

# Moving Through Math

Latin Ballroom Dancing through the  
Lens of Math

Lida Tetyusheva

# AGENDA

INSPIRATION

EXPLORATION

TAKEAWAYS

FRACTIONS

GRAPHING

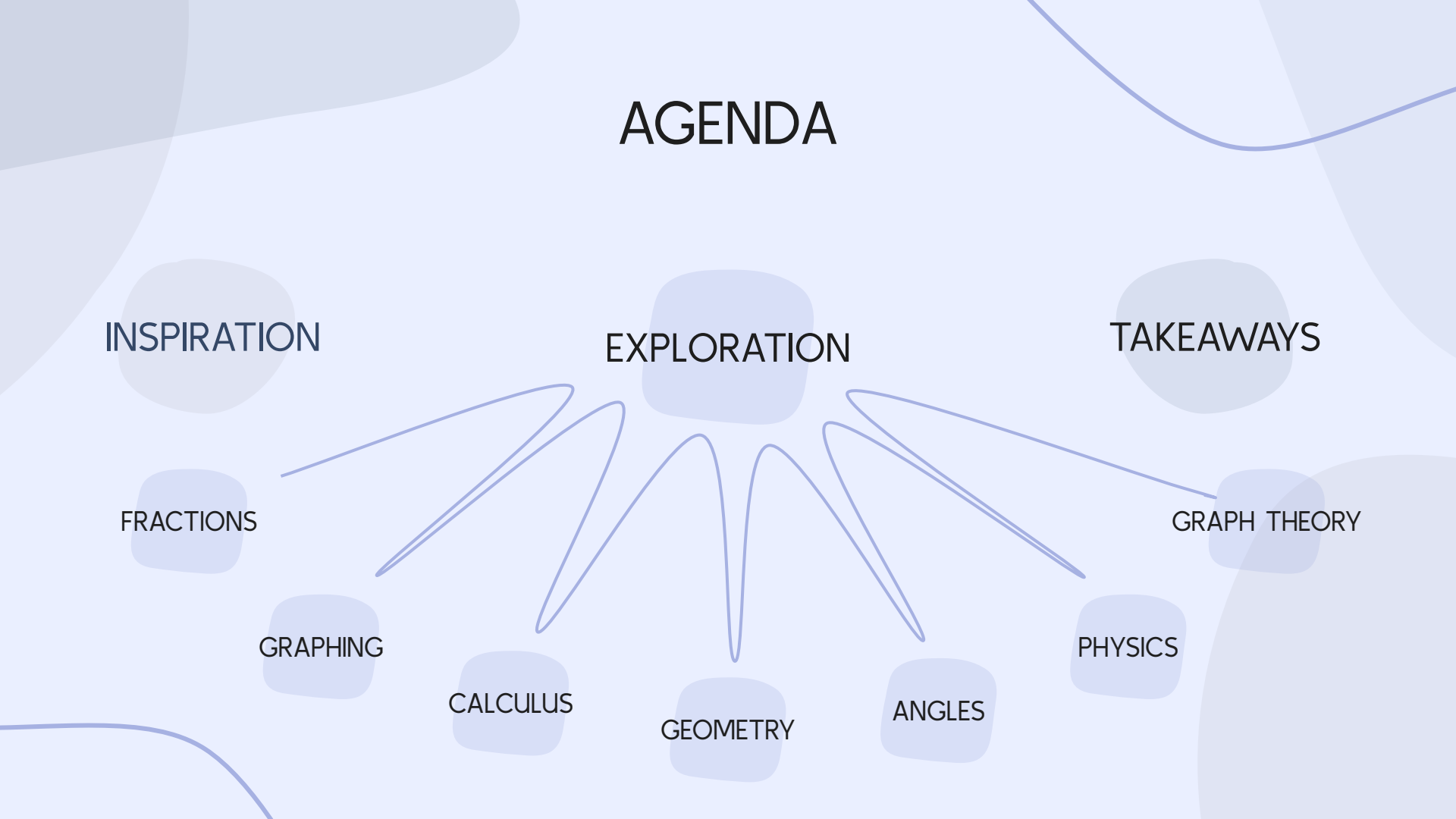
CALCULUS

GEOMETRY

ANGLES

PHYSICS

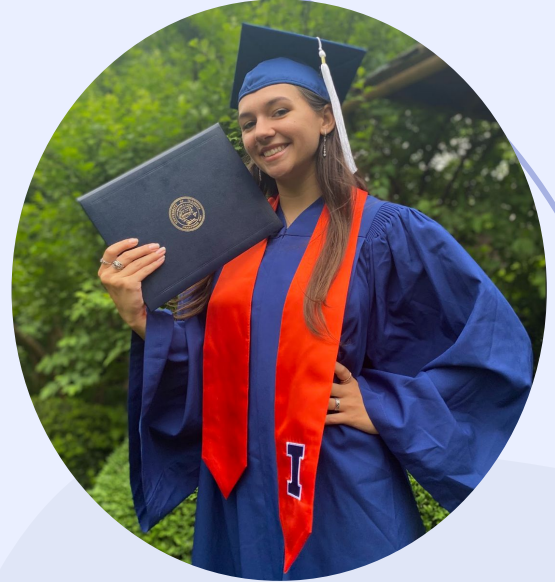
GRAPH THEORY



# ABOUT ME



- Dancing since I was 4
- Teaching for over 5 years



- Undergrad in Statistics
- Data Analyst at Viatrix
- MSDS Student

# INSPIRATION



**Math and Data are Involved in Everything!**

MSDS 400: Math for Data Modelers

← TEDTalk by Roger Antonsen: Math is the Hidden Secret to Understanding the World

**Math is the Science of Patterns and Patterns are an Integral Part of Dancing!**

# FRACTIONS

Tempo, Time Signature, Notes and Beats

# FRACTIONS

Tempo

$$\text{Tempo} = \frac{\# \text{ of Beats}}{\text{Minute}}$$

**Cha Cha:** 120–128 bpm

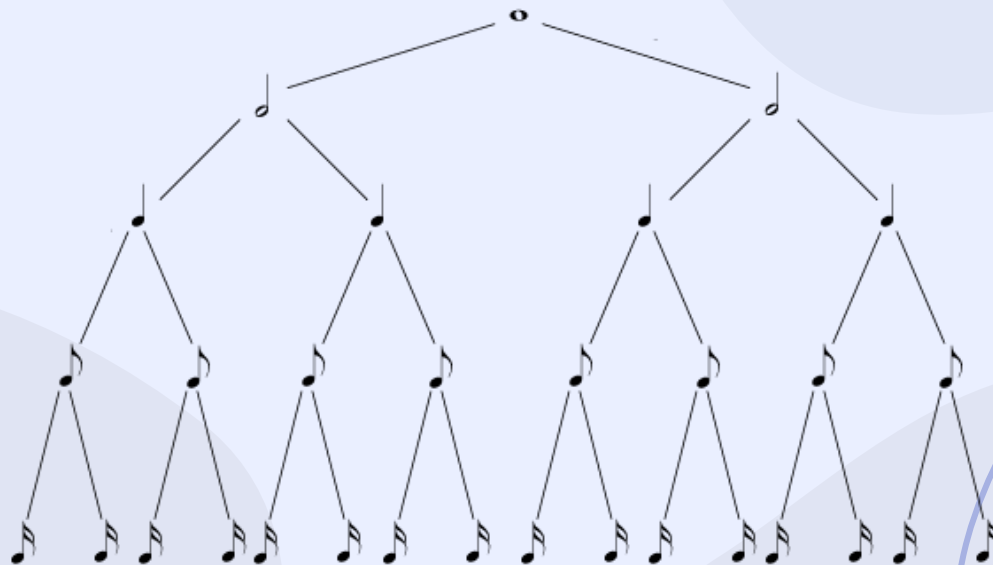
**Rumba:** 100–124 bpm

**Waltz:** 84–90 bpm

# FRACTIONS

Music Notes

Music Notes are Fractions!



# FRACTIONS

## Basic Steps

**Slow** = 2 beats

**Rumba:**

Slow Quick Quick =  $2 + 1 + 1 = 4$  beats

$\frac{1}{2} + \frac{1}{4} + \frac{1}{4} = 1$  measure

**Quick** = 1 beat

**Foxtrot:**

Slow Slow Quick Quick =  $2 + 2 + 1 + 1 = 6$  beats

$\frac{1}{2} + \frac{1}{2} + \frac{1}{4} + \frac{1}{4} = 1.5$  measures

# FRACTIONS

## Basic Steps

increase in step complexity = increase in fractions

### Basic Steps



Quick-Quick-Slow-Quick-Quick-Slow

### Higher Level Steps



Slow-Quick-Quick-and-Slow-Quick-Quick-  
k-Slow-Quick-and-Quick-and-Slow

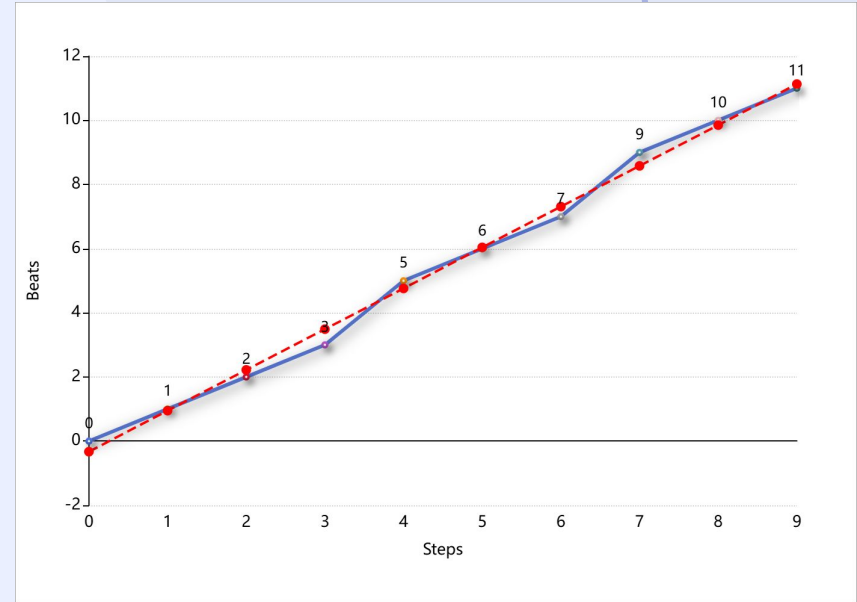
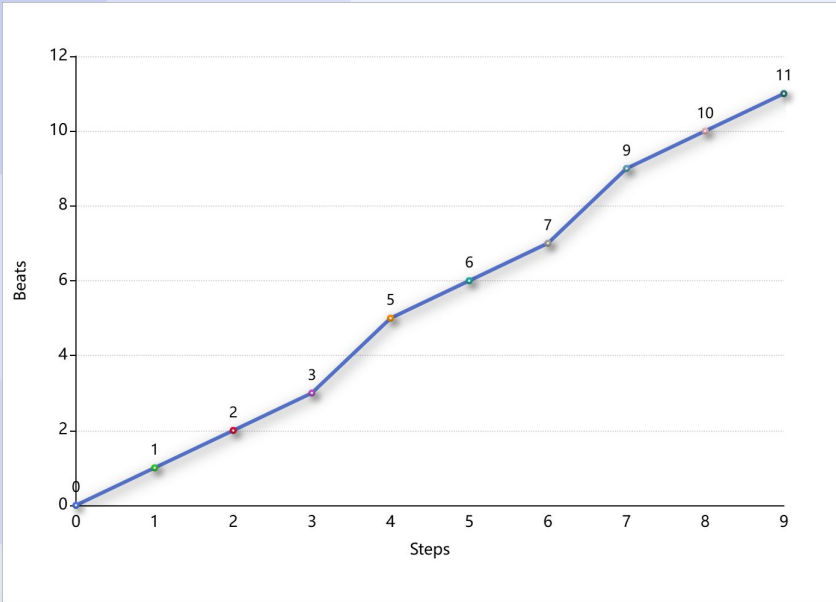
# GRAPHING

Beats in Basic Steps

# GRAPHING

## Time Taken in a Basic Step - Rumba

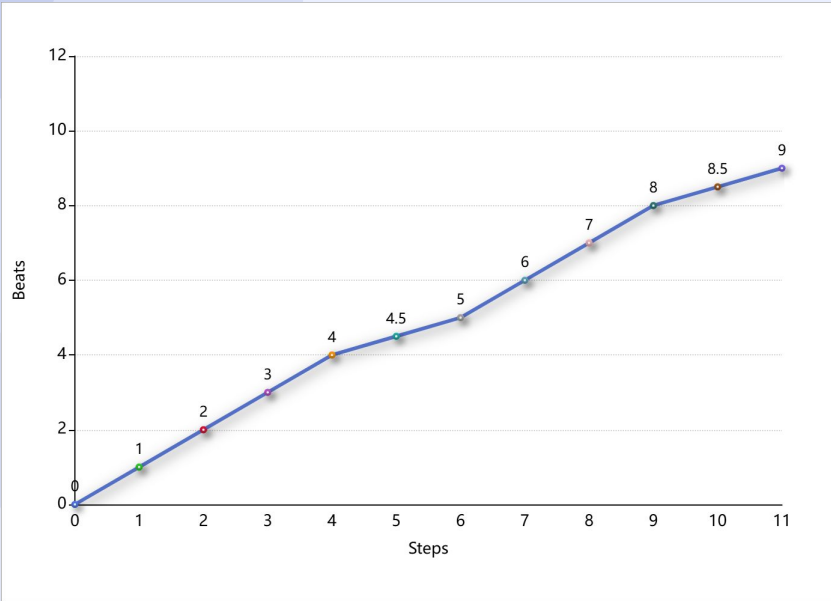
$(11 - 1)/(9 - 1) = 10/8 = 1.25$  beat average  
for rumba basic step



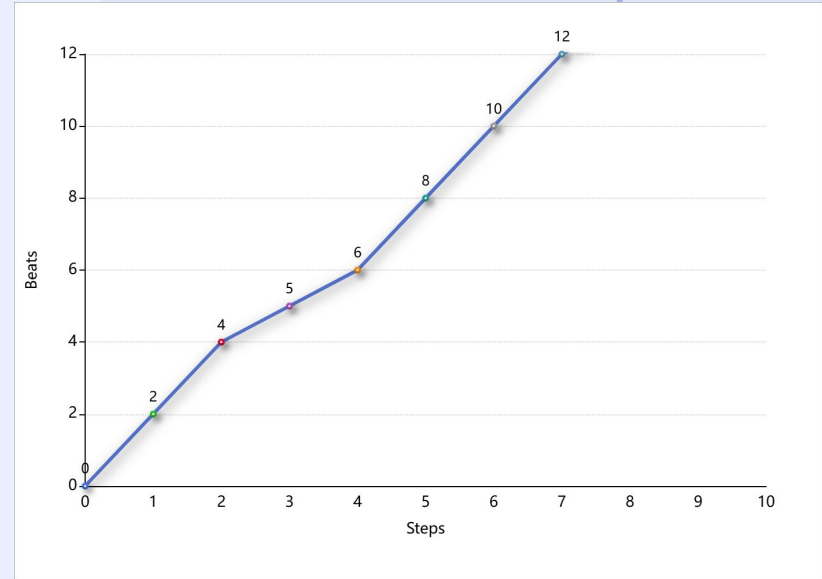
# GRAPHING

## Time Taken in a Basic Step - Cha Cha and Tango

$(9-1)/(11-1) = 4/5 = 0.8$  beat average for  
Cha Cha basic step



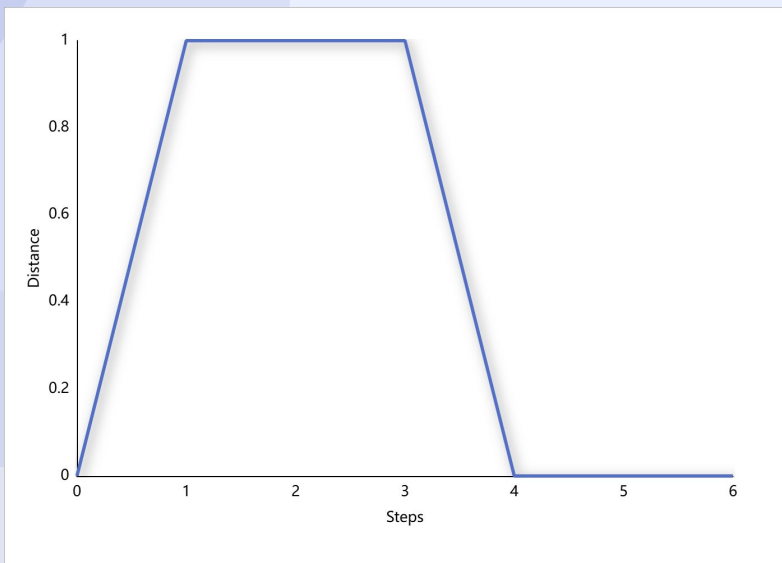
$(16-2)/(10-1) = 14/9 = \sim 1.56$  beat  
average for Tango basic step



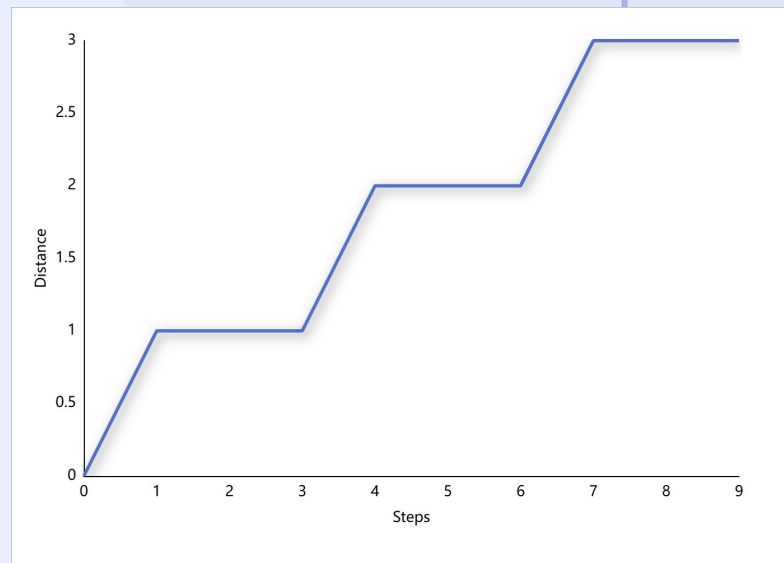
# GRAPHING

Distance from Starting Point

**Rumba Basic**



**Waltz Basic**



# CALCULUS

Derivatives

# CALCULUS

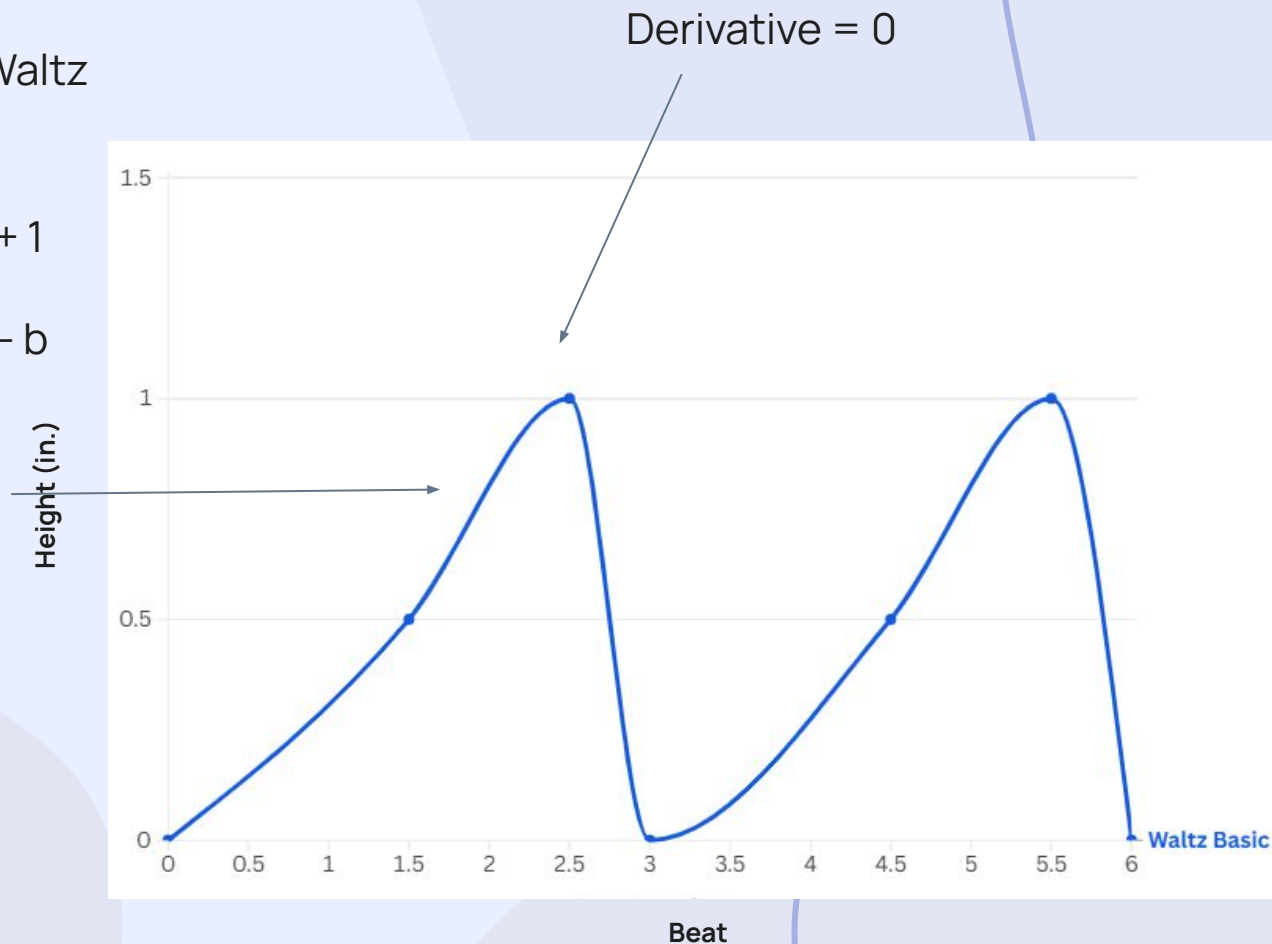
## Derivatives - Rise and Fall of Waltz

$$\text{Height} = -0.5(\text{Beats} - 2.5)^2 + 1$$

$$dh/db = -0.5 \cdot 2(b - 2.5) = 2.5 - b$$

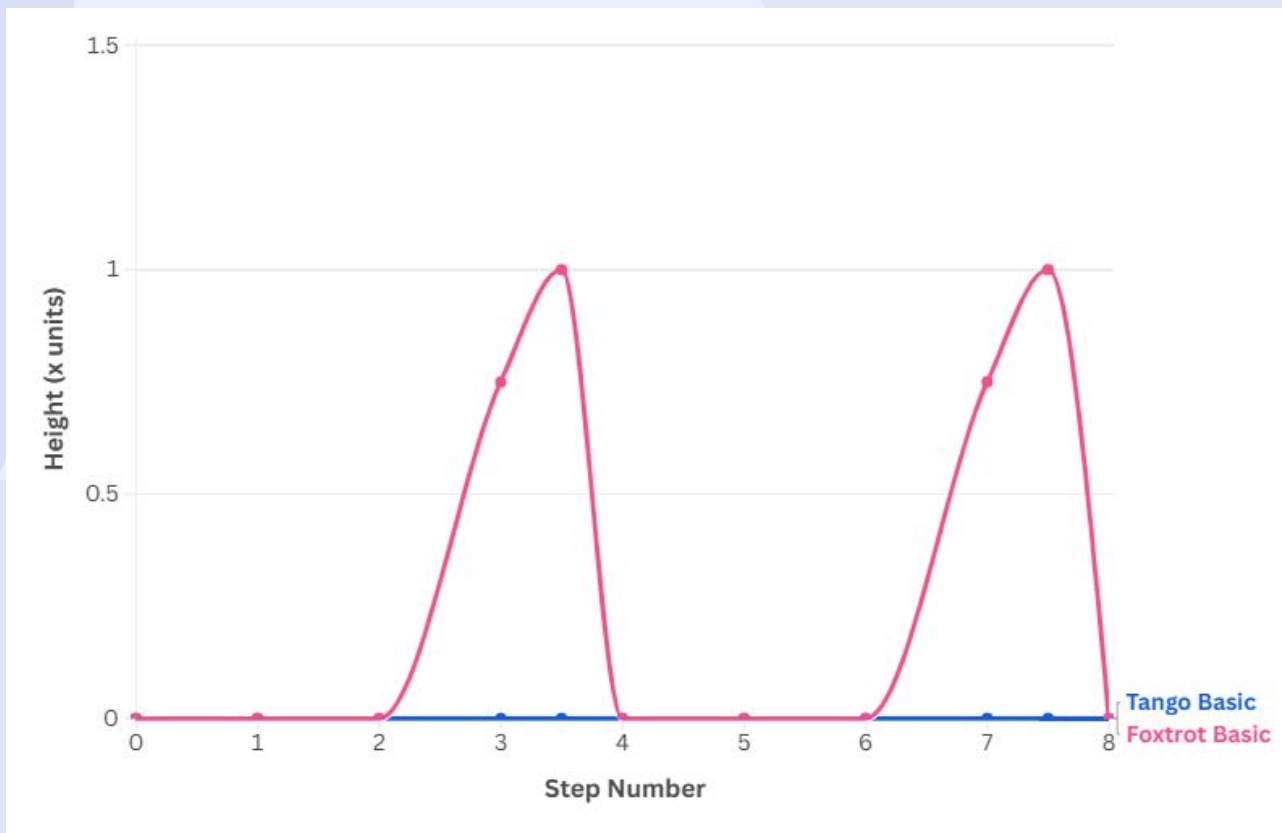
“The rate of change in height per beat at beat 2 is 0.5 inches per beat.

At beat 2 I should still be actively rising in my step.



# CALCULUS

## Derivatives - Rise and Fall of Tango and Foxtrot



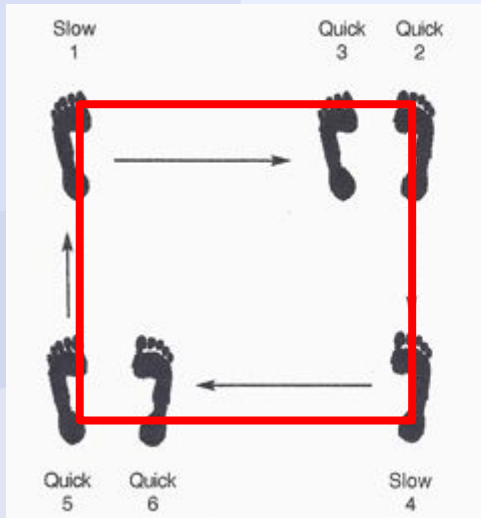
# GEOMETRY

Bird's Eye View Shapes

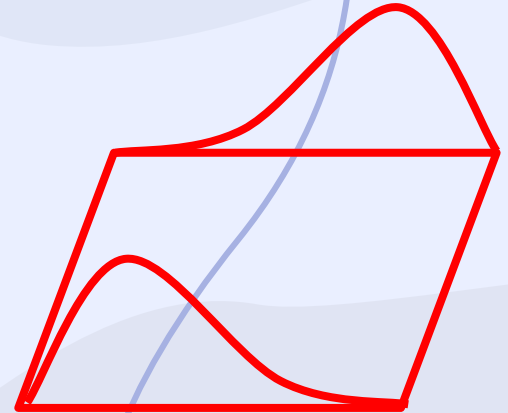
# GEOMETRY

## Bird's Eye View Shapes - Basic Steps

### Rumba



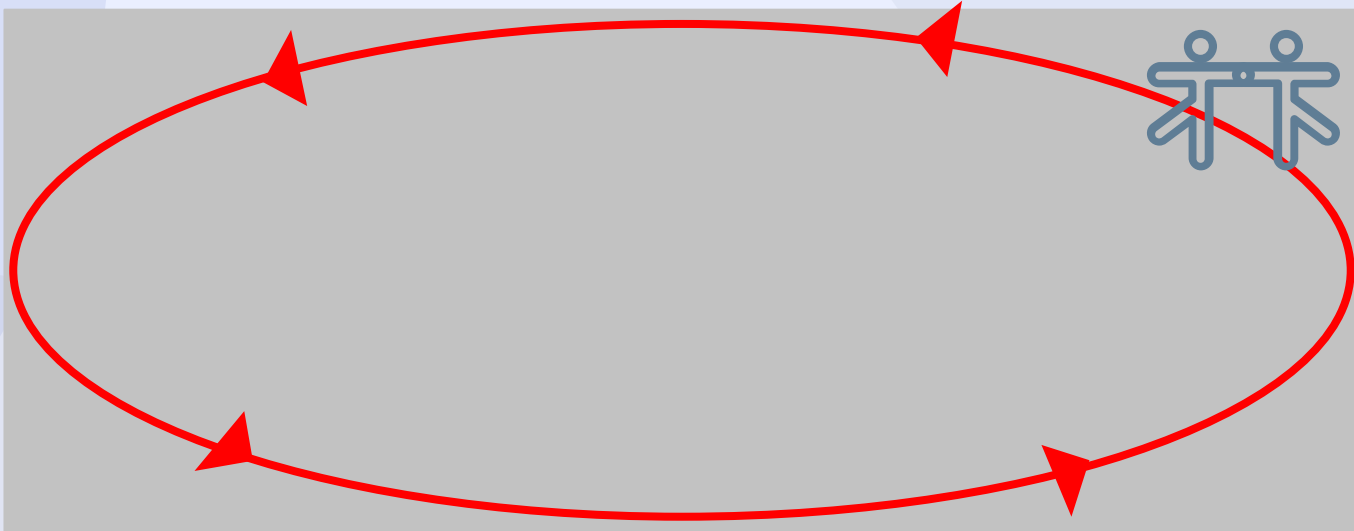
### Waltz



# GEOMETRY

Bird's Eye View Shapes - Flow Across the Floor

## Ballroom Choreography



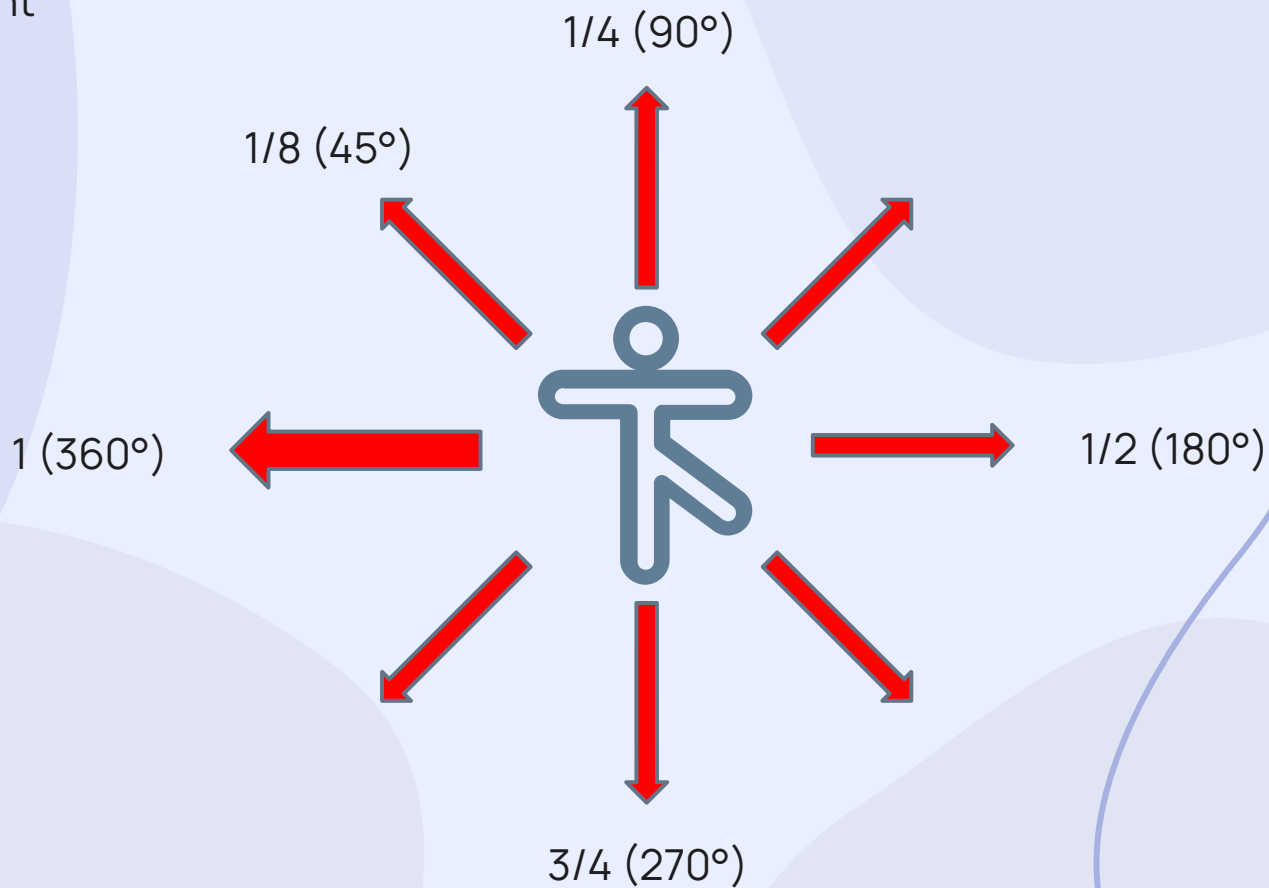
**Oriented Curve:** A line/curve with a specific and consistent direction of travel

# ANGLES

Pointing and Turnout, Floor Alignment, Dance Moves

# ANGLES

Floor Alignment



# ANGLES

Foot Placement

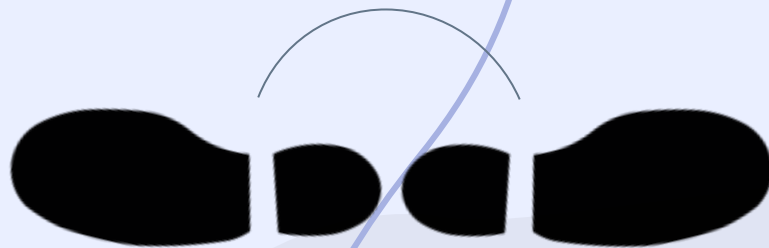
## Latin

30-45°



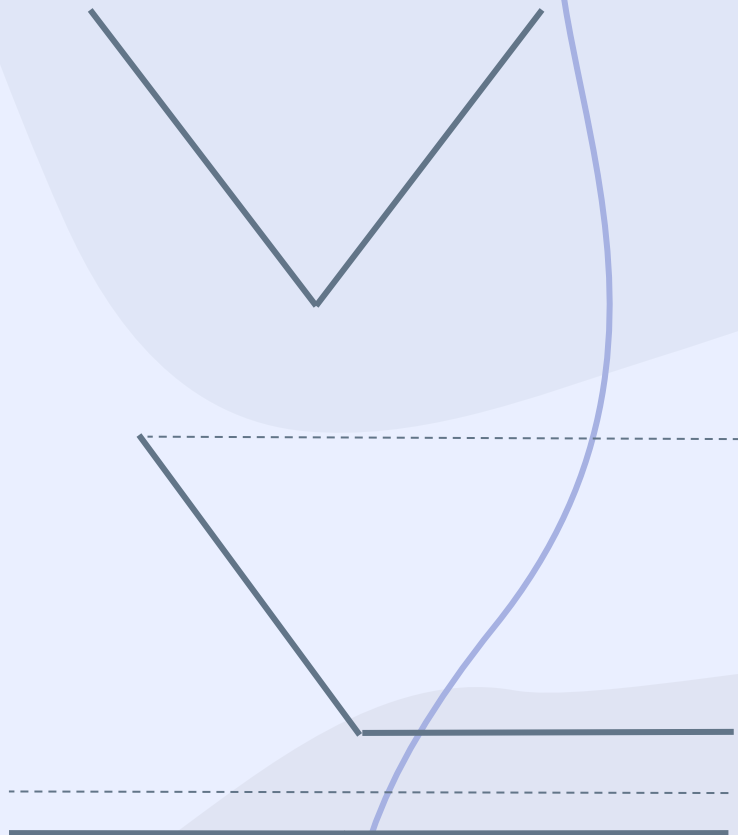
## Ballet

180°



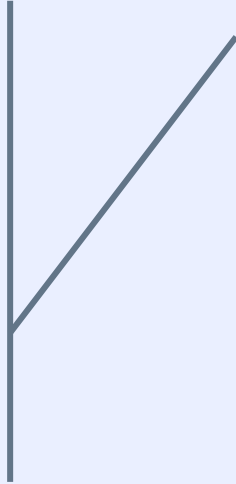
# ANGLES

Dance Moves



# ANGLES

## Dance Moves



# PHYSICS

Kinematic Study of World Champion Ballroom Dancers

# PHYSICS

## Kinematics Math of Waltz Spins

- Researchers measured **world champions vs national dancers** using motion sensors.
- Focus: **step length, pelvic speed, trunk rotation** during spin movements.

What did they find?

Champions ...

- Have **Longer steps** and **faster pelvic motion**.
- Lead with the pelvis and follow with the rib cage (to **build momentum**)
- Have larger trunk **rotation angles**.
- **Balance their velocities** for smoother spins.

# GRAPH THEORY

Creating a Graph Database for Choreography Generation

# GRAPH THEORY

Creating the Graph Database

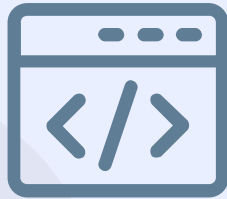


# GRAPH THEORY

Creating the Graph Database



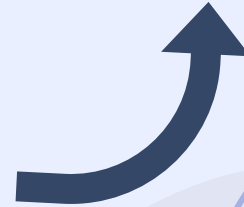
Outlined all of the Nodes and Relationships for Waltz Beginner Dance Steps



Converted to Cypher format



Input into Graph Database Software



# The Graph Model

**Directed Graph:**  
Each relationship/edge has a direction



# GRAPH THEORY

## Generating a Choreography

```
neo4j$ MATCH p = (s:Step {name:"Natural Turn"})-[:CAN_FOLLOW*4]->(t:Step) WITH p, ran
```



Table

RAW



choreography

```
1 ["Natural Turn", "Left Closed Change", "Right Closed Change", "Natural Turn", "Basic Weave"]
```

Started streaming 1 record after 4 ms and completed after 12 ms.

# TAKEAWAYS

Hobbies  Expertise  Fun

# PERSONAL TAKEAWAYS

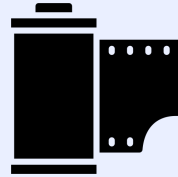
- Learned more about dancing **and** math
- Created a tool that I can enhance and use in the future
- Found new ways to teach concepts to my students
- Had fun!

# INNOVATIONS



## Velcro

Invented by an  
engineer on a hike  
with his dog



## Roll Film

Developed by a  
chemist who loved  
photography

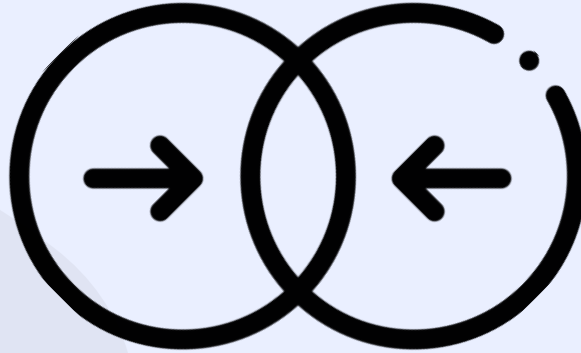


## Nylon Rope

Created by  
chemists for  
climbing tools

I CHALLENGE YOU!

Hobbies/Interests



Work/Expertise

# THANK YOU!

Questions?



Lida Tetyusheva