was actually doing, so a rethinking of this button should be done.

The final UI of *Piktotegner* can be seen in Figure 6.4.

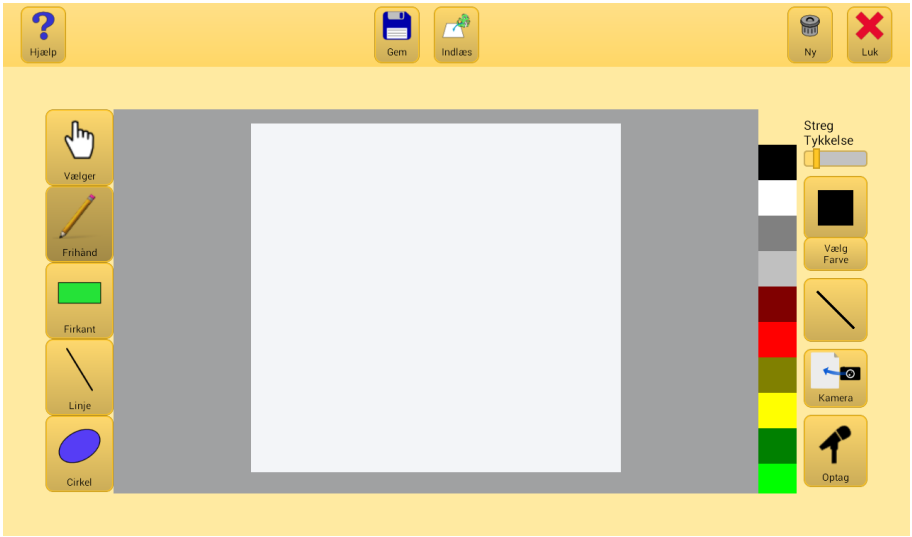


Figure 6.4: The final UI of *Piktotegner*.

This concludes the development phase of the project, all remaining issues are written in the product backlog for easy reference for future developers, see Appendix B.

7. Collaboration - Audio

This chapter was written in collaboration between the groups sw608f14 and sw615f14 and is in both reports.

Sound for pictograms was deemed important by the customers, and as of such, *Piktotegner* and *Piktooplæser* chose to cooperate in developing libraries for this. The libraries are mainly split into two parts, a media player and a Text-To-Speech library. The cooperation for developing the libraries is done by way of pair programming, with one person from each group per library. As of such, a mutual agreement is found for how the libraries should be developed. A description of these as well as motivation and a description of their implementation is given hereafter.

7.1 PictoMediaPlayer

Associating sound to pictograms was stated as of great importance from the customers. For that reason a library is developed that provides an easy to use sound playing service.

Both *Piktotegner* and *Piktooplæser* need the sound playing feature. *Piktotegner* needs it to get a preview of the sound recorded, to be saved when creating a pictogram. *Piktooplæser* needs the feature as the key feature of *Piktooplæser* is to get the sound of the pictograms played sequentially.

When initialising the library it needs a context and can additionally take a path for the sound file, a pictogram, or a bytearray. The context is needed for the *PictoMediaPlayer* to know where to play the sound. In List 7.1 we see a constructor for the *PictoMediaPlayer*.

```
1 public PictoMediaPlayer (Context activity, String path)
2 {
3     this.activity = activity;
4     assignMediaPlayer();
5     setDataSource(path);
6 }
```

Listing 7.1: Constructor for *PictoMediaPlayer*.

When assigning a datasource to the *PictoMediaPlayer* the *setDataSource* method, seen in List 7.2, is called. The method releases an old *MediaPlayer* and assigns a new one if sound has already been attached to the *MediaPlayer*. Then the *MediaPlayer* gets a file descriptor assigned as source.

```
1 public void setDataSource(String path)
2 {
3     if(hasSound)
```

```
4       {
5           mediaPlayer.release();
6           assignMediaPlayer();
7       }
8
9       try
10      {
11          FileInputStream fileInputStream = new
                FileInputStream(path);
12
13          mediaPlayer.setDataSource(fileInputStream.getFD());
14          hasSound = true;
15      }
16      catch (IOException e)
17      {
18          e.getStackTrace();
19      }
20  }
```

Listing 7.2: SetDataSource method of *PictoMediaPlayer*.

The *OnCompletionListener*, seen in List 7.3, is necessary for external sources to detect when a sound is finished playing. The listener allows external sources to respond to a sound finished playing, e.g. a button icon change.

```
1   private final MediaPlayer.OnCompletionListener
        onCompletionListener = new
        MediaPlayer.OnCompletionListener()
2   {
3       @Override
4       public void onCompletion(MediaPlayer mp)
5       {
6           isPlaying = false;
7           if(customListener != null)
8           {
9               customListener.soundDonePlaying();
10          }
11      }
12  };
13
14  public interface CompleteListener
15  {
16      public void soundDonePlaying();
17  }
```

Listing 7.3: onCompletionListener method of *PictoMediaPlayer*.

For *Piktooplæser* to play the sound of multiple pictograms in succession we make the *playListOfPictograms* method as seen in List 7.4. We first store the old listener in a temporary variable and stop playing sounds. Then we overwrite the method which is run after a sound is complete, so that it plays the sound of the next pictogram in the list. When all pictograms in the list have been read the old listener is restored.

```
1   public void playListOfPictograms(ArrayList<Pictogram>
        pictogramList)
```

```
{
    pictogramListIndex = 0;
    this.pictogramList = pictogramList;
    TempCompleteListener = customListener;

    if(isPlaying)
    {
        stopSound();
    }
    this.setCustomListener(this);
    this.setDataSource(pictogramList.get(pictogramListIndex));
    this.playSound();
}

@Override
public void soundDonePlaying()
{
    pictogramListIndex ++;
    if (pictogramListIndex < pictogramList.size() &&
        pictogramList.get(pictogramListIndex) != null)
    {
        setDataSource(pictogramList.get(pictogramListIndex));
        playSound();
    }
    else
    {
        this.setCustomListener(TempCompleteListener);
        pictogramListIndex = 0;
    }
}
```

Listing 7.4: playListOfPictograms method of *PictoMediaPlayer*.

To illustrate the ease of use of the *PictoMediaPlayer* we created the example seen in List 7.5. We here see how a *PictoMediaPlayer* is used to play a sound and writing "Sound is finished playing" when the sound is finished playing.

```
public class example implements CompleteListener
{
    private void examplemethod(Context context, String path)
    {
        PictoMediaPlayer pictoMediaPlayer = new
            PictoMediaPlayer(context, path);

        pictoMediaPlayer.setCustomListener(this);
        pictoMediaPlayer.playSound();
    }

    @Override
    public void soundDonePlaying()
    {
        System.out.print("Sound is finished playing");
    }
}
```

Listing 7.5: Example of *PictoMediaPlayer*.

7.2 Implementing Text-To-Speech

The motivation for creating a Text-To-Speech (TTS) functionality is that the customers should be able to play the sound of all pictograms, even if a pictogram does not have a sound associated with it. The reason why the customers need to play a sound of a pictogram is to teach the autistic people to associate a pictogram with a sound.

The *Piktooplæser* application should use the TTS functionality whenever a pictogram without a sound is added to the sequence to be read. Furthermore, *Piktooplæser* should add the newly created TTS sound, so the pictogram have the specific sound for later usage. The newly generated TTS sound should therefore be stored in the local database, which will synchronize the updated pictograms with the other users, such that the sound is only generated once. For *Piktotegner*, with pictograms created by the customer where no sound is recorded, a sound should be created by reading the inline text of the pictogram. This should of course also be stored to the database for later usage.

Available Text-To-Speech Tools

To enable the TTS function, the different available TTS tools should be compared, so the best suitable tool for this project can be chosen. There are a lot of different TTS tools, but there are some requirements:

- The tool must be free to use
- The tool must be able to pronounce the given text in danish
- The tool must be usable with an Android application

From these requirements, the built-in Android TTS can be excluded, because it does not support the danish language. Tools which fulfil these requirements are found and the ones we compare are listed below:

- Voice RSS
- eSpeak
- JeSpeak
- Google Translate TTS

Voice RSS

Voice RSS [10] is an online TTS tool with an API. Voice RSS has a Danish voice for their TTS, but has a limitation of usage. It is only the first 350 requests per day which are free, thereafter you have to pay a fee for more requests. The sound of the TTS is relatively good, and the Danish voice is understandable. To make a request to Voice RSS, the device must be connected to the internet.

eSpeak

eSpeak is a free open source TTS build for Linux and Windows with many supported languages, including Danish [11]. The advantage of eSpeak is that it is free to use, and do not need internet access to work. The disadvantage is that it is not made directly for use with Android.

JeSpeak

JeSpeak is a Java Library built from eSpeak [12]. The advantage for this TTS tool is that it is a Java Library which makes it compatible with the Java written *GIRAF* project. The downside is that it is not very well documented and requires not only Android SDK, but also Android NDK.

Google Translate TTS

Google Translate TTS is a possibility to use their API to make web based request and receive a sound file. It is very similar to Voice RSS, but has higher limit on the number of requests. It has a wide range of languages, including a quite good Danish TTS.

Comparison and Selection of TTS Tool

As seen, there are four examined solutions for enabling TTS in the *GIRAF* project. A comparison of the different TTS tools can be seen in Table 7.1.

TTS Tool	Advantage	Disadvantage	Requires Internet Access	Price
Voice RSS	Easy well documented API, understandable voice	Requires internet access, limit in requests	Yes	Free up to 350 requests per day, hereafter a fee starting from 5$
eSpeak	Free, does not require internet access	Not built for use with Android	No	Free, Open Source
JeSpeak	Free, made for Java	Not made directly for use with Android.	No	Free
Google Translate TTS	Free, supports many languages, easy to implement	Requires internet access	Yes	Free

Table 7.1: Comparison table for different TTS tools.

Due to this comparison, Google Translate TTS is chosen. It is very easy to implement, compared to e.g. JeSpeak, free to use, and it has a good Danish TTS.

Handling TTS

As seen in Section 7.2, Google Translate TTS is chosen as the TTS tool for this project. As it is a web-based tool, it must be considered how it should be used, and how to handle the situation where there is no internet connection. There is also the possibility that the creator of the pictogram has recorded his own reading of the pictogram. In this case the TTS should not be used. From

these statements, a flowchart of the behaviour of playing a pictograms sound can be seen on Figure 7.1.

With the behaviour in place, the TTS and soundplaying method can now be implemented. Note that once the sound has been generated, it is stored to the pictogram in the database, so it should only be generated once. The updated pictogram is synchronized with the remote database, so every other tablet also gets the sound file.

Implementation

The implementation of the TTS functionality is created by opening an URL connection to *Google Translate*'s TTS method. When the URL connection is established, a stream starts to return bytes. These bytes are then saved in an array so they can be translated into sound afterwards. How to get the bytes and save them can be seen in List 7.6.

```
1  private void DownloadFile() {
2      try{
3          URL url = new URL(soundURL);
4
5          URLConnection urlConnection = url.openConnection();
6          InputStream inputStream =
               urlConnection.getInputStream();
7          BufferedInputStream bis = new
               BufferedInputStream(inputStream);
8          ByteArrayBuffer byteArrayBuffer = new
               ByteArrayBuffer(50);
9          int current = 0;
10         while ((current = bis.read()) != -1)
11             byteArrayBuffer.append((byte) current);
12
13         SoundData = byteArrayBuffer.toByteArray();
14     }[...]
15 }
```

Listing 7.6: *DownloadFile* method

Before calling this method, it must be ensured that the device has a valid internet connection, because if there is no internet connection you are not able to connect to *Google Translate*. To check if there is an internet connection, a connection manager checks if it can get network activity. If the connection manager does not find an internet connection the *DownloadFile* method cannot be called.

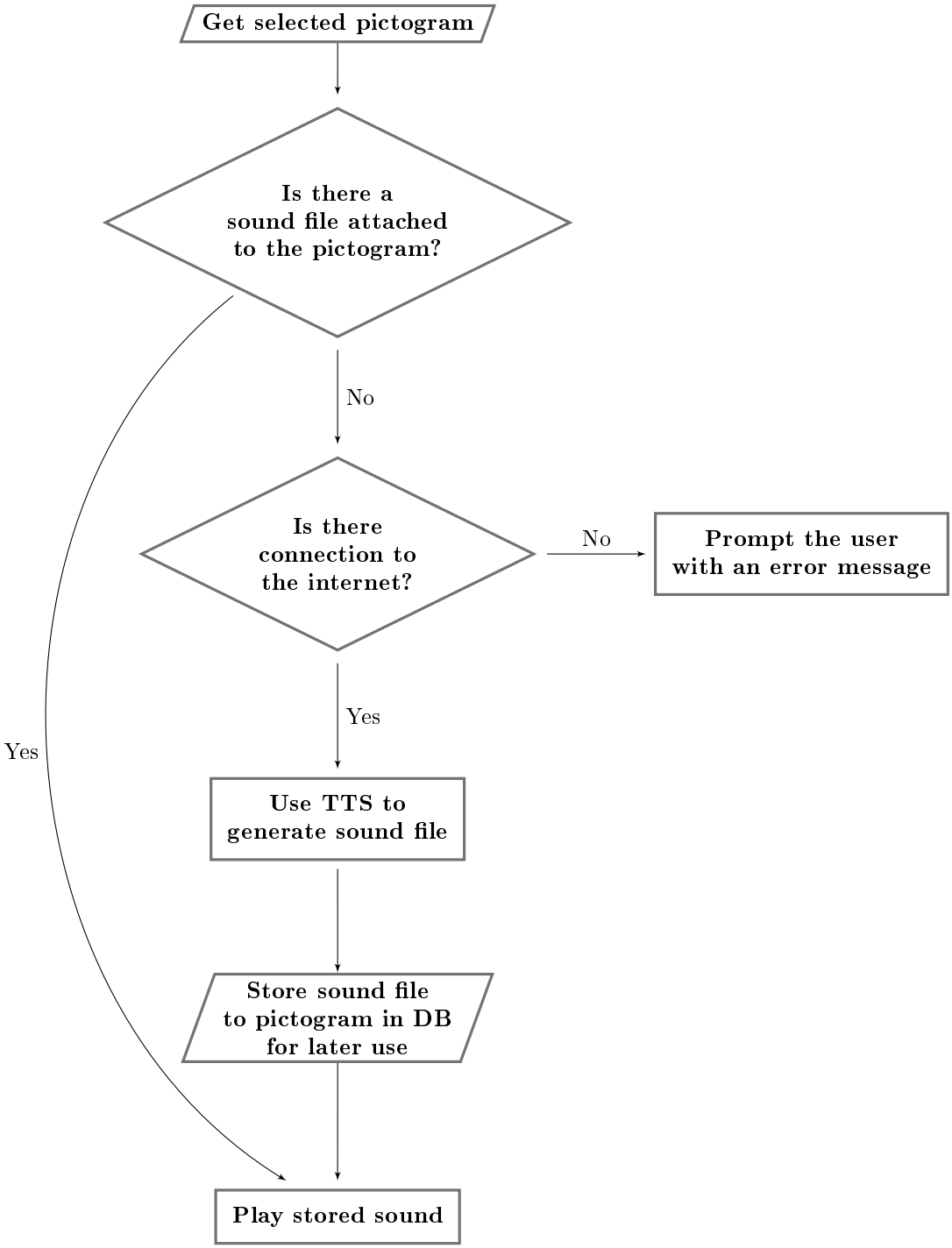


Figure 7.1: Flowchart for the use of sound on pictograms

8. Collaboration - Code Review

This chapter was written in collaboration between the groups sw606f14 and sw608f14 and is in both reports.

A common activity was performed between the *GIRAF Web Admin* (sw606f14) and *Piktotegner* (sw608f14) groups, where a code review was done. It was done in order to secure a better code quality, to find bugs, and as a learning experience. By code quality meaning e.g. suitable comments, reducing redundancy, and following the code standards, camel casing for example.

The code review was constructed in an informal way, as it made us able to cover more code in the same time span as a formal code review. The formal code review may find more serious bugs, however, it would only be able to cover a limited amount of code with the time at hand, thus the prioritisation of an informal code review over a formal version.

8.1 Approach

In order to secure that the two groups understood each others applications' architecture, a presentation was performed before the code review. For *GIRAF Web Admin*, it was told how it is based on the model-view-controller pattern. For *Piktotegner*, a class diagram showing how entities are structured as well as their respective handlers were presented. This gave insight to how the code, to be reviewed, was structured, in order to avoid confusion that could help us get to review more code and to give a better review of the code.

The review was done in a pair of two, such that two groups from *GIRAF Web Admin* reviewed *Piktotegner* and vice versa. The presentation was the first time the groups were presented to each others code, and as of such we sat in the same room when reviewing. This ensured that if any questions arose, regarding the architecture and language specific operations, a group from the other application could then fast be consulted.

The corrections and suggestions found during code reviewing was documented with the file name, the line number(s), and a description.

In hindsight, it would be good if the two groups had more experience in the languages of the code and the problem domain of the application they reviewed, as *GIRAF Web Admin* is primarily programmed in *PHP* and *Piktotegner* is programmed in *Java*. If the groups had more experience with these different languages, more bugs would likely be discovered, and code optimisations might have been suggested.. However, despite this, it was found that the code reviewing was helpful and is a practice that should be continued in the future.

We find it a good practice to review code, however, if the comments given on ones code is not addressed, the code review does not give much value. Therefore both groups addressed the problems found during the code review session as the first activity the day after the code review.

Experience

The overall impression of the code review activity was positive, and is agreed upon by both groups. About 2500 lines per project group, including comments, was covered by the code review, which may have been too much for a four hours code review. It is believed that instead of having a singular lengthy code review activity, it would be better to perform several shorter ones, in order to not get tired and do inefficient code reviewing.

GIRAF Web Admin was lacking comments to document their code, it was recommended that all functions was given a comment to concisely describe them. *GIRAF Web Admin* had inconsistency in their naming conventions. *camelCase* and underscores for variable names, *PascalCase* and underscores for functions, and *camelCase*, *PascalCase*, underscores, and dashes for *CSS*, were used. Furthermore, redundant code was found in the *PHP* classes and it was suggested that the similar code could be moved to a new function or separate library. Lastly, suggestions for optimisation of *SQL* queries was given.

Piktotegner had a lot of comments explaining both complex functions as well as the simple ones, some comments were deemed unnecessary or being superfluous. The variable names followed a coding convention but a few were found to not follow this convention or were found to have non describing names. Most properties had no constraints which might cause an error in the application if the properties were to be used improperly.

In addition to this, an opinion of both groups is that having people not familiar with the code, try and read the code, gives the advantage that it checks which parts of the code is hard to read and what code may need more documentation or refactoring.

9. Reflections

Working in a multi project setting has been a great learning experience. Starting the multi project, confusion existed as to how the project should be structured, as the project guidelines have been very different from previous semesters.

That being said, after the first couple of weeks getting used to the setting, the development was fun. However, it requires that you are willing to cooperate with other groups, and is necessary to get the whole software package to be consistent. Furthermore, it helped loosen up the project groups and provided a more social environment than the previous semesters. When questions arose, it was a matter of knocking on the door of the other group's room, and the issue would be quickly resolved.

We found SCRUM a good technique, as when groups had problems, they could be found before too many resources were spent. The product and sprint backlogs of most of the applications were organised in the tool called *Redmine*, and we found this a useful tool. It was useful because it made you able to monitor your own project as well as the whole multi project, to see if you are on track. In addition to this, it was a way to give a concise description of each issue and ensure that no issues were forgotten. Due to this agile methodology, documentation is kept to a minimum to allow as much focus as possible on developing working software.

In order to estimate the issues, to ensure that the sprint backlogs were fitting, we used planning poker. We found planning poker a useful tool, and is highly recommended for future groups working with an agile methodology as it is a low resource estimation technique, which at the same time, for us, was fairly accurate.

Git was also a useful tool, as it helped ensure version control, and is recommended for future students. In addition to this, because we work in a big multi project, it is mandatory to have a tool such as *Git*. The reason for this is that we depend on libraries developed by other applications, such as the database library and pictogram library. You do not have to adapt to changes in their developed libraries immediately, where you could risk getting interrupted all the time, to adapt to the changes made in those libraries. Instead you can wait to update your submodules for a fitting time in your schedule. However, it takes some time getting used to *Git* as submodules were good but some *Git* structure was problematic. This occurred if we were dependant on a submodule with which we had a shared submodule. The submodule would then use our submodule which may have another revision and would have to be adjusted thereto. For future students, it is recommended to use a development branch if you are making some unstable changes to your code. Furthermore, before pushing you should ensure that your code is compilable.

In relation to this comes the automatic build service *Jenkins*. It was set to automatically build the different changes when new revisions were added to *Git*. People who may have pushed non-compilable code would then be notified, such that they could correct their mistakes. As good a tool as *Jenkins* was, it got in use late in the development cycle, and if we were to do the multi project development again, we would recommend getting *Jenkins* in use as early as possible.

In order to also ensure that we had a role in the multi project, we had a person responsible for making icons for all the applications in the multi setting. This ensured that we also provided a role other than developing the *Piktotegner* application, in order to feel that we provided more to the whole project. Future students are also recommended to engage in such activities, being it icon creation, *Git*, *Jenkins*, or *Redmine* responsibility.

Customer communication was a positive experience, although it was difficult to establish contact. This is found to primarily be due to not contacting the customers in timely manner. As the other responsibility roles, we also had a person responsible for establishing contact with the customers. We found that usability tests was performed too late, as it was done in the two final days of sprint 4, thus the experiences from the usability tests could not be implemented in the application. In the future, it would be wise to perform the usability tests earlier, in order to correct on the issues found during the tests. In addition, it would be beneficial to have more than two testees and preferably also people that are not the customers but are a part of the target audience as they are not affected by the development process.

During development of the application, the features developed were based on customer communication as the customers wanted a stable application, so those improvements were made autonomously. Furthermore, when new requirements were received, we either made a prototype if the requirement was GUI related, otherwise we discussed it in the group to ensure common understanding and then implemented it. Additionally, once this requirement was implemented, the sprint end meeting served as a quality assurance such that our understanding of the requirement correspond to the customers' expectations. There was, however, one feature requested by some of the customers that did not get implemented, the eraser tool. The eraser tool was attempted to be developed, but as the drawing is based on vector graphics, deleting parts of an entity did not make much sense. When introducing a customer to the ability to removal of one entity at a time as an alternative, it was agreed upon to be a suitable replacement.

To summarize, the multi project was a great learning experience and is recommended to try for any student, as you get to work in a very different setting than what you are used to in previous semesters. Furthermore, we found that the development process went well, and the contact with the customers was appreciated as it is for them the application is developed for.

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A. Croc UI Screenshots

Figure A.1: UI of camera dialogue.

Figure A.2: UI of audio dialogue.

B. Product Backlog

Editing pictograms
: It should be possible to edit pictograms, when it is the same author editing it. By editing we mean a change to either its name, sound, picture, access settings, or tags. Currently, if you have to edit a pictogram, you load it into *Piktotegner* from *Pictosearch*, and save it as another instance in the database.

Crop camera pictures
: A request from a customer was to crop pictures taken with the camera. For example if the user takes a picture of an apple on a table and would like to only have the apple, they would like to exclude the unnecessary parts of the picture before inserting it.

Undo button
: Some colleagues suggested to add an undo button, as it was tedious to select the entity first and then delete it every time they made a mistake.

Categorising pictograms
: Newly created pictograms could have the possibility of being categorised when saved.

Change colour of drawn entities
: It should be possible to change the colour of already drawn entities. This could be by either drag-and-dropping a colour onto an entity or selecting the entity and then choosing a colour.

Camera dialogue buttons
: During the usability test, the testees had trouble reaching the *capture* button when they tried to take a picture. A suggestion is to reorder the buttons such that they are on the side of the tablet.

Template pictures
: A suggestion was to add a setup assistant for template pictures, such that users could add some customisable figures into their pictogram. An example of this could be a stick figure, but with a customisable posture.

Memory issues
: The application uses a lot of high quality pictures which causes memory issues on certain tablets. These are the pictures seen in the help dialogue and the camera pictures.

New icon for clearing the canvas
: The current icon for clearing the canvas is a trash bin with the text *Ny*

which means new. The text does not hint at the functionality usually associated with such an icon, and should thus be changed to something more appropriate. A suggestion to such an icon would be the usual blank paper with a folded edge and a plus sign, as seen in most text editors and graphics painting application.

Close and exit icons
During the usability test, the testees stated that the citizens associate the current close and exit icons with cancelled activities. Therefore, these icons should be changed or removed.

Flatten button icon
The flatten button, which puts entities to the back of the canvas, was not clearly understood by the testees during the usability test and should therefore be redesigned.

Pinching
During the usability test, testees tried to resize an entity by pinching it on the touchscreen. This functionality is not currently supported, but since people are used to this gesture when using touch pad applications, this functionality should be considered.

Names in save dialogue
The text fields in the save dialogue were causing confusion both to the customers and our colleagues. The idea of these fields was that the inline text was the text written on the pictogram whereas the name was the actual name of the pictogram which the guardian used as reference. An example of this is two pictures, one with a red car and the other with a blue car, having the same inline text "Car", but for reference the guardian would like to know the colour of the car through the name, thus "Red car" and "Blue car".

Rethink preview button
Both in the usability tests and the sprint end meeting, the preview button was found unintuitive. The doubt was first the double functionality of the button, as it is a preview button and a swap colour button. A solution could be to scrap the preview button and instead have a clearer illustration of what tool is selected, and at the same time have a new button with its functionality being the swapping of colours.

Alternative help dialogue
During the sprint 4 sprint end meeting it was proposed that the help pictures of the help dialogue should be made larger. As an alternative to this, it was proposed to provide short video clips to demonstrate how to use the application, and is the suggestion we recommend for future groups. If the help pictures solution is kept, clarifying text for these pictures would be beneficial.

Placement of timer
The application *Timer*, developed by another *GIRAF* group, provides a timer to keep track on how long a citizen is provided for a given activity. The timer is placed in the top right corner of the tablet and should be

taken into account, as at this point in time it overlays the exit button, or the *Timer* application should add a functionality to move this timer.

Reconsider selection of entities

During the usability tests, it was evident that the testees found the selection tool unintuitive. With training they may get used to the tool, however, they tried some other gestures to select an entity and is worth considering. Gestures used was double click on a given entity to select it or long clicking. Maybe these forms of gestures should replace the selection tool or be an alternative way to select entities.

Saving and loading *drawStack* with bitmaps in the database

Find a reasonably efficient way to serialize bitmaps, so they can be stored in the *drawStack* in the database and loaded again.

C. Turnkey – Piktotegner

If you would like to work with an application that is essential to the creation of new pictograms, you should choose *Piktotegner*. *Piktotegner* is an Android application which provides a pictogram creation environment for tablets. It is an application where the essential functionality to create pictograms is already established, but where usability improvements are needed.

When working on this application, we recommend performing several usability tests as well as stability testing, as there is some unclosed memory leaking issues. Unit testing is also recommended, as none of this has been performed. As of such, a GUI redesign is recommended, based on your performed usability tests and knowledge from the DEB course.

If you find that the application becomes well polished for the users' needs you can embark in a whole new part of the pictogram creation environment. What is thought of here is a template environment, where you do not have to draw your own images, but can instead construct images from some predefined image structures, such as balls, stickmen, animals, machines and so forth, but where the user gets to choose the posture, colour theme, and accessories.

If you want to delve into how the elements of the image are drawn, rotated, and resized, be prepared for linear algebra, with rotation matrices, and euclidean geometry (taught in Advanced Algorithms).

C.1 Application structure

When launching the application, you start with the *MainActivity.java*. This is where all fragments and UI are launched from.

The drawing entities and their corresponding handlers are basically structured as seen in Figure C.1, and may need some restructuring.

Apart from this, the application is structured into the *mainActivity*, which contains a *drawFragment*, record dialogue, camera dialogue, save dialogue, and help dialogue. We recommend when you start to examine each class, as the code is well documented and in itself should serve as sufficient documentation.

Furthermore, we recommend Vogella's Android tutorials [13] for any uncertainties regarding Android development, as they have been of great help throughout development.

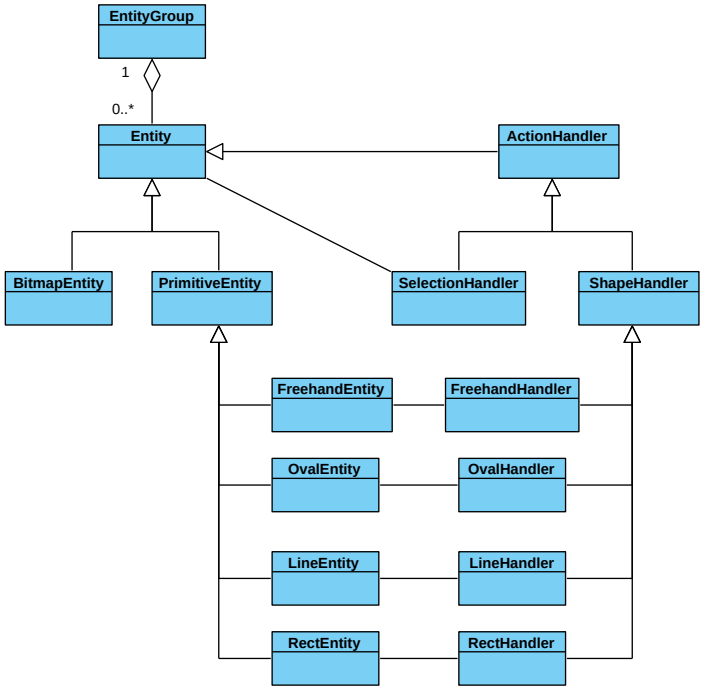

Figure C.1: Class Diagram with entities and handlers

D. Resume

We develop an application for creating pictograms, *Piktotegner*. *Piktotegner* was first developed in the spring of 2013. In the spring of 2014, we have further developed *Piktotegner* to be usable in the larger software package called *GIRAF*. You are taken through the development process of *Piktotegner*, from the application not being deployable, to an application that is usable for the *GIRAF* costumers. In the current version of *Piktotegner* you are able to draw lines, ellipses, and rectangles. Additionally, you are also able to take pictures with ones tablet camera, record sound or use an auto generated one, and reuse other pictograms from the *GIRAF* database. Regarding the database, it is possible to load and save the created pictograms, such that they can be used by the other applications of *GIRAF*.

GIRAF is an autism communication software package developed for Android tablets by students at Aalborg University. *GIRAF* is meant to aid autistic people and their guardians in communication and learning. In the package you find applications to construct and read sentences by help of pictograms, speech training tools, categorisation tools, scheduling applications, and more.

The development of *GIRAF* was done in a multi project setting, as the applications of *GIRAF* are dependent on each other as well as the need to have a common design. To collaborate in the multi project setting, a SCRUM of SCRUMs is applied, and a description thereof can be found in the report. In the description, you find how the technique has been applied in the multi project setting as well as the outcome and the experience gained thereof.

In the report you find a description of how we handle geometric problems of drawn objects, such as rotation, resizing, and selection. You can also find our thought process of designing an intuitive user interface in collaboration with the customers. In that regard, usability tests were performed to evaluate this interface design. A description of the flaws found in *Piktotegner* can therefore also be found, and can be used for future development. Furthermore, collaboration with other groups to develop a shared audio library and how we utilised a code review is described. The shared audio library includes a media player and a Text-To-Speech method.

The report is structured in a chapter containing an analysis of the organisational context, four sprint chapters, a chapter with our reflections of the multi project and our development process, as well as two collaboration chapters. The sprint chapters include the sprint backlog for that sprint and a description of the solutions used for each issue of the sprint backlog. The two collaboration chapters are written in collaboration with other groups.