

Taxonomy of Dance

A study in dance and data visualization

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Initial concept

I was curious...

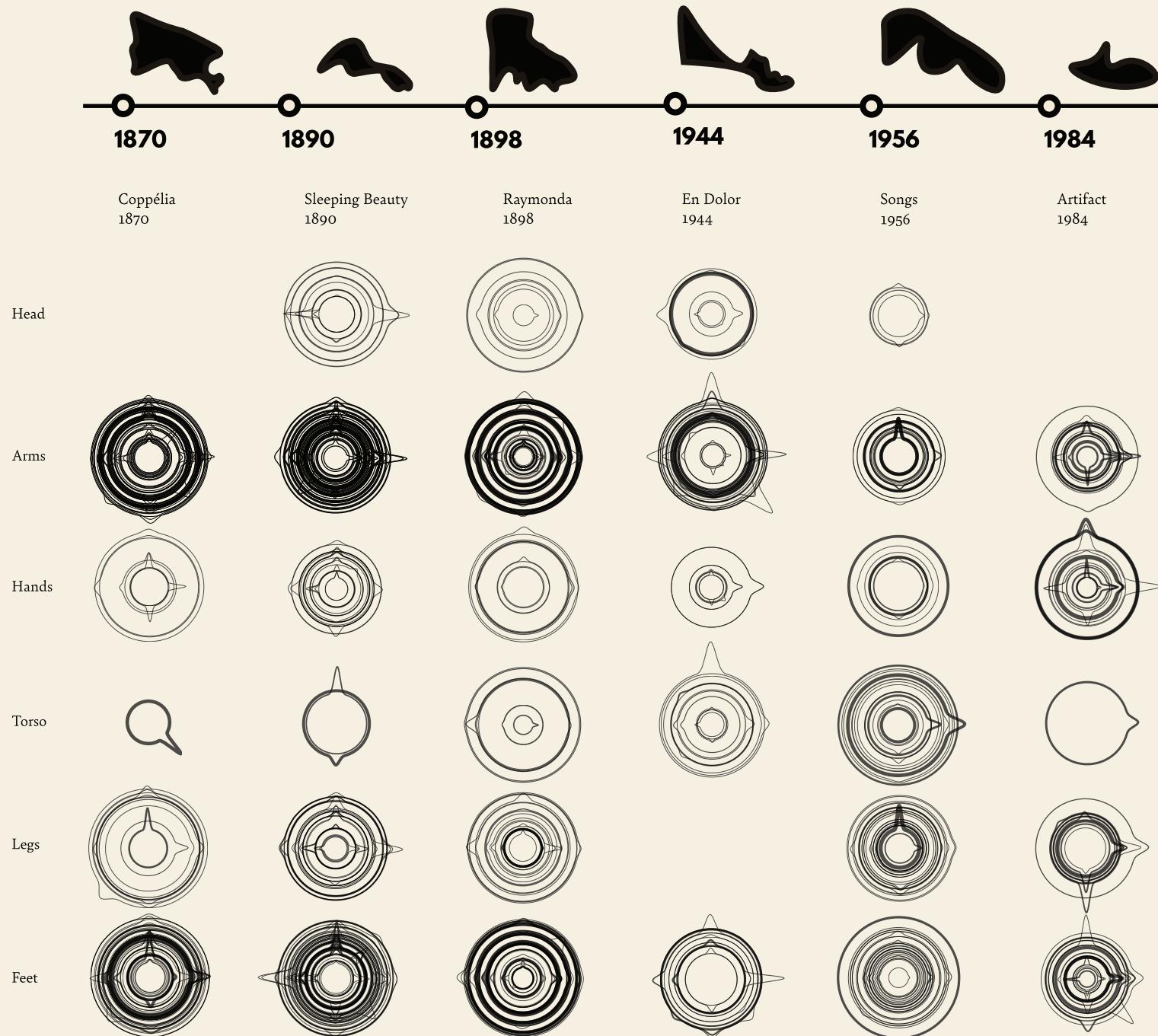
What would choreography look like if it were treated as data and visualized without a dancer?
Could I create a visual signature for a dance that would be unique from other dances?

Would I be able to visually infer characteristics about the dance, like rhythm patterns or body symmetry?

Could I eventually use these data to perform analysis on dances?

After researching a good deal, I discovered a digital archive of choreography recorded in Labanotation maintained by the Dance Notation Bureau.

Initial concept



Here's a sneak peak of the final product.

Keep this visual in mind for the remaining slides.

Inspiration

Previous work:

Github repository of machine learning classifier trained to detect which culture a folktale originated from based on its text.
<https://github.com/GossaLo/afr-neural-folktales>

Github repository of dance notation classifier in MATLAB <https://github.com/michelledebock/Labanotation>

Visual inspiration:

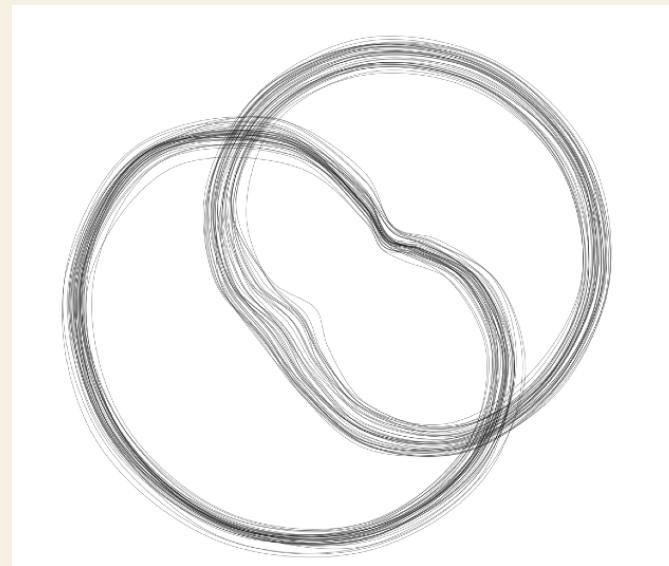
Recording history of movement in ink



Remy Charlip's "Airmail Dances"



Intricate concentric lines



Who would be interested?

Myself- passion project

Gallery attenders interested in technology and fine art

Medium readers and people interested in analysis of qualitative data not typically shown

Dancers and choreographers who would like to experience their art form in a different perspective

Choreologists and dance notators: Dance Notation Bureau

Why?

To explore

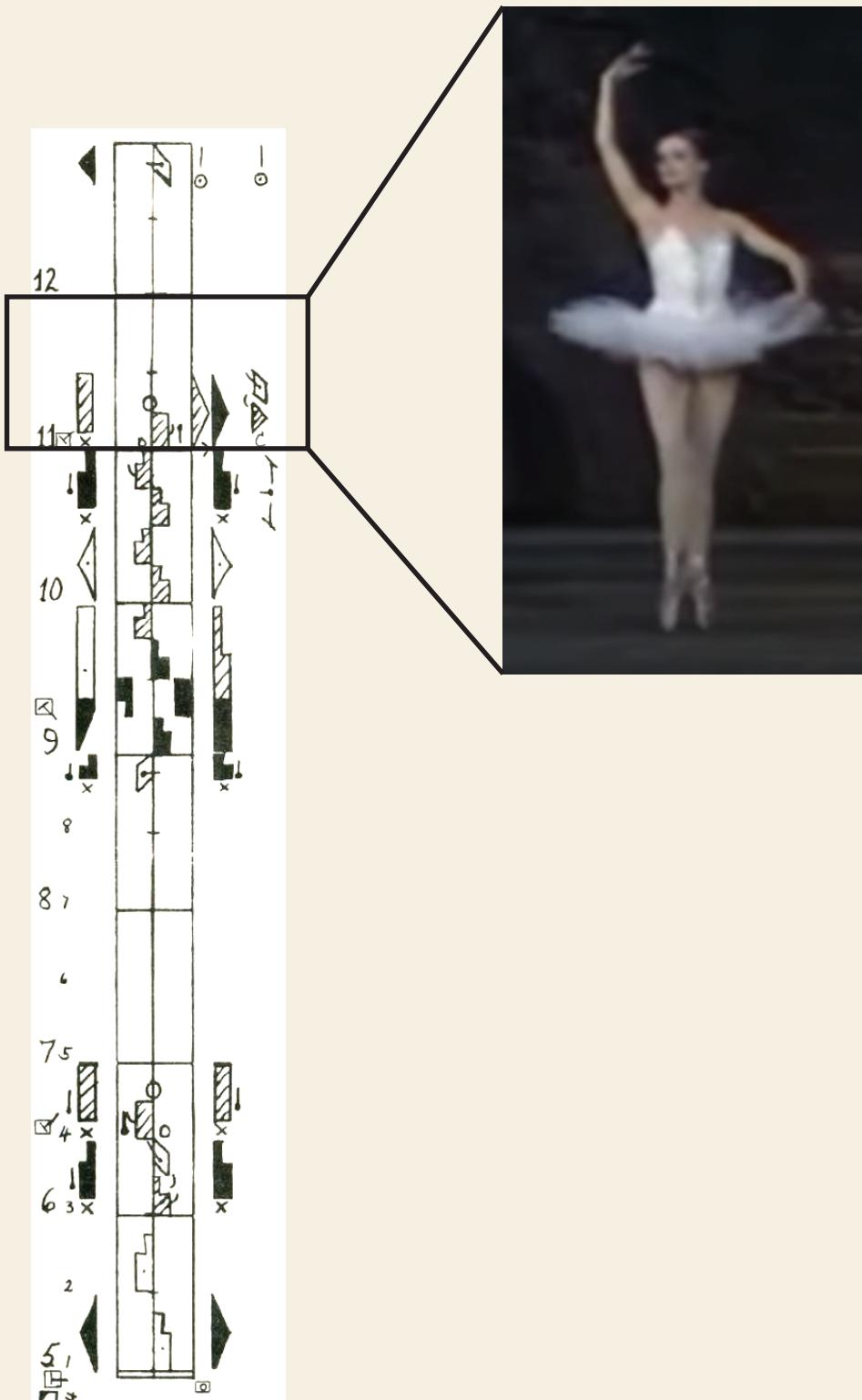
To create delight

To inform

Where did the data come from?

Labanotation: a form of choreography notation using symbols to denote a body movement in terms of body part, direction of movement, height of movement, and time length of movement.

The *Dance Notation Bureau* digital archive provides hundreds of pdf's and images of historical and contemporary dances recorded in Labanotation.



Where did the data come from?

Use labeling software to select notated movements and label with body part, direction of movement, height of movement.

Labels for body part and movement height:

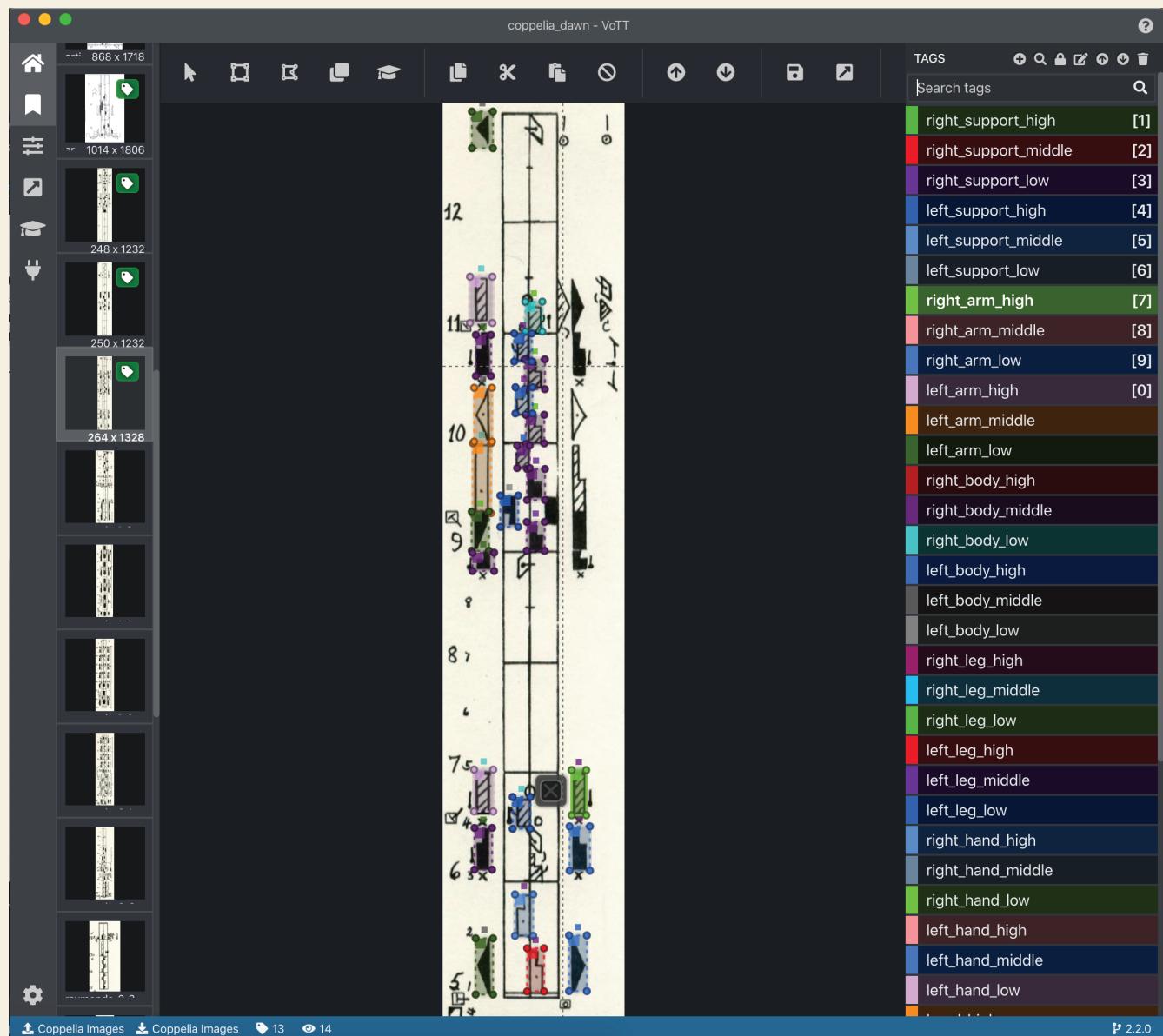
- right_support_high
- right_arm_low
- left_body_middle
- head_high
- ...

Labels for movement direction:

- left
- right
- forward
- forward_diagonal
- place
- ...

Labeled dataset output fields: xmin, xmax, ymin, ymax, label1, label2.

Labeled >1500 boxes



Labeling software VoTT is a Microsoft product intended for building training datasets for machine learning classifiers.

Processing the choreography data

Wrote Python data processing scripts that parsed csv file outputs from VoTT labeling software into visualization-ready data.

The scripts parsed x,y coordinate label boxes into ordered musical measures using geometry.

Simple statistics were also performed to calculate:

- 1) movements per measure
- 2) number unique movements per measure
- 3) number unique movement directions per measure
- 4) repetition index = num unique movements / total movements in measure
- 5) direction diversity index = num unique directions/ total movements in measure

| image | ballet | ymin | ymax | staff_num | step_length | label | direction_m | body_moven | height_movement |
|--------------|--------------|------------|------------|-----------|-------------|---------------|-------------|--------------|-----------------|
| coppelia_dav | coppelia_dav | 1228.17559 | 1362.7852 | 1 | 0.37429492 | left_arm_mi | left | left_arm | middle |
| coppelia_dav | coppelia_dav | 1222.4717 | 1360.69901 | 1 | 0.38583206 | right_arm_mr | right | right_arm | middle |
| coppelia_dav | coppelia_dav | 1232.64927 | 1356.01659 | 1 | 0.33844241 | left_leg_low | forward | left_leg | low |
| coppelia_dav | coppelia_dav | 1227.7108 | 1355.5518 | 1 | 0.3527093 | right_suppor | place | right_suppor | middle |
| coppelia_dav | coppelia_dav | 1131.84566 | 1216.93866 | 2 | 0.21638257 | left_support | forward | left_support | low |
| coppelia_dav | coppelia_dav | 1093.37292 | 1192.95496 | 2 | 0.26258927 | left_arm_lov | place | left_arm | low |
| coppelia_dav | coppelia_dav | 1066.78771 | 1097.93488 | 2 | 0.04434511 | right_suppor | place | right_suppor | high |
| coppelia_dav | coppelia_dav | 976.401673 | 1078.91917 | 2 | 0.27195068 | forward, righ | forward | right_arm | middle |
| coppelia_dav | coppelia_dav | 979.961784 | 1077.87116 | 2 | 0.25725503 | left_arm_mi | forward | left_arm | middle |
| coppelia_dav | coppelia_dav | 1035.05633 | 1066.0644 | 2 | 0.04390151 | forward, righ | forward | right_suppor | low |
| coppelia_dav | coppelia_dav | 973.869224 | 1036.92026 | 2 | 0.14608905 | forward, left | forward | left_support | low |
| coppelia_dav | coppelia_dav | 935.834698 | 977.078181 | 2 | 0.07654305 | forward, righ | forward | right_suppor | high |

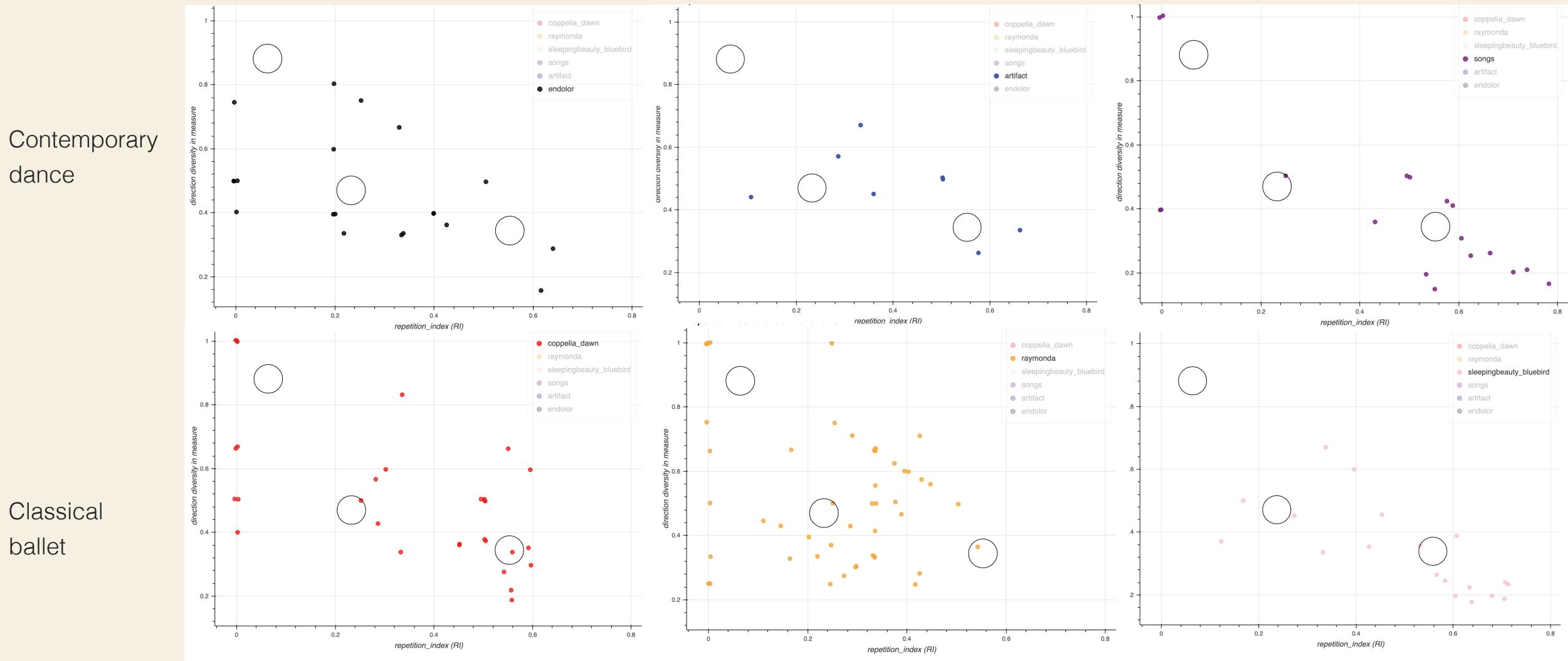
| ballet | measure_nu | movements | unique_body | unique_direc | repetition_in | direction_div | year | length_secor | choreograph | nationality |
|--------------|------------|-----------|-------------|--------------|---------------|---------------|------|--------------|---------------------|-------------|
| coppelia_dav | 1 | 4 | 4 | 4 | 0 | 1 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 7 | 9 | 4 | 2 | 0.55555556 | 0.22222222 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 8 | 6 | 4 | 5 | 0.33333333 | 0.83333333 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 9 | 7 | 5 | 4 | 0.28571429 | 0.57142857 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 10 | 2 | 2 | 1 | 0 | 0.5 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 11 | 10 | 4 | 3 | 0.6 | 0.3 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 12 | 2 | 1 | 1 | 0.5 | 0.5 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 13 | 11 | 5 | 3 | 0.54545455 | 0.27272727 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 14 | 1 | 1 | 1 | 0 | 1 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 17 | 4 | 3 | 2 | 0.25 | 0.5 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 18 | 8 | 4 | 4 | 0.5 | 0.5 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 19 | 3 | 3 | 2 | 0 | 0.66666667 | 1870 | NA | arthur_saint-french | |
| coppelia_dav | 20 | 6 | 4 | 2 | 0.33333333 | 0.33333333 | 1870 | NA | arthur_saint-french | |

Analyzing the choreography data

Question: Can I create a feature space in which distinct clusters emerge based on when a dance was choreographed?

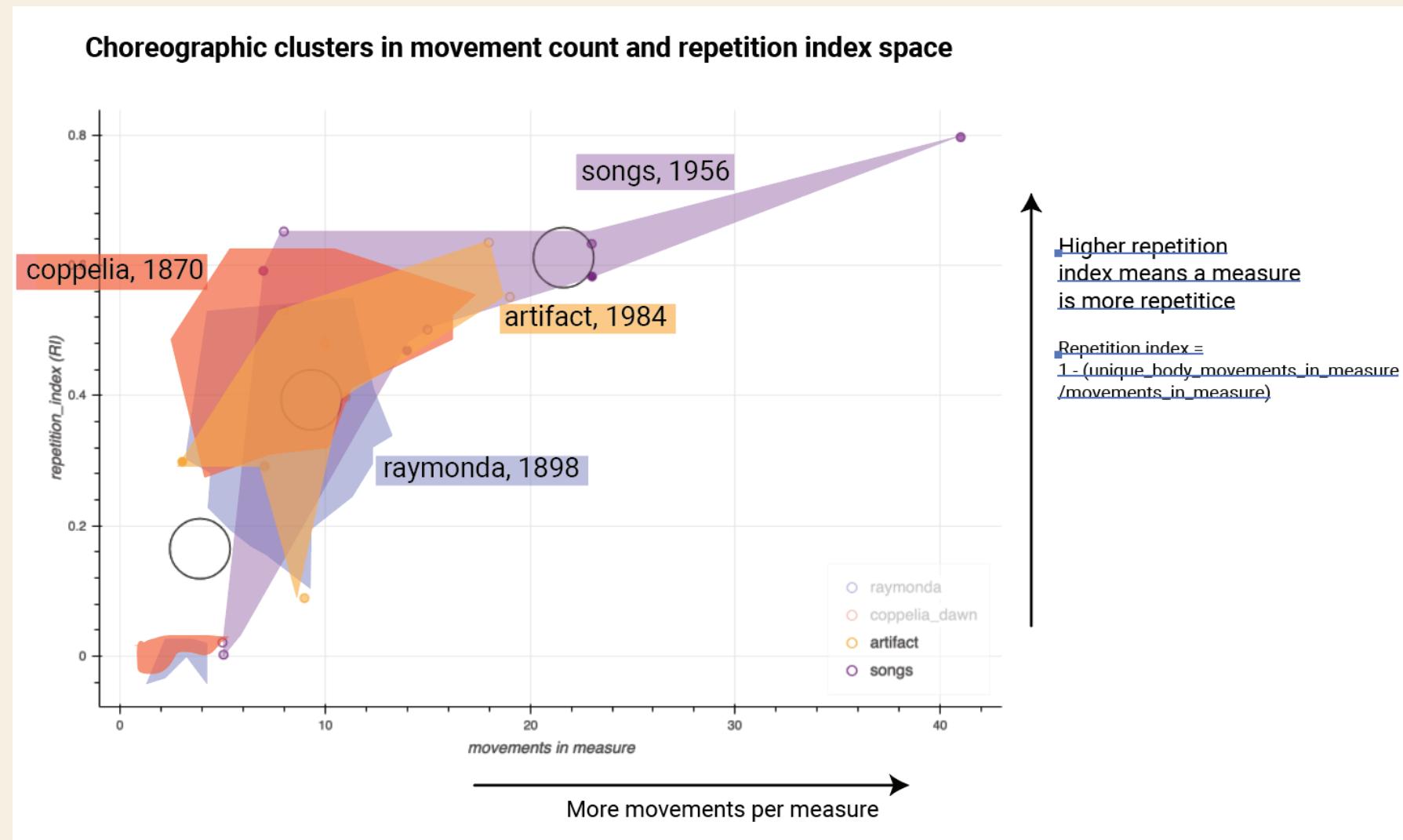
This could be used to eventually train a classifier which would be able to place a dance in its respective era by learning on a large dataset of Labanotated choreography.

Measures plotted in (repetition index, direction diversity index) space



Analyzing the choreography data

Measures plotted in (movements per measure, repetition index) space

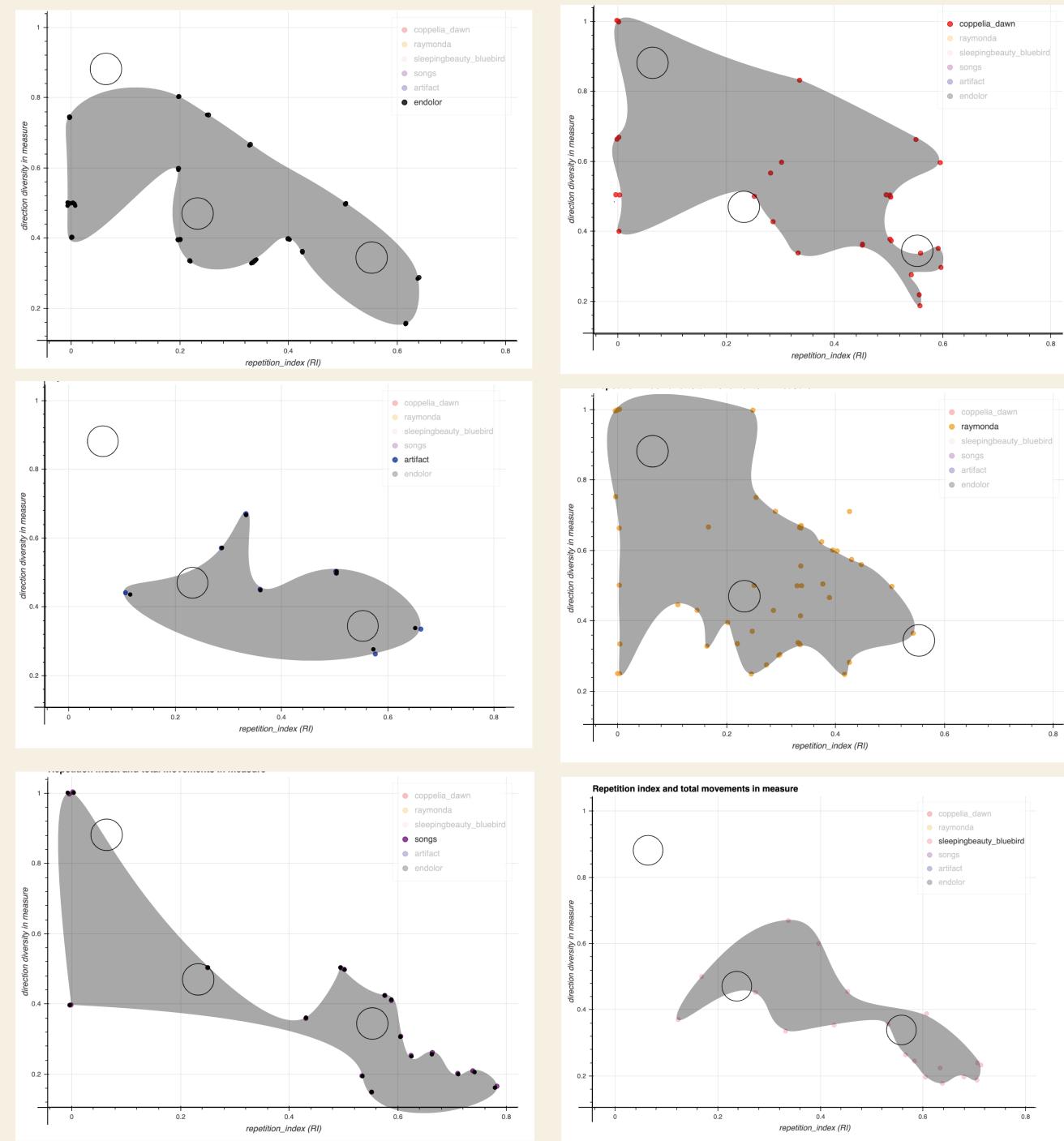
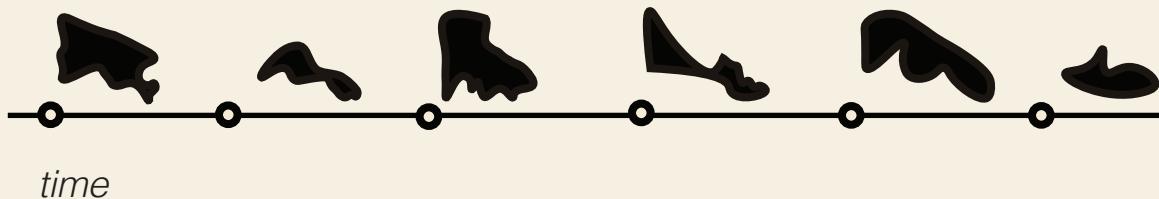


No luck with finding feature spaces where distinct clusters of measures emerge per dance...

Analyzing the choreography data

But these feature spaces still tell us something about the dances.

I can use these feature shapes to create illustrations that convey information about the repetitiveness and directionality of measures within the dance



Initial visualizations

First step: An exploratory dashboard created with the Python library Streamlit.

Problem: I did not find much a story in the data.

Viewing the data in a timeseries plot does not make sensing rhythmic patterns easy.

Furthermore, just seeing frequency charts of movement height and direction does not give a *sense* of the dance.

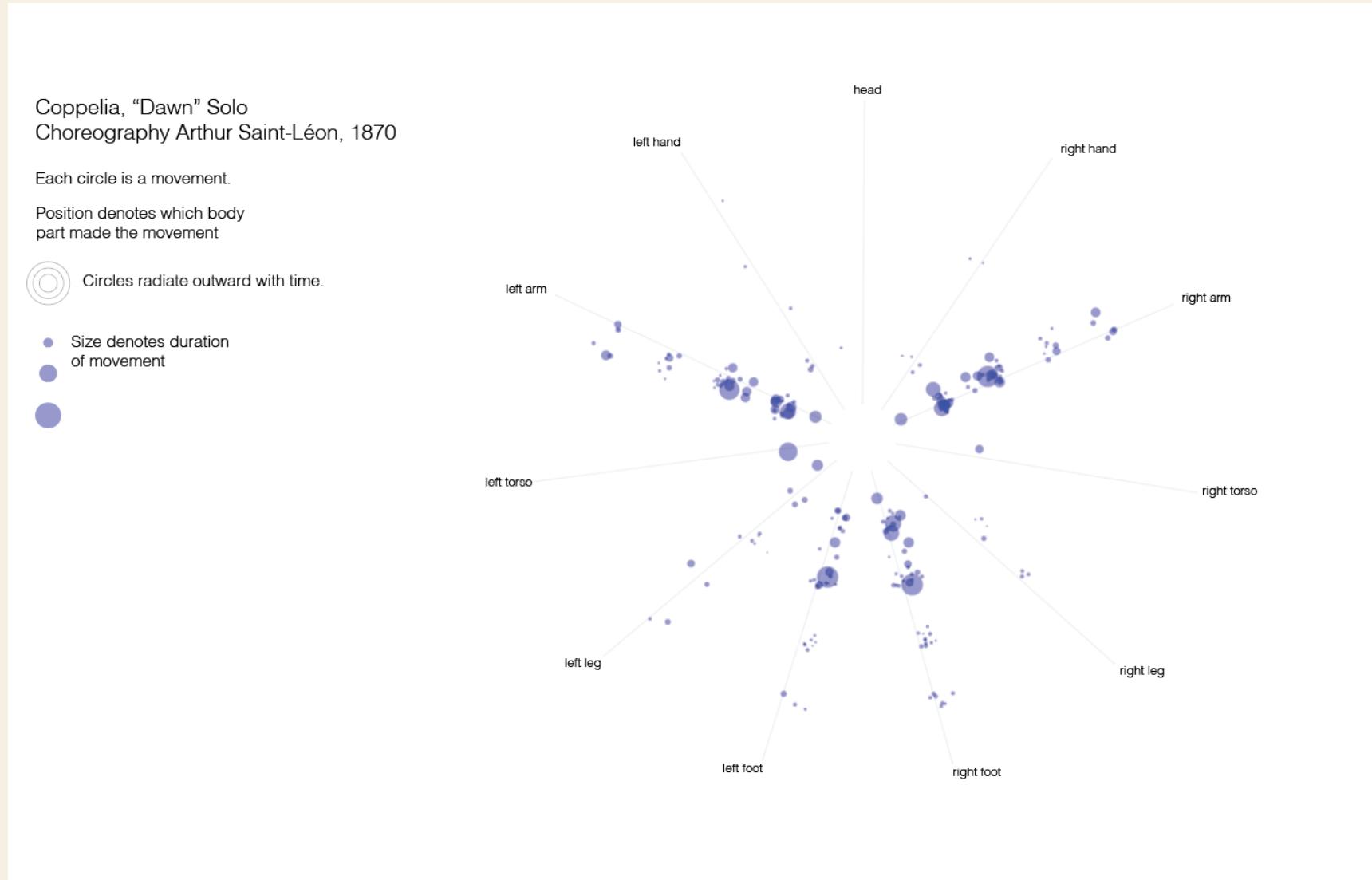


Initial visualizations

Second step: What about a radial layout where movements are shown radially outward in time?

I can distribute 11 spokes radially representing all the body parts used. Hoping this psuedo-anthropomorphic design would be intuitive.

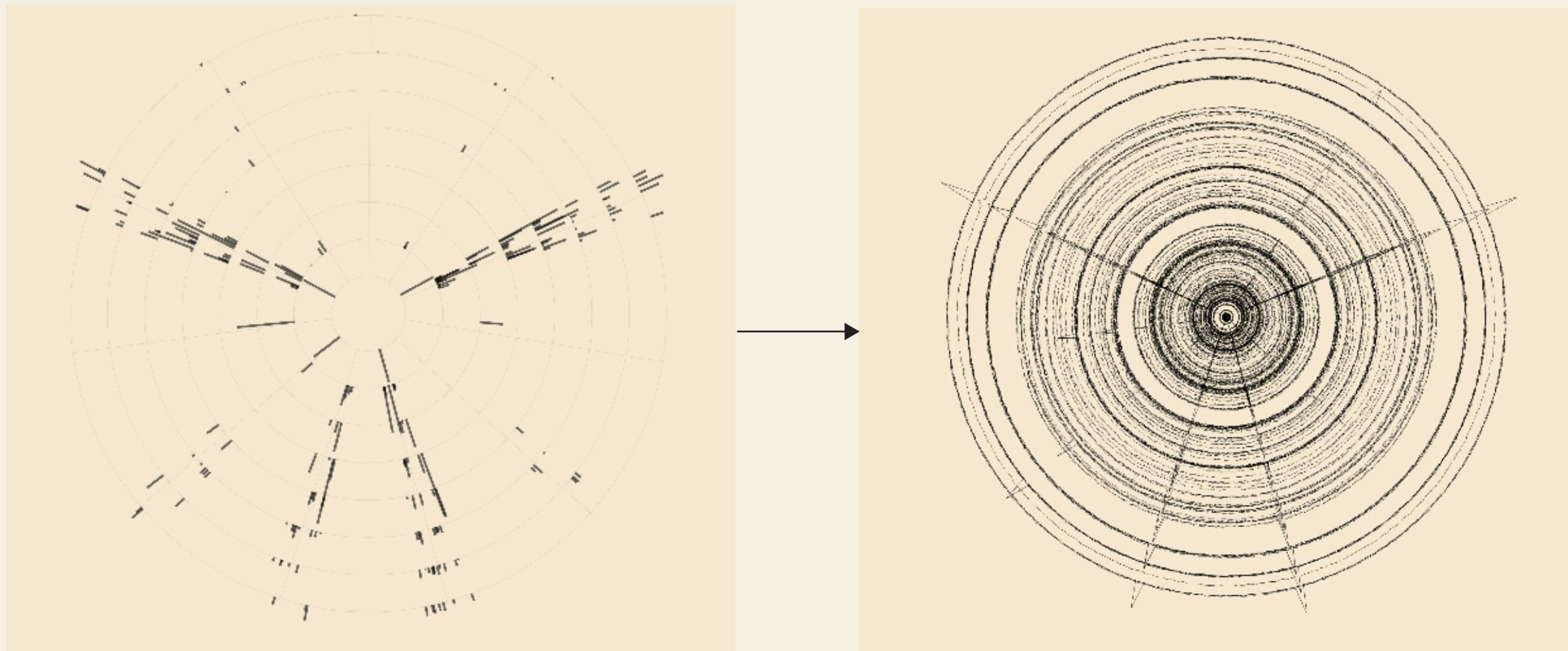
Problem: Although the radial form is promising, all dances are going to favor the arms and feet, therefore all dances will look similar. This does not achieve my goal of creating a visual signature for each dance.



Initial visualizations

Third step: Define an equation of a circle with peaks at the theta values of the body part spokes.

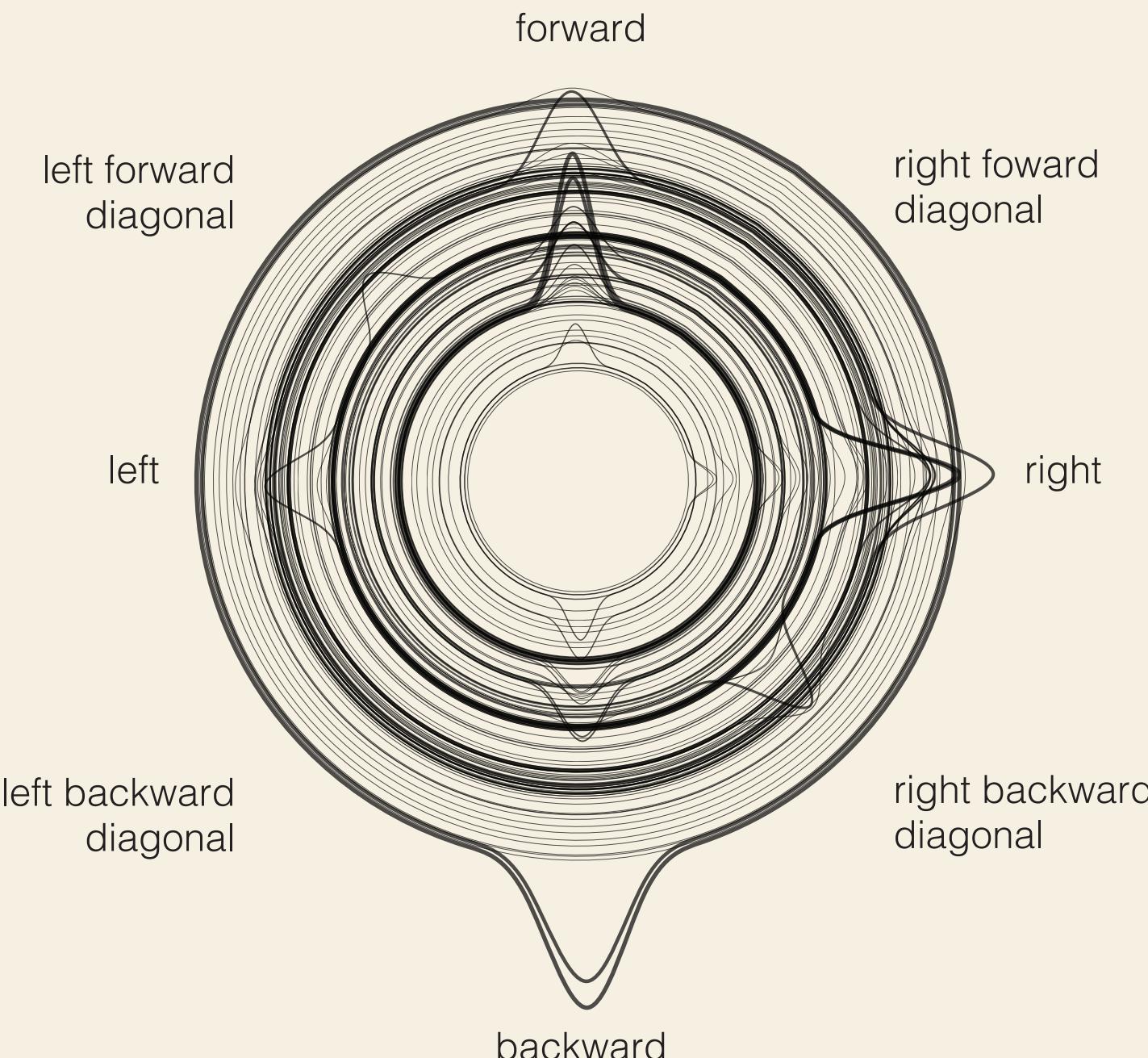
Problem: Though this is more visually pleasing, the anthropomorphic design is not working.
Only the feet and arms stand out.



Final visualization format - Eureka!

Final step: Change the angular spokes from body part to direction of the dancer's movement.

Problem: This solves the problem of how I was going to integrate the directional information of each movement. To show a certain body part's movements in the dance, I can simply isolate those radials from the others.



Benefits of the final visualization format

Conveys both directional and time data (length of spoke and thickness of radius correspond to movement length).

Temporal aspect of dance translates into visual rhythm of radii patterns.

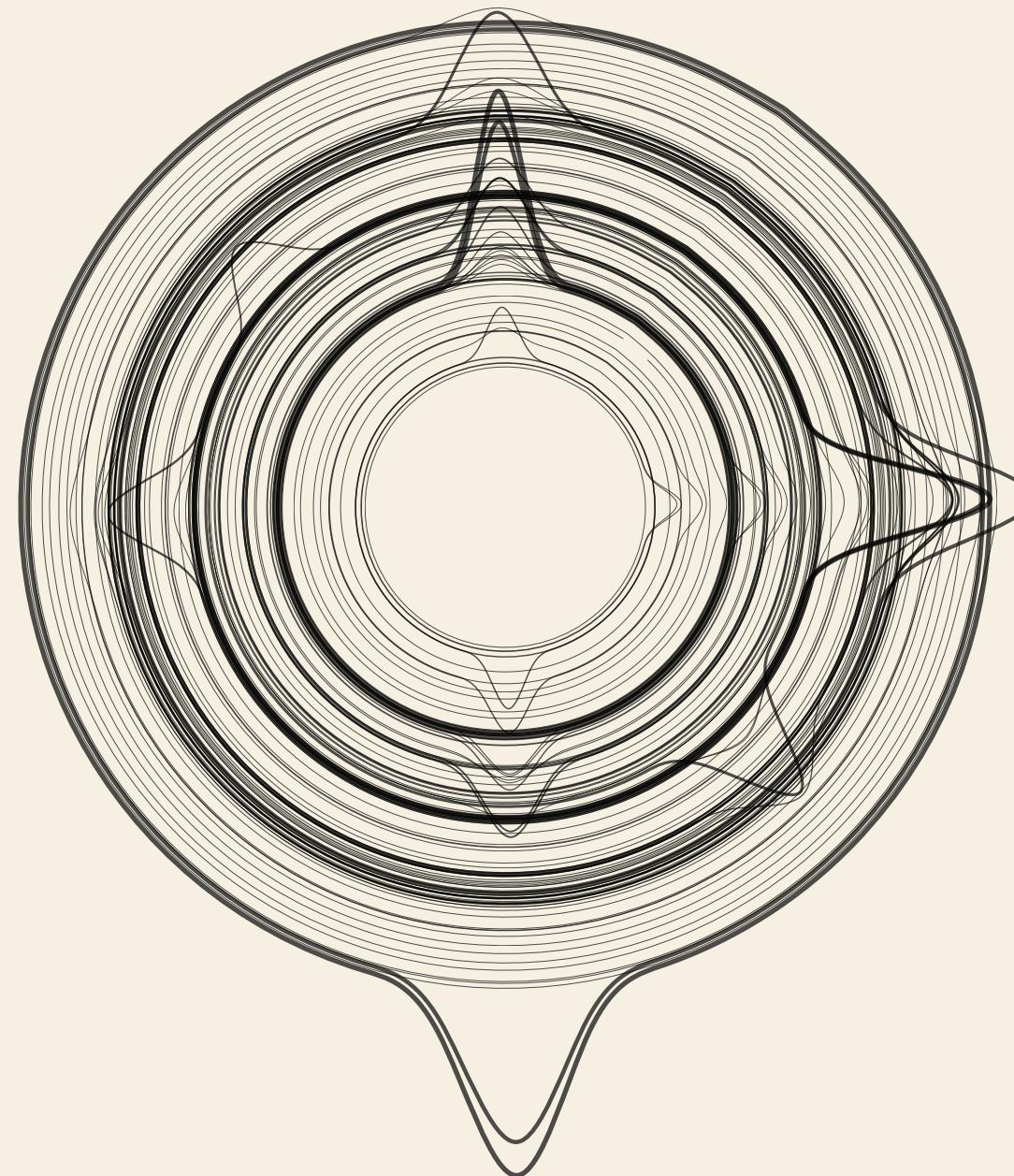
Overall corresponds to a unique signature of the dance piece by using the visual elements of:

Line width (duration of movement)

Height (duration of movement)

Angular position (direction of dancer's movement)

Radius (time)



Crafting the digital essay

Question: How should I partition these dance data so that a story emerges?

Possibilities: Time period, nationality of choreographer, or an aspect of the dance itself that emerged in analysis?

Throughout analysis, no clear trends emerged across nationality (due to historical global intermingling of choreographers).

No trends emerged from the analysis itself, probably because of my small sample size.

The most logical choice was to present the choreographic visualizations within formal partitions that already existed: historical periods of western dance.

The two that presented most visual contrast were the *Classical (1800s)* and *Contemporary (1950s onward)* periods.

What remained was to choose a sampling of dances from these periods and construct a narrative.

Crafting the digital essay

Question: What narrative flow would introduce the visuals understandably while presenting an enjoyable exploration into the era partition and each dance itself? How best to convey the impression of a dance?

1. Reading graphic guide to visualizations (priming)
2. Table of contents graphic
3. Era introduction
4. Animated visualization playback
5. Era overview
 Repeat 3-5 for second era
6. All dances overview
7. Colophon