Knitting a Picture: Algorithmically Generated Patterns from Drawing Inputs

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Abstract

This paper attempts to relate the creation of knitting patterns from visual elements of the final product, such as a grid pattern, to an algorithmic approach to creating patterns based on these elements. By using edge detection on an image, the locations of each pixel in a given row can be used to determine the number of stitches in the row.

1 Introduction

Knitting, a method of pulling one continuous line of yarn [8] through live loops held upon needles to create and manipulate fabric, through different stitch techniques—such as knitting and purling, increasing and decreasing, as well as casting on and off, and other various methods—produces a result that is similar, in form, to matrices.

The manner in which knitting patterns are read in relation to the physical piece of fabric, in a zig-zag manner from top to bottom, indicates that an algorithm should be able to read an image in this manner to create a pattern for a knitter to use.

1.1 Project Goals

The main goal of this project is to create knitting patterns based on a drawn shape and gauge measurements supplied by the knitter. A drawn shape can be interpreted into a matrix of binary operators to represent stitches in the fabric and then into a written textual pattern that a knitter can use to create their drawn shape.

Knitting patterns consist of a list of abbreviated instructions for each stitch in each row of knit, from the cast-on and through the body of the knitted piece to the cast-off edge, as seen in Figure 1.

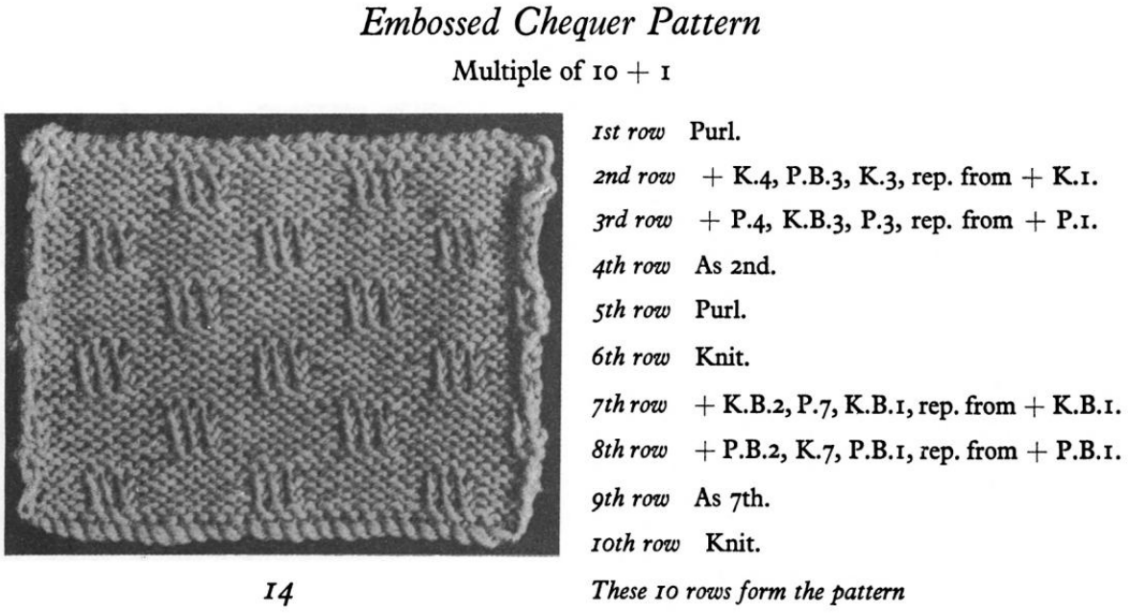


Figure 1: Example of a knitting pattern [10]

Through this algorithm, a knitter will be able to submit a drawn shape, along with their gauge information, to result in a written knitting pattern that they can follow to create a knitted fabric that matches the drawn shape.

2 Knitting Basics

When knitting, there are multiple factors that go into the shape, size, and look of the finished piece. Varying the number of stitches from one row to another changes the shape; tension and size of needles impacts the size of the finished knitted piece; and different stitches, commonly knit stitch and purl stitch, change the way the fabric looks.

2.1 Mechanics of Knitting

There are many different techniques used by knitters to create varying effects in their knitting; increases and decreases, casting on and off, as well as a few others, described in the following sections.

2.1.1 Decreasing and increasing

Decreases and increases both alter the number of stitches in a given row, allowing knitters to make interesting shapes in their knitted pieces. There are multiple ways to decrease and increase the number of stitches, each having a different impact on the way the fabric looks, as seen in Figure 2. Decreases and increases both change the shape and curvature of a knitted piece [2].

Figure 2: Decreasing (left) and increasing (right).

Decreasing in knitting most commonly takes the form of knitting two stitches together, referenced in a pattern as 'k2tog'. In Figure 2, the left square shows a decrease using this method. Another method of decreasing involves slipping two stitches onto the right needle separately and knitting them together, referenced in a pattern as 'ssk.'

The most common way to increase is knitting in both the front and the back of the loop, referenced in a pattern as 'kfb'. As shown in Figure 2, this method yields an extra loop in front of the new column of knit stitches, similar to a purl stitch. There are methods to avoid this, such as knitting into the back of the stitch before the front [11]. Other methods of increasing include picking up yarn from the left or right of a stitch, referenced in a pattern by 'm1l' or 'm1r,' meaning make one left or right, respectively.

2.1.2 Casting on and off

To begin a project, the knitter must cast on a number of stitches to work into in the next row. Due to the nature of casting on, this must be done on a straight edge. It can be beneficial to use a small cast on edge in conjunction with increases in subsequent rows to create curves. With this in mind, it is likely that choosing a cast on edge at random and algorithmically will yield similar results in the final knitted piece.

With the cast on edge having been arbitrarily selected, this leaves the cast off edge to be at the opposite end of the work. Casting off is achieved by pulling each live loop over its neighbor until one remains. The yarn is then cut and pulled through the loop and weaved into the work to prevent the work from unraveling.

2.1.3 Other Knitting Techniques

Other knitting techniques that will not be considered in this algorithm include ribbing and cable knitting, as shown in Figure 3; as well as differing stitch combinations to create patterns, as seen in the knitted piece in Figure 6; and knitting in the round, which is done using circular needles and creates a tube of knit. Possible future iterations of this project might include functionality to use these techniques in patterns.

Figure 3: Example of a two-by-two ribbing (left) and a cable knit (right).

While this algorithm does not include functionality for the techniques mentioned above, knitters could incorporate these elements into their own projects if they wish to do so, though some alteration to the pattern will be necessary.

2.2 Tension and Gauge

Each knitter has a different method of holding their working yarn, the yarn that they are looping around their needles as they work, which is attached to the ball of yarn. This is a factor in their tension. Knitters who hold their yarn taught will make smaller pieces than those who hold their yarn loosely, even when using the same needles, yarn, and pattern. This is what makes tension important when thinking about knitting a piece that needs to adhere to a certain size, such as clothing.

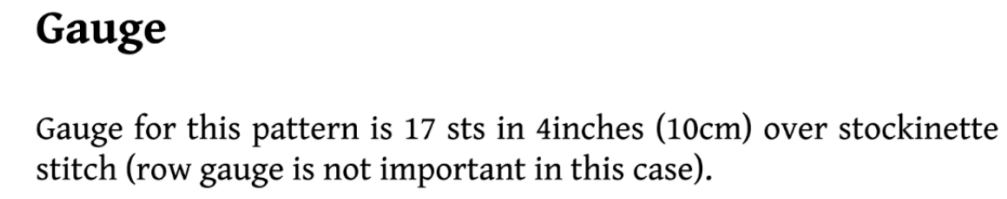


Figure 4: Example of a gauge section in a knitting pattern [5]

In most knitting patterns, the 'introduction' section, where yarn weight and needle size for the pattern can be found, there is usually a place that outlines the measured size in a finished square, or swatch, after knitting x rows and y columns, like in the pattern seen in Figure 4. Figure 5 shows a knitted 20 by 20 gauge swatch, made for use in Knitting an Algorithm, which asks the knitter to create a swatch of these dimensions.

Figure 5: Example of a Gauge swatch in a Pattern.

Needle size and yarn weight play an important part in the size of the piece knitted. If the needle used is smaller than recommended based on the yarn's weight, the piece will be smaller than expected, while a larger needle will yield a larger piece. The packaging on most yarns lists a recommended needle size to be used based on the weight of the yarn. Depending on the knitter's preferences, they may choose a different size needle. This information is displayed in patterns to provide a starting point for a knitter to use when creating swatches to test their gauge.

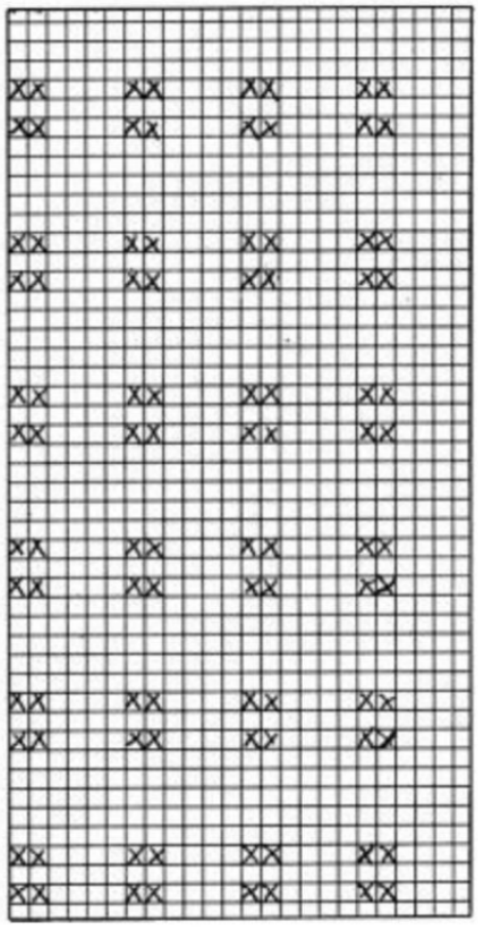
Gauge is an important factor when thinking about creating patterns of a specific size (e.g., hats, socks, or sweaters). If the gauge is not correct the finished piece will be either too big or too small. Most times, knitters will alter their needle size (bigger needles should be used if the gauge is too small, larger needles if the gauge is too big) and make another swatch until the correct gauge is obtained.

3 Knitting Patterns

Knitting patterns are like a recipe for making fabric. Depending on the type of project and the knitter's preferences, a grid pattern or a written pattern can be used to knit the desired

product.

3.1 Types of Patterns



18 Polperro: Laughing Boy
8 rounds
4 rounds st.-st.
Round 5: K.
Round 6: (K.4, P.2). Repeat to end.
Rounds 7 and 8: As 5 and 6.

Figure 6: Example knitting patterns [14] with finished product.

Knitting patterns can be written in a few different ways, namely grid and written patterns [17]. Grid patterns are read top to bottom, then alternating from left-to-right and then right-to-left from one row to the next, similar to a zig-zag, or a "bustrophedic" [1] reading. Depending on preference, some knitters use grid patterns while others use written patterns to make projects.

3.1.1 Grid Patterns

Grid patterns, mostly used for colorwork, are a more visual pattern that represents the final knitted piece from the front view (also called the 'right' side), as seen in Figure 6. This type of pattern can be thought of as a coordinate plane, with one axis representing the rows and the other columns, with each square representing one stitch and having a boolean value which represents if the stitch is knitted or purled.

3.1.2 Written Patterns

Written patterns use textual abbreviations of the stitch names, such as 'k' for knit and 'p' for purl, as instructions for how to deal with each stitch as the knitter works across the rows in a bustrophedic manner. These patterns usually have a recursive element to them which calls for a repetitive increase or decrease in stitches, as seen in Figure 6. Generally, these types of patterns are most widely used among knitters [16].

3.2 The Derivation of Written Patterns from Grid Patterns

Using Figure 6 as an example, it is evident that there is some way to translate a grid pattern into a written pattern. This project aims to find a way to algorithmically perform this task based on an image supplied by the user.

This algorithm will focus on the creation of knitting patterns from drawn images, so it will approach the grid patterns from a knitter's perspective by 'knitting' through the image. Techniques that will not be considered in this algorithm include cable knitting, purl stitches, and working in the round.

3.2.1 Previous Literature

While there do not exist many developed algorithms for creating patterns, there are some algorithms for generating colorwork [7] and three-dimensional models of crocheted and knitted animals [4]. It is important to note, however, that the latter consists of inconsistent references to knitting as crochet and vice-versa. Kryven's article on pattern generations

for colorwork discusses how their algorithm can be used to transform "a line drawing or a photograph into a durable knitting pattern," [7].

With the rise in popularity of Artificial Intelligence (AI), some crocheters and knitters have asked an AI bot to make patterns for them. There is a sort of sub-genre of TikTok in which users post their resulting crocheted or knitted pieces along with the pattern given to them from the AI. Woolner, a user who mainly posts AI pattern-related videos, has published a pattern for a narwhal they asked the AI bot to make [13].

Another online pattern generator to note is KnitAnything [12], which allows a user to select style options for a knitted sweater as well as logistical elements such as gauge, measurements and stitch type.

3.2.2 Using Matrices

Similar to grid patterns, matrices can be utilized in a similar manner to represent individual stitches in terms of columns and rows in a binary operator as to whether there exists a stitch in that space or not, similar to how grid patterns use a binary operator to communicate which type of stitch is used in a space.

3.2.3 Creating the Final Written Pattern

Using the idea of a bustrophedic reading, the algorithm should be able to loop through a matrix to create instructions based on the differences in the number of stitches in each row, taking into account the location of the stitches to determine where exactly the increases or decreases should be placed.

Once these instructions are created, they must be checked for repetition to cut back on redundancies in the pattern. This will allow for an easier understanding for the knitter as it reduces the number of rows they are required to interpret from the pattern.

4 Algorithmically Creating Patterns

Knitting an Algorithm aims to algorithmically create knitting patterns from a drawn image utilizing image processing in conjunction with the knitter's gauge input. Using these elements

together ensures correct sizing of the knitter's final product.

4.1 Input Information

To create the pattern, the knitter will be asked to provide some information about the needles and yarn they are using as well as their gauge and the image of the shape they want to knit.

4.1.1 Sizing Inputs

In most patterns, the size of knitting needle and weight of yarn are listed in the introduction as a base for knitters to start with when creating their swatch.

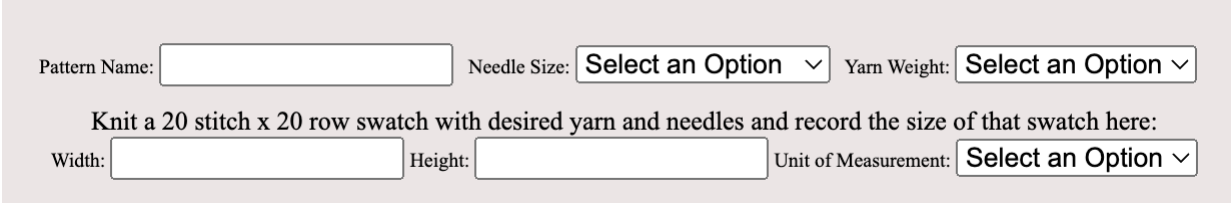


Figure 7: Pattern attribute input section.

In Knitting an Algorithm, the knitter is prompted to include a title for their pattern, the needle size, and the yarn weight for their project, as well as their gauge information, each of which will show in the introduction section of the outputted pattern.

Gauge information will be calculated by the knitter by knitting a twenty stitch by twenty row swatch using the same needles and yarn used as they indicated in the input section. The knitter will measure their swatch using their preferred unit of measurement, noted in the 'Unit of Measurement' attribute.

4.1.2 Drawing Inputs

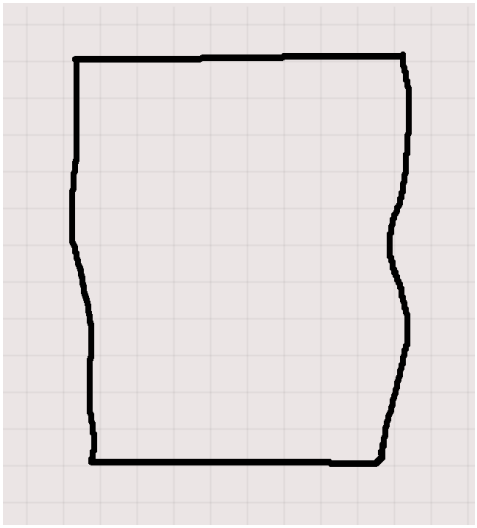


Figure 8: Example of inputted user drawing for use in creating a pattern

To create a space for knitters to input their shape, a canvas was used within the HyperText Markup Language (HTML) document. The canvas element allows the knitter to use their mouse to draw any shape they wish to knit. It then saves the shape, once submitted, for use in image processing. Figure 8 shows an image input from the knitter's view in the creation of their pattern. The grid shown represents one square unit of measure, supplied by the knitter in the form.

4.2 Creating the Pattern

To create the pattern from the image supplied by the knitter, the pixels can be read in rows, storing the location of the first and last black pixel in the image. Based on the number of pixels between the first and last as well as the gauge inputs, the number of stitches in each row can be calculated.

In comparing one row of knit to the next, it can be determined where and how many decreases and increases should be placed.

5 Results and Analysis

Knitting an Algorithm is able to take inputs from a knitter regarding the tools they used for their knitting project as well as their gauge information and a drawing for use in creating a pattern. The application puts this information supplied by the knitter into a Portable Document Format (PDF).

5.1 Limitations

As mentioned previously, this application does not focus on implementation for circular knitting, differing stitch types, and cable knitting. Future iterations of this project may aim to achieve these goals.

6 Conclusion

While the aim of this project was to create a knitted piece based on a knitter's drawn image, the software was not successful in achieving this. While it does take the knitter's inputs from the form attribute (pattern title, size of needle, weight of yarn, gauge inputs, and the drawn image) and append them to a PDF file, it does not create a pattern. Due to the lack of research in this type of image processing and time constraints, this application has not yet been finished.

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