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SALSAEditor: Creation of a Domain Specification Modelling Language for Latin Dances

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ABSTRACT

SALSAEditor was proposed as a domain-specific language (DSL), providing a well-structured definition language for creating salsa dance diagrams. The tool provides comprehensive system constraints through its conceptual metamodel to define the necessary elements needed to specify a complete salsa dance diagram scenario. The representation of the salsa dance diagrams increases productivity, comprehensive and understanding salsa dance diagrams that are effective for dance education. Visual diagrams are more effective than text between novice users and experts users, and in this case, it is effective for dance learning. An easy-to-use drag and drop component was provided to design different dance diagrams, with a graphical modeling component and an editing canvas on the interface. The step notation tool was developed using JavaScript frameworks which provided an easy mechanism to develop the tool. The Domain-specific Modelling Language (DSML) is designed with abstract syntax and concrete syntax models. The application tool will not include the language definitions and details to make the tool for end-users such as dance students and dance teachers. This paper will consist of further information about building the graphical editor with the FabricJS library. This paper intends to find out the user's ability to understand the graphical step notations and find how effective the produced step notation tol is. After conducting the surveys, both student and teacher were able to understand the salsa dance diagrams. Even though the student did not have any idea of what dance diagrams were, was able to understand them. The applicability of the DSML was demonstrated by its application in two uses cases: the basic step with eight beats and the creation of a dance diagram from scratch (advanced level). A user evaluation was conducted to discover whether the application is effective for dance education. As a result, the application met all the requirements and can be considered adequate for dance learning.

CCS CONCEPTS

• **Domain Specific Languages → Domain Specific Modelling Languages**; • **Graphical Editor**;

KEYWORDS

Dance diagrams, Domain Specific Languages, Modelling Languages, Graphical Editor, Dance Education, Latin Dances, Salsa Dance

1 INTRODUCTION

Dance is a movement of the body rhythmically through the sound of the music. Learning how to dance can be a challenging activity. Dancing requires precise coordination and a reasonable interpretation of rhythms and beats. Usually, people learn how to dance with the help of an instructor. The learner benefits because the feedback is immediate, and they socialize with other students. However, during these past years, new dance learning techniques were emerging through web-based applications, mobile applications, motion capture [7, 11, 18, 19, 23], among others. Due to Covid-19, the education systems began to provide alternative teaching techniques, including the dance education sector. Although remote teaching was already used , it became more popular in the last year. Teaching remotely has become a popular method of teaching [22]. These technological improvements will provide the students and teachers new tools for developing their dance skills. The tools will allow the members of the dance community to refine their dance practice through online platforms. Recording dance moves through videos is typical in the dance community which is a problem because the videos are not clear enough to follow the steps correctly.

Evolution Dance Company (ECD) is a leading salsa dance studio located in Cape Town, which intends to make salsa dance accessible over Cape Town. The dance company's purpose is to provide a learning space that allows students to express themselves and encourages them to put all body, energy, action, and time into dance as an art form. The Latin Dance Studio aims to deliver new learning techniques to new technology to the South African social dance education community. This project was conducted in partnership with Evolution Dance Company with the purpose of creating new effective dance learning technologies. The aim of the project is to develop a user-friendly, graphical editor tool in a web application system for both teachers and students to record the salsa dance step notations or Latin dances, which provides an innovative approach on the salsa dance learning methods. The outcome of this paper is a domain-specific modelling language for salsa dance steps, which provides modelling concepts from the salsa dance vocabulary. More precisely, this tool will allow novice and expert dancers to create and edit salsa dance step notation through graphic notations for dance learning purposes. The following research questions that will be addressed are:

(1) Can the learners understand and use graphical notations of the salsa dances?
(2) How effective is the salsa dance graphical editor?

In order to answer these questions, data related to graphical notation will be presented and substantiated, in addition to the components that formulate the proposed DSML.
The remainder of the paper is composed of the background and related work related to the questions presented, the requirements analysis of the construction of the domain-specific modelling languages (DSML), the system development and implementation, theoretical analysis of the salsa grammar, results and discussion of the usability test, and finally the conclusion.

2 BACKGROUND AND RELATED WORK

This section will expand on some concepts for the understanding of this paper. Firstly, we will present the concepts relating to dance education and dance notations available and afterwards we will explain precisely what are Domain Specific Modelling Languages (DSML), outline and explain the structure of it and concepts relating to dance education and dance notations available.

2.1 Dance Education

Currently, dance teachers and the academia community are looking for new strategies for teaching dance. Over the years, with the technologies advancements lead to the use of technologies in dance education. They are many dance platforms for teaching dance integrated with technologies that combines videos, motion capture, web-based, database-based [7, 12] and among others.

2.2 Dance Notations

The dance notations represent the movement of the dance using various graphical symbols such as bars, shoes, steps, among others. They are used for dance documentation purposes and for analysis and reconstruction of dance choreographies[17]. In prior years, there have been many attempts to create accessible dance notation systems through notion systems used to represent human movement. Consequently, describing body movements is a complicated task, meaning that is challenging to comprehend. Labanotation [10], is one the most popular dance notations used today. It represents the overall body movement which is frequently used for dance notations. However, it is considered complex only easily understood by the experts in the study[5]. As a result, dance novices have difficulty to understand in respect to the available patterns[**? ?**].
LabanWriter[20], LabanEditor [21] are some examples of the application of Labanotation. LabanWriter is a Labanotation editor, which store the labanotation into graphical format and does not perform grammar checks, thus we cannot ensure the accuracy of the elements. The are also human readable tools, through eXtensive Markup (XML) such as LabanXML[24] and MovementXML [15] which they it represents the semantics of Labanotation.The MovementXML is an extension of the LabanXML that simplifies how the scores will be correct.
The Benesh Movement Notation (BMN) is another notation system used to document body movements through symbols, similar to the musical notation [37]. But, lacks in the representation of complex movements for dance such as step movement and turns. MacBenesh [31] and Benesh Notation Editor [37] are applications of the BMN through a graphical interface. A notation using mathematical expressions in the form of a text-based diagram, “Space of Salsa” was created by Renesse and Ecke [36]. The notation systems is only performed for the arm movement and lacks notation for the feet movement which is crucial for the representation of the steps of the salsa dance moves. Boschelli and Lyons [29] introduced a concept of "salsa lines" and "salsa elements" that composes the salsa languages. The lines are the salsa hold, direction, leader , common action and follower and the four elements are hand holds, directions positions and actions.

Figure 1: An example of a salsa dance diagram [1]

2.3 Domain Specification Languages

Domain-Specific Languages (DSL) are languages that are designed for a specific application domain [14].
[34] listed the benefits of enhancing productivity, allowing the solutions to be expressed at the level of abstraction of the problem domain. The DSL targets end-user programmer that can perform simple programming relating to an specific domain, which means that the can be used for many purposes with different contexts, for expert users or novice users [14]. For example, spreadsheet programming using the Excel program.

2.3.1 Domain Specification Modelling Languages. Domain Specification Modelling Languages (DSMLs) are a subtype of Domain Specification Languages (DSLs). Generally, the DSLs are languages design for a specific application domain [14]. Whereas DSMLs also focus on increasing the level of abstraction of further abstraction programming which is similar to problem domain. They present model stability that consists of constraints included in the language. Graphical notation and concrete syntax of the DSMLs are used to promote simplicity and comprehension related to a specific domain. The DMSLs are defined by an abstract syntax, a concrete syntax and semantics. The abstracts defines the concepts of the languages and the concrete syntax is the visual representation of the abstract syntax concepts (elements). Semantics is the combination of both, were the definition of the model happens. [34], has a proposed process on how to to develop DSMLs which was implemented in this project, which will be described on this paper.

2.3.2 Domain Specific Modelling Languages in Dance. Despite the fact that there are no tools available for dance representation through domain specification languages there are many available dance notations that allows the creation of dance diagrams through graphical representation. As mentioned above, LabanEditor [21] and LabanWriter [20] are examples of graphical editor using Labanotation [10] systems. Benesh Notation Editor[37] and MacBenesh [31] are dance notation graphical editors that use the Benesh Movement Notation (BMN). While there are no applications of DSL in the dance are, there are various other methods of creating dance diagrams such as copy and paste, paper-based notation are used to create or edit dance steps creating dance diagrams using Scalable Vector

Graphic editor [13]. There are many other applications of the domain specific modelling languages such as Smart Health Modelling Language (SHML)[32], in the health system domain, which is a domain specification modelling language that models the health ecosystems centred on the smart health domain. Additionally, there is an example in the aviation domain which is the Aviation Scenario Definition Language (ASDL) [35], a domain-specific modelling language that provides a graphic structure that defines the multiple aviation scenarios.
Given this information, there are many applications of the domain-specific modelling languages [34] because it aims to develop notations and abstractions of a particular domain through the design of a specification language.

3 REQUIREMENTS ANALYSIS AND DESIGN

This section describes the requirements for this project in the user requirements context to meet the final product expectations. Thereafter it will outline the development method chosen to assist and ensure that a reliable graphical step notation is produced.

3.1 Requirements Analysis

The following requirements analysis is aimed at preparing basis for the design of the DSML for the salsa dance which justifies the choice of a DSML. By applying Frank's approach [34], it is required to identify specific requirements towards the proposed modelling language. The requirements should be identified in close collaborations with domain experts. In this manner, was essential to connect with dance teachers and participate on an introductory dance classes for salsa and bachata. At the beginning of the project a meeting was conducted with our client from Evolution Studio Company, to know what was expected from the tool. During the meeting,the proposed functional and non functional requirements aspects were described and discussed that were in need for the graphical notation tool.
Regarding to the meeting expectations, further knowledge was gained from observations of the available online dance diagrams in accordance to the dance classes with one of our clients. Subsequently three main scenarios were identified according to the client's expectations. The scenarios are:

- *Fist Scenario.* Indicates that in each beat, must only have two feet or text (PAUSE).
- *Second Scenario.* Focuses on updating the status of each beat, guiding the user to have a more complete dance diagram layout. This provides support for the specification of the dance diagram.
- *Third Scenario.* Centralizes on the tool as a whole, where naming the generated diagram is essential for the representation of the different salsa dance moves.

Before the construction of a DSML, it is fundamental to set the requirements of the DSML before the requirements of the whole application are set [34]. A DSML has general requirements which are applied to all DSML, but requirements for this specific DSML are unique. The general requirements for this DMSL, comprise of a combination of the formal requirements, user-orientated requirements and application-orientation requirements. The requirements of a DSML are as follows: **R1**: The specification of a modelling language should include a clear specification of its syntax, the salsa dance steps. In an ideal case, this will be a formal specification. The syntax specification should allow the user to decide if the model is syntactically correct or not. Rationale: Correct syntax is a prerequisite for the consistency of the models.
R2: The rules defining the meaning of the language should be suited to guide clearly the intended users with the construction of appropriate models and their adequate interpretation. These rules should be formalized if this does not compromise the intended meaning.*Rationale:* The DSML should be constructed to guide the users while designing the models following the rules.
R3: The concept of the dance modelling language should resemble the concepts to the intended users, in this case, the DSML about dance steps for dance members. Additionally, the graphical symbols are suitable to correspond to the concept meaning.
Rationale: If the users are aware of the concepts of the DSML and their symbolism (salsa dance steps), it will be easier for them to understand and interpret the DSML.
R4:A DSML should provide a manageable set of basic concepts that are sufficient for creating simple models.
Rationale: Often, there will be users that do not need to develop elaborate models because it would be unnecessary if they could use the language only after they had learned more elaborate concepts, too. In this case, the DSML should include a part that represents a lightweight version.
R5: The salsa dance modelling should allow the construction of the model on a distinct level of abstraction. The user should not be forced to specify unnecessary details.
Rationale: Generally, some users do not need to develop advanced models. Normally in the DSML, the user has different demands for the level of abstraction and detail provided by a model, which might be used by a novice user or an expert. It should be taken into consideration that some might be bothered with a higher level of detail, while others focus on problems requiring a higher degree of detail.
In addition to the main scenarios of the tool relating to the features and the general requirements, the final product should comply with the main components that makes up the system.

The main components of the system are:

- Graphical User Interface.
- A modelling language with salsa dance constraints.
- A canvas that illustrates 8 beats spaces for each dance step.
- A system that is also able to support other Latin Dances, such as Bachata.
- A visual representation of salsa dance elements, to be specific and moves, steps, arrows and text.

3.2 User Interface

The user interface of the tool was inspired by the salsa online available salsa dance diagrams which part of it centers on the constraints of the tool. During the design phase, many solutions features were presented and discussed in correlation to the user needs and basic features of a graphic editor.

3.2.1 Design Process. The design technique chosen for the design process was the User-Centered Design (UCD) which focuses on the user needs. Throughout the design process, the participation and

the meeting with our client helped in establishing the user needs. The target users for the tool are both students and dance teachers. The teachers' input was crucial because they are the main experts regarding the dance steps and diagrams and their collaboration with a new set of design ideas and features. When building a DSML, it is necessary to specify the requirements of the graphical editor. Since there are different types of requirements, the user helped to identify and specify the user requirements for the tool, which are also the user-orientated requirements of the DSML.
Previously to the development of the solution, personae originated to best capture the broad range of users for whom the tool is tailored. Three personas were established between a novice dance student who is a beginner in the salsa dance, an expert dance student who is capable of teaching others and conducting beginner salsa dance lessons, plus a middle ground between the personas. Throughout of the development of the solution, low-fidelity paper prototypes were developed to identify and structure of the information to be displayed in the web-page, give an layout of the page and present an general user interface.
The iterative process continued concentrating on meeting the user needs and improving the features of the tool to satisfy the user needs.

3.2.2 Design Principles integrated in application design.
Help and Documentation. In case the user is confused about how the canvas works, they might feel frustrated and reluctant to use the application. Help and documentation are presented in the form of information icons on-screen, providing a guide on how to use the application. These allow users to get clarification on things they may be confused about, increasing the overall usability of the application. [6].

Recognition over Recall The user interface is straight to the point, users are able understand the concept of the tool and provide them with information on how to use the tool. In this particular case, recognition and recall were relationship between controls and their actions should be obvious[28] is applied for the layout of the web page which has a simple and minimal design. The canvas is organized in 8 blocks which ensembles the online salsa dance diagrams and the users are able to recognize it.

Aesthetic Usability Effect In previous studies, it was found that more appealing applications often perform better in usability tests [33] . The application is simple, minimalist with a canvas divided in 8 parts.The layout is intentional and links to the modelling element of our application. Font style and size are consistent throughout the application, making it readable and pleasant to use.

Hicks Law "The time taken to reach a decision goes up as the number of choices increases" – Hicks Law[26]. Overall, as mentioned above, the application as a minimal design. The exclusive layout of the 8-part canvas and buttons corresponding each beat to add shapes. They only add the step notations for each beat as input. This allows them to save, view and select only from the movements that they require.

Principle of Least Effort According to the Principle of Least Effort, "Make frequent things easy, and unlikely things harder" [3]. The application utilizes this principle by populating the user features on the same page, in this case the application is a single page application. If a user clicks on a beat then they will be taken to the relevant beat block on the canvas.

Visibility of System Status The system communicates to the user according to its choices. In this case, when a beat is active, it changes color. When the user adds a beat, the status of the beats changes, and when there are two beats on the system, it gives feedback to the user assuring that they are on the right track.

3.2.3 Structure of the Salsa dance diagrams. According to the majority of the dance diagrams available online, each dance step is represented in each beat. Furthermore, the salsa dance moves usually have eight beats (Fig. 1). The beats can be divided into 8 parts vertically, or they can be divided into four parts and split on the center to represent eight beats. Usually, each beat is represented by the two feet, where one foot can have the weight in, which means that it needs to be moved (solid color) and the other can be in place. Both can be in movement or in place (no color). Also to represent, pause, the keyword PAUSE can be used instead of the two feet together.

4 THEORETICAL ANALYSIS OF THE CREATION OF THE GRAMMAR

This section provides an analysis of the dance diagrams input and the validity of the salsa dance steps. The grammar for the web application was implemented following the context-free grammar (CFG) rules, which structure defines the rules and simplifies the constraints of the tool.
Preceding the construction of the grammar, a salsa vocabulary was built for a better understanding of the basic salsa step positions.

4.1 Salsa Vocabulary

The vocabulary construction was inspired on the Salsa or Mambo footwork from the SalsaisGood [29] Dictionary of Salsa and Mambo moves.
For starters, the Salsa or Mambo footwork has a table (Fig. 2) for advanced and basic steps and the salsa vocabulary was focused on the basic steps. The symbols used to describe the foot moves of the basics steps. After the meeting with our client, a new updated version of the salsa vocabulary was designed (Appendix A) The same concepts were used, where the symbols describe which foot moves and where.

The development of the salsa vocabulary entailed the two iterations.
The *First iteration*, follows the symbols of the salsa or mambo basics steps footwork and translated into a graphical image (Fig. 3) and in the *Second iteration*, were made some corrections of the positions "Left back to the right", "Right back to the Left","Right forward to the Left" and "Left forward to the right" according to the salsa dance lesson taken and the client knowledge.

L=left in place	R=right in place
$\underline{L}$= (left forward)	$\underline{R}$= (left forward)
$\overline{L}$ =(left back)	$\overline{R}$= (Right back)
L| = left sideways	|R= right sideways
L| | = left further to the side	| |R= right further to the side
|$\overline{L}$= left back to the right	$\overline{R}$|= right back to the left
|$\underline{L}$= left forward to the right	$\underline{R}$| = right forward to the left

Figure 2: Table of the Salsa or Mambo Footwork [29]

4.2 Constraints of the salsa dance grammar

The requirements gathering of the tool to the user interface design identified several rules during the iterative design process, which became limited to the domain of the application, the dance diagrams for salsa dance steps. The available salsa dance diagrams were resourceful for this phase in terms of its constraints. Constraints were necessary to guide the user on how the dance diagrams work and are created. In terms of the CFG, the salsa language was defined by the beat spaces for each movement to be created.
Once we established the grammar requirements, the development of the grammar commenced applying the constraints. The grammar requirements considered the general conditions of the DSML to be created along with the salsa dance diagram constraints. In addition to that, the grammar corresponds to the language of each beat or dance move.

4.3 Construction of the grammar

The development of the grammar entailed an iterative process to reach the final product. During the iterative process, each step involved the design of production rules to impose the constraints of the tool considering the steps movements. The iterative process happened between the development of the tool and the evaluation of it.

4.3.1 First Iteration. Before the construction of the grammar, a salsa vocabulary was built for the salsa language. A vocabulary was necessary because it contains different step movements that are part of the salsa dance moves. The movements were:

- Both feet in place
- Left foot forward
- Left foot back
- Left foot sideways
- Left forward to the right
- Left back to the right
- Right foot forward
- Right foot back
- Right foot sideways
- Right forward to the left
- Right back to the left

The vocabulary aided in the production of the terminals to describe the constraints of the grammar. The representation of the elements in the grammar followed the the general representation of the CFG and unique names of the terminal where created to represent different productions. For this particular grammar, there is one important propriety with the positioning of the steps. The steps can be positioned in male perspective and the female perspective. The right step and the left steps are represented as r and l successively. The different step movement for each beat are as follows:

- sideways to is characterized as s, where the user illustrates the left foot going sideways to the right or right foot going sideways to the left.
- backwards is characterized as b, where the step goes to back behind of the right/left.
- forward is characterized as f, where the step is illustrated as going forward.
- back to is characterized as bt, where the step goes back to its initial position.

When both left and right foot are together, the movement between the two would be represented as an empty string, in this case the final string can be either *rl* or *lr* for both male and female sides. If the one of the of steps is going forward to, left is going forward to right or right is going forward to the left, is represented as *rfl* or *lfr*. The same happens when the steps are going back to or backwards where the final strings would be *rbtl* or *lbtr* when the right foot is going back to its original position and *rbl* or *lbr* when the left foot is going backwards to the right or right foot is going backwards to the left.
The set of the non-terminal symbols is N =S,A,B,C and the set of the terminals is T = f, s, b, bt,ϵ, r, l and P stands for the production rules and the S is the starting symbols. The first grammar version is as follows:
P1: S $\rightarrow$ ACB | BCA
P2: C $\rightarrow$ f | s | b | bt | ϵ
P3: A $\rightarrow$ r
P4: B $\rightarrow$ l
The goal of this grammar was to set a language that validates the steps movements. There was a need to have more explicit grammar in terms of recognising the weighting of the steps and the step movements on each beat of the salsa dance move.

4.3.2 Second Iteration. In the second version of the grammar, a new production was added and two terminal where added to symbolize when the is a solid color and when there is no color. The terminal that represents the solid color and # represents no color. The new grammar version is as follows:
P1: S $\rightarrow$ ACB | BCA
P2: C $\rightarrow$ f | s | b | bt | ϵ
P3: D $\rightarrow$ | #
P4: A $\rightarrow$ Dr
P5: B $\rightarrow$ Dl

This grammar was only used to comprehend the salsa dance diagrams constraints. In terms of implementation, the grammar was implemented in a different way. Putting differently, the grammar production rules were translated without the parser and another method was used. we will discuss this matter in the next section.

5 SYSTEM DESIGN AND IMPLEMENTATION

In this section, the design and implementation are described. The methodology to implement the project was the waterfall method. The waterfall method comprises of the requirements analysis, design, implementation, verification and maintenance. A meeting was

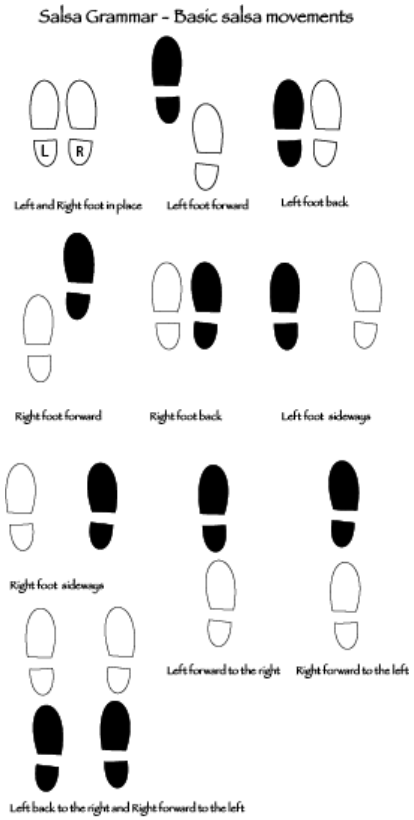


Figure 3: Salsa Vocabulary

conducted with our client to gather comprehensive information that the project requires. After the requirements were clear, begins the design phase. The design phase follows the three development approaches of the DSML from Frank's [34] Outline of a Method for Designing Domain-Specific Modelling Languages. The approach first focuses on the language specification with the creation of abstract syntax and concrete syntax.

5.1 Design

As stated in section 3, the salsa grammar was designed using a context-free grammar with the intention of a better understanding because the CFG is a notation for describing language. Although its design was used in this project, the implementation of its parser will not be used for this particularly tool, due to its complexity and the structure of the tool which will be discussed on the next subsection of the paper.

The front-end of the system was implement with HTML and a react package, react-bootstrap which is a combination of react components and Bootstrap front-end framework. The user interface design went through two iterations (Appendix F), the first iteration was a minimal design to test the application in terms of the functional requirements. The final iteration focused on the user interface design to increase the user experience. The Appendix B demonstrates the changes of the system.

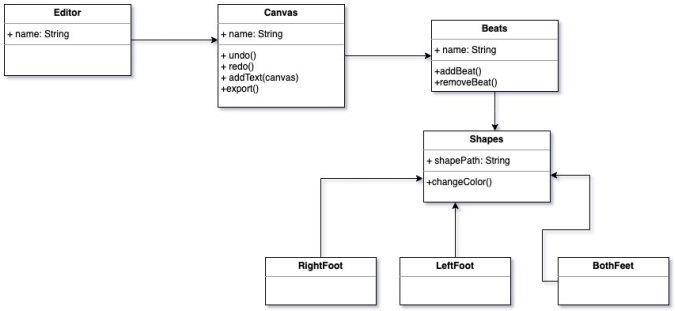


Figure 4: The DSML meta-model

5.2 System Implementation

5.2.1 Abstract Syntax. The abstract syntax is generally documented as a meta-model, following the Meta-Modelling (MEMO) method's language architecture [34]. The meta-model used in the construction of the DSML used the UML class diagram to represent the components of a salsa dance diagram. The starting point is the editor class. The main constraints are expressed on from the beginning of the meta-model in a graphical DSML.

An *Editor* can have only one canvas, and a *canvas* has eight beats. A *beat* can only have between up to three shapes, a right foot and left foot, both feet, and arrows or the keyword PAUSE.

There are four types of shapes *right foot, left foot and both feet* and each beat can only illustrate two feet.

5.2.2 Concrete Syntax. Concrete syntax is visual representation of different concepts formalised during the creation of the abstract syntax [34]. They can be represented textually or graphically, but for this particularly DSML the visual representation is mainly graphical. For each abstract syntax concept , there is a concrete syntax symbol.

The concrete syntax is a crucial to the usability of the tool. Also the graphical representation is essential because it represents the project better because of the symbols accordingly with the available online salsa dance diagrams.

A concrete syntax was created for the definition of the steps which helps the user understand what is happening on the diagram. All model elements displayed are SVG elements, on the concrete syntax. The graphical representation of the concrete syntax is determined by mapping the SVG element to each class element from the UML diagram and its relationships. The graphical symbols were developed by creating a SVG path in order to create a complex shape, in this case the step shape. The modelling tool contains create, read, and delete operations, such as adding shapes, uploading them, visualizing them and delete them which are performed through mouse clicks. The basic elements of the salsa language, represent a step notation and its actions to symbolize movement. The shapes are represented by an arrow, a right foot , left foot, both foot and the word PAUSE which represent no movement. The model focuses on the dance movement proprieties. An instance of a beat can have two shapes, one right foot shape and one left shape or one shape which contains both feet or even the keyword PAUSE. An editor can only have a canvas and a canvas can only have eight beats that

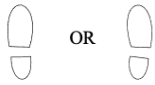
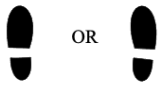
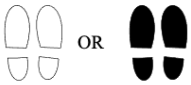
	Symbols	Explanation
Steps with no color		Represent the light step.
Steps with color		Represents the weight on the steps.
2 steps together in place		Can represent pause or just both step together.
Arrow		Movement between the steps
PAUSE keyword	PAUSE	Represents the pause between beats

Figure 5: Table of the DSML graphic symbols

represent the eight salsa beats. The table below, shows a description of the symbols and its meanings:

5.2.3 Development of the tool. During the development of the tool, the first thing that was considered was the features of a traditional diagram, such as undo, redo, adding text, and export the canvas as an image. In addition, features such as provide control to the shape size and positioning so that the user can choose how they would prefer the layout for the men(leader) or women(follower). The development of the tool entails the connection between abstract syntax and concrete syntax to give meaning to the tool. The tool associates rules and constraints of the language to the visual representations of the elements of the DSML.

5.3 System Architecture

A web application was chosen for this project over a mobile application because it was convenient for this particular application. The architectural design of the system was influenced by the architecture of a DSML, considering the main feature, which is the drag-and-drop component. A client-server architecture was implemented in the project. The web application is a client that interacts with a server that is hosted by firebase, a application software development managed Google Cloud Systems.

The proposed architecture (Fig. 5) comprises of two main stages namely the DSML definition and the application of the DSML. During the DSML application process, the DSML developer defines the DSML. The definition of the DSML includes the resolution of the abstract syntax with its properties and methods, the concrete syntax (graphical representation). The abstract syntax's meta-model (Fig. 4) is implemented with JavaScript through React components and were build in a desktop setting and the concrete syntax was defined on the front-end of the desktop setting through FabricJS library. The web-application is defined using the FabricJS library

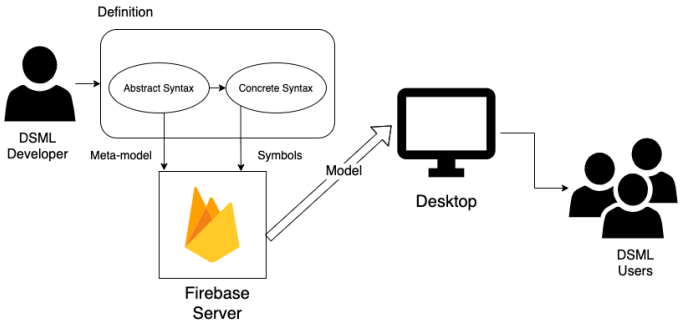


Figure 6: Proposed architecture

by assigning the different shapes into the meta-model components. Both the meta-model and the graphical representation of the symbols are applied in the tool and then deployed by the Firebase server. The students and teachers, in this case, the DSML users are able to access the application in the cloud server and make use of it.

5.3.1 ReactJS. The application was implemented with JavaScript (JS) programming language. According to the design of the web-application it was concluded that it should be a single page application. React[2] is a component-based JavaScript library used to build user interfaces. Generally, React is used to build single-page applications. React applications are expressed by by multiple components that are part of the application components tree. For each React component it is requires to return one block of JavaScript XML (JSX) code that allows the code be directly in the HTML in React in the JS code [2]. The JSX converts the HTML code into React components. The component-based logic was fundamental for the implementation of the web-application. The web-application has a simple implementation, that only contains 3 components: App, Canvas and NavBar components. The App component is the root component, were it contains the child components Canvas and NavBar. The Canvas component is "stateful", contains various elements that use states that alter the status of the application, such as the canvas and beats. The NavBar is "stateless" because does not contains states that change the behaviour of the application.

5.3.2 FabricJS. FabricJS [4] is a "powerful simple JavaScript HTML5 canvas library". It is open-sourced library. This library was suitable for the implementation of the of the application. FabricJS is complete, because facilitates the manipulation of the HTML5 with canvas and gives an object model features for canvas, SVG parser and interactivity tools. This library has the main component which is the drag-and-drop, the object model model and the most important the drawing complex shapes features. It supports the complex shapes, the step figure for instance. In addiction, fabricJS supports the traditional graphic tools methods such as undo, redo, change color, add text and resize and rotate the objects. Also, it has the ability to manipulate the objects and change according to its properties and methods[16]. Althought fabricJS is not a tool that create DSMLs, it has the ability to build new applications with the same result.

5.3.3 Firebase. Firebase [27], is a cloud platform managed by Google Cloud that has numerous functionalities such as hostiong, real-time

database , among others. The platform was chosen for the back-end development of the application because of its free-plan and the various ways to expand. Firebase is a good choice because it is fully cloud-base with high availability, scalability and low infrastructure costs. The web-application relies on the Firebase hosting service which is secure and fast for the web application which is appropriate for the development and approaches used in the SALSA dance editor. The web-application does not use any cloud functions for firebase and does not use the real time database, considering that the application does not need anytime of storage.

5.4 System Testing

As a developer, it was essential to perform acceptance testing to determine whether the application system met the requirements to be considered acceptable to be used by the domain users. The acceptance test was essential to the verification and maintenance phases throughout the iteration process because it helped understand what functionality needed to be corrected. The table displays in Appendix B the requirements that were accepted or not.

5.5 System Constraints

The the parser of context-free grammar described in section 4 of this paper was not implemented. The implementation of this application was focused on the grammar constraints and the production rules were translated in to JS code. Due to the system application structure, the translation of the production rules were more feasible than applying the parser of the grammar. Although, majority of the browsers contain build-in parser it is still difficult to perform online parsing, because handwritten parsers with a new syntax can detect multiple syntax errors [30]. Considering that the construction DSML is hard [9], the construction of this web application with the JS frameworks to represent the constraints of the grammar was appropriate for this case.

Additionally, the final system has the following constraints:

- The steps of a specific beat are bound to the specific beat.
- A beat can only have two steps or a keyword PAUSE.
- The system considers the status of each beat to be either incomplete or possible complete.
- The canvas is divided in 8 parts.

6 RESULTS AND DISCUSSION

6.1 Results

6.1.1 User Evaluation. The aim of the user evaluation is test the effectiveness of the tool. The participants of the user evaluation were teachers from the Evolution Dance Studio. They were from recruited our client. The user evaluation was conducted in three phases, which the user will be given time to explore the application without any guidance to test how easily the features can be discovered. The second stage will consist of predefined t activities (Appendix E) where they were asked to perform within the application. The third stage was be a post-evaluation survey, where they will be be asked to give general feedback. Before the user evaluation initialized, the participants were introduced to the problem domain, what the aim of the evaluation is and how the evaluation occurred was and the procedural structure. Informed consent was given to the participants and was obtained from the participants. The participants had a chance to individually navigate the application themselves. The survey was concerning to the usability of the application and its effectiveness of the tool.

6.1.2 Online Survey. Due to time constraints and the availability of one of the client was not possible to obtain credible results because of the lower number of participants.

The description of the results from the online survey (Appendix C) will be a comparison between the responses of the student and dance teacher to come in a consensus of how appropriate these tool is for students and the dance teachers.

Unfortunately, the online survey had only two participants, a student and a teacher, it was expected to have at least 8 participants, four students and four teacher.

In the survey both student and teacher considered themselves as intermediate, the teacher believes that dance diagrams are effective for the dance education while the student had no idea of what dance diagrams are. The student was neutral in relation of the existence of a step notation to facilitate the creation of diagrams depicting dance moves whereas the teachers agreed with it. Considering that the diagrams are a visual representation of how the dance steps movements both were able to identify correctly the function of the icons of the dance diagrams. Overall, both participants prefer diagrams that contain steps with split and arrows when interpreting a diagram. The student and teacher had similar opinions when it comes to their preferences to dance diagrams in terms of the color shading. The teacher preferences would be a slip sole to indicate when the weight is the foot palms (advanced level) and arrows to indicate when necessary and the student preferred the use of the arrows.

6.2 Discussion

A post-evaluation survey (Appendix D) was conducted after the user evaluation, and it was possible to measure the user experience, based on the teacher experience. Although the user evaluation was performed with one user, the user evaluation session was valuable because of the constructive and overall feedback. The user evolution was performed with a dance teacher, assuming that the dance teacher has more knowledge in the dance field. The general feedback on the step notation tool was positive, with constructive criticisms which led to better functionality to build upon the final design of the tool. The participant appreciated the simple and minimal layout and thoughtful design of the tool relating to the domain area pertaining to the DSML and its design. Considering that the users might not know how the application works, a mini-guide with introductory information is provided on the application. After that, the participant described the tool as self-explanatory, easy to use, and understandable. The navigation was smoothly performed. The participant described the interface as easy to use and understandable. The introductory information that the application provides to the user was appreciated. The participant was able to create dance moves for each beat and mentioned that it was easy to add each step. A suggestion was made to add the functionality, where instead of undoing each beat one by one, it would be more convenient if the undo feature could work to a specific beat and not for the whole

canvas. After all, the participant agreed that the tool with the suggestion made would be effective in dance education, at least for the Latin dances, to create salsa dance diagrams and practice their dance skills with a tool that illustrates clear dance steps notations. Relating to the online surveys, it was possible to verify based on the participants' input that both student and teacher were able to understand the salsa dance diagrams. However, the student did not have idea that those types of diagrams existed. Learners are able to understand the salsa dance diagrams and its notation. Considering that the teachers are the ones with the domain knowledge, it is acknowledged that the DSML is more appropriate for dance teachers than students due to their knowledge and belief that a graphic editor for would be effective for dance education.

7 CONCLUSION AND FUTURE WORK

In this paper, we presented a design solution for an application to provide a dynamic approach to teach Salsa. This paper work was defined by creating a DSML for salsa dance, which can also be extended for other latin dances such as bachata. Frank's [34] approach to developing a DSML was used. In addition to that, an iterative process involving the user was performed to reach their desired goal. The tool was evaluated by teachers assuming that students are not interested in the technical side of the salsa dance. Unfortunately, the application did not meet all the requirements regarding the traditional features of a traditional graphical editor, such as undo and redo. Besides that, the tool met the remainder of the requirements. The use of the CFG was essential to really understand how the constraints of the tool would work to be centralized of the domain which is salsa dance. The user input was crucial for the development of the tool, during the iterative process, help to understand how they would like to have the tool for a better user experience and effective use of the tool. Overall there was positive feedback from the end-users and some enthusiasm from the user evaluation. We can consider that the tool is useful for representing salsa dance moves and the salsa dance diagram. We can deduce that this application may be a helpful tool for the dance community, among the dance teachers. We can also conclude that learners can understand the salsa dance diagram notation, but there is a lack of enthusiasm and knowledge about these salsa dance diagrams. We could recommend that teachers start promoting the use of salsa dance diagrams for a better learning experience. Further research is needed to create another DSML or an extension that supports a notation for a full-body movement (arms and legs) for Latin dance that is minimal, simple to use and understand. The outcome of this paper is the first ever modelling language for dance for Afro-Latin dance.

Although the development of DSMLs is expensive and difficult to implement [34], it was a good solution for this specific project that focused in a specific domain which is salsa dance and we can encourage the development for them because of its advantages. For future work references, there are software specialised in constructing domain-specific modelling languages, such as Eclipse [8], MPS[25] and among others that can achieve the same result. In addition, we may consider using another effective language, more appropriate for a graphical notation platform, and maybe extend the application to animate the images and transform them into gifs for a better understanding of how the steps should work.

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A UPDATED SALSA VOCABULARY

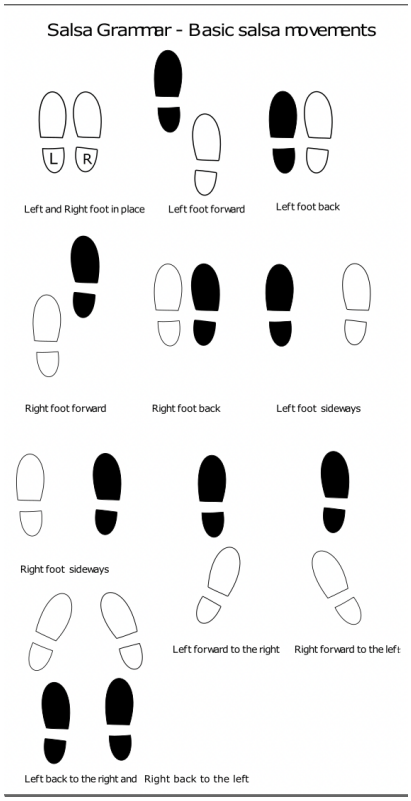


Figure 7: Updated version of the salsa vocabulary

B ACCEPTANCE TEST

ID	CRITERIA	RESULT
1	Add only 2 steps per beat.	PASS
2	Add only the keyword pause on the beat.	PASS
3	Undo all the changes	PASS
4	Redo all the changes.	PASS
5	Change the shape color.	PASS
6	Add text and arrows.	PASS
7	Receive status per each beat.	PASS

Figure 8: Acceptance test

C SURVEY QUESTIONNAIRE

Department of Computer Science - Salsa Dance Education Research

Dear participant,

I'm a student from the University of Cape Town, undertaking research for our Honours in Computer Science programme. You are invited to participate in the following study which aims to identify the participants preferences of the symbols of the graphic notation of the available salsa dance diagrams and the levels of knowledge in terms of the salsa dance diagrams and the creation of a graphical editor that allow user to create salsa dance diagrams.

This research has been approved by the Science Faculty Ethics in Research Committee. The duration of the questionnaire should last approximately 10 minutes.

By completing the questionnaire, you are providing consent for your responses to be used in the data analysis stage of the research. Your participation is completely voluntary, and you may also exit the questionnaire at any time, should you feel that you no longer want to participate in the research. All the data will be completely confidential and fully anonymised. Please email me at the following address if you require any assistance: DNXANA001@myuct.ac.za: (Researcher, Ana Rita Dauane)

*Required

1. By selecting the option "Yes", you are confirming that full consent was read and you giving us consent to continue with the survey and use your information the search. Inform consent: https://drive.google.com/file/d/1IWDCUPvaE8Ekkop9rg6SH6BJKY6hLxlF/view?usp=sharing *

   Mark only one oval.

   - Yes
   - No

2. Are you a dance student or dance teacher? *

   Mark only one oval.

   - Student
   - Dance Teacher

3. What level of dancer are you? *

   Mark only one oval.

   - Beginner
   - Intermediate
   - Advanced

4. I find the dance diagrams to be effective for dance education. *

   Mark only one oval.

   - Strongly disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly agree
   - I have no idea what you're talking about / have never seen 'dance diagrams'

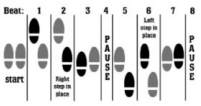
5. I think a dance step notation tool is essential to facilitate the creation of diagrams depicting dance moves. *

   Mark only one oval.

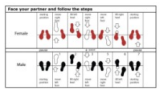
   - Strongly disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

Can you please take a moment and observe and carefully analyse the diagrams below:

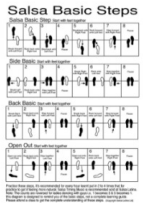
A



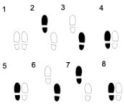
B



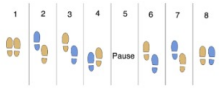
C



D



E



6. What would you assume that the solid color represents? *

   Mark only one oval.

   - Weight on the step
   - Movement
   - Other: _____

7. What does a step without color represents? *

   Mark only one oval.

   - Static Movement
   - Movement
   - Taking the step backwards or forward
   - Other: _____

8. The arrows represented on the dance diagram are used for: *

   Mark only one oval.

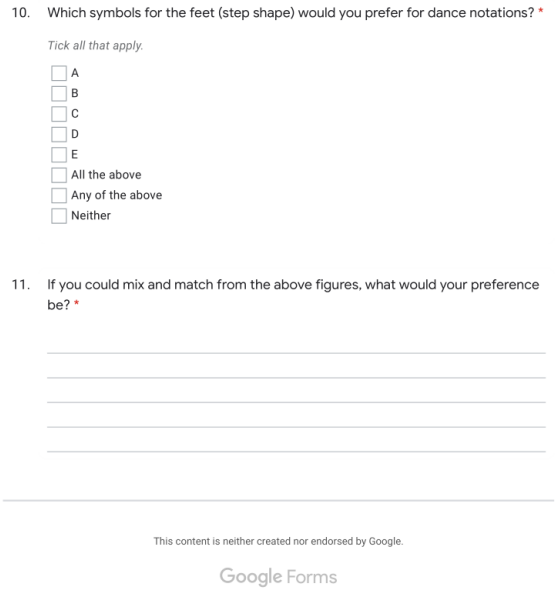
   - Movement between the steps
   - Weight on the foot
   - Connecting the step notation
   - Other: _____

9. Considering the figures above, which diagram would you prefer when interpreting a dance diagram? *

   Tick all that apply.

   - [ ] A
   - [ ] B
   - [ ] C
   - [ ] D
   - [ ] E
   - [ ] Neither

Figure 9: Questions 1 to 9


10. Which symbols for the feet (step shape) would you prefer for dance notations? *

Tick all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] All the above
- [ ] Any of the above
- [ ] Neither

11. If you could mix and match from the above figures, what would your preference be? *

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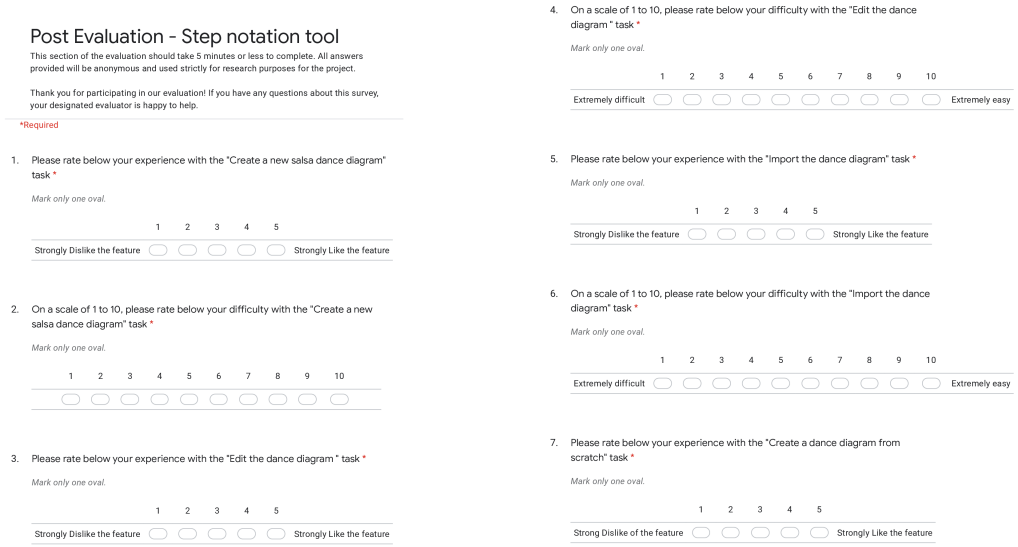
Google Forms

Figure 10: Questions 10 to 11

D POST EVALUATION SURVEY QUESTIONNAIRE



Post Evaluation - Step notation tool

This section of the evaluation should take 5 minutes or less to complete. All answers provided will be anonymous and used strictly for research purposes for the project.

Thank you for participating in our evaluation! If you have any questions about this survey, your designated evaluator is happy to help.

*Required

1. Please rate below your experience with the "Create a new salsa dance diagram" task *

Mark only one oval.

	1	2	3	4	5	
Strongly Dislike the feature	◯	◯	◯	◯	◯	Strongly Like the feature

2. On a scale of 1 to 10, please rate below your difficulty with the "Create a new salsa dance diagram" task *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	

3. Please rate below your experience with the "Edit the dance diagram " task *

Mark only one oval.

	1	2	3	4	5	
Strongly Dislike the feature	◯	◯	◯	◯	◯	Strongly Like the feature

4. On a scale of 1 to 10, please rate below your difficulty with the "Edit the dance diagram " task *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Extremely difficult	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely easy

5. Please rate below your experience with the "Import the dance diagram" task *

Mark only one oval.

	1	2	3	4	5	
Strongly Dislike the feature	◯	◯	◯	◯	◯	Strongly Like the feature

6. On a scale of 1 to 10, please rate below your difficulty with the "Import the dance diagram" task *

Mark only one oval.

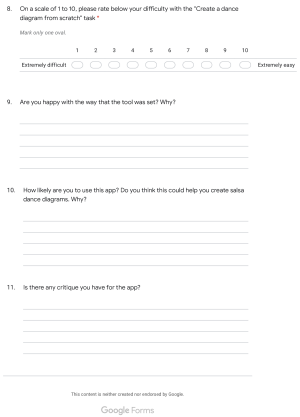
	1	2	3	4	5	6	7	8	9	10	
Extremely difficult	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely easy

7. Please rate below your experience with the "Create a dance diagram from scratch" task *

Mark only one oval.

	1	2	3	4	5	
Strong Dislike of the feature	◯	◯	◯	◯	◯	Strongly Like the feature

Figure 11: Questions 1 to 7



8. On a scale of 1 to 10, please rate below your difficulty with the "Create a dance diagram from scratch" task *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Extremely difficult	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely easy

9. Are you happy with the way that the tool was set? Why?

10. How likely are you to use this app? Do you think this could help you create salsa dance diagrams. Why?

11. Is there any critique you have for the app?

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Figure 12: Questions 8 to 11

E ACTIVITIES LIST

		Task Description	Rationale
1.	Create a new salsa dance diagram (Basic 8 beat steps)	Without mentioning the path that the user needs to take the user will be asked to create a new salsa dance diagram. The user will be given a picture of the 8 beat salsa dance steps diagram and will requested to recreate the salsa dance diagram. This evaluation task will be deemed as successful if the user creates the dance diagram.	This task will help us determine whether the user can successfully navigate through the application and if successfully perform the main task.
2.	Edit the dance diagram	We will ask the user to edit the dance diagram.	This task will allow us to check if the user is able to easily navigate after creating the dance diagram.
3.	Delete dance diagram	The user will need to remove the dance diagram created.	This will inform us if the user can remove an unwanted diagram or a mistake.
4.	Import the dance diagram	The user will be asked to import the dance diagram.	This will help determine if the user knows how import the diagram. This is quite important as this allows the user to save the diagrams created.
5.	Create a dance diagram from scratch	If time permits, the user will be asked to create dance diagram.	This will help determine if the application is more suitable for both novice and expert user or just users.

F USER INTERFACE

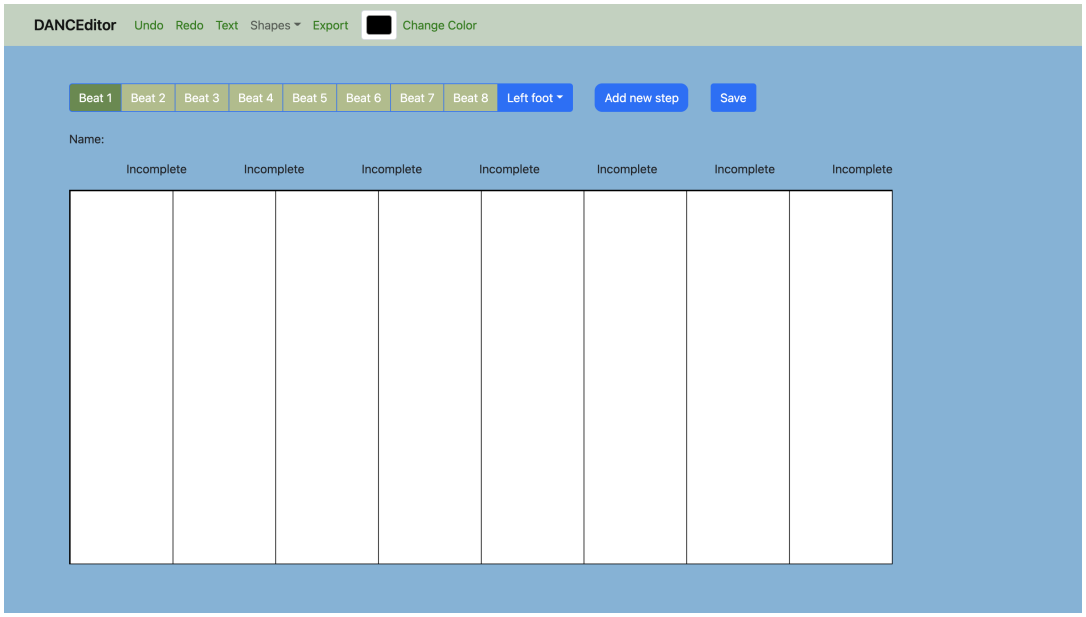

Figure 13: First version of the user interface

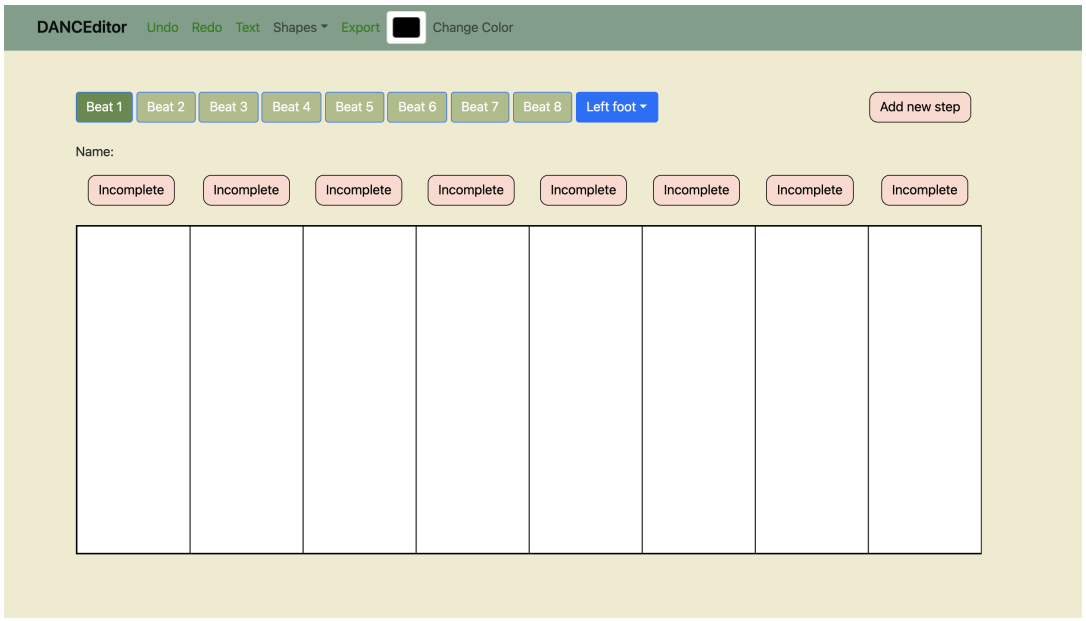

Figure 14: First version of the user interface