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December 16th

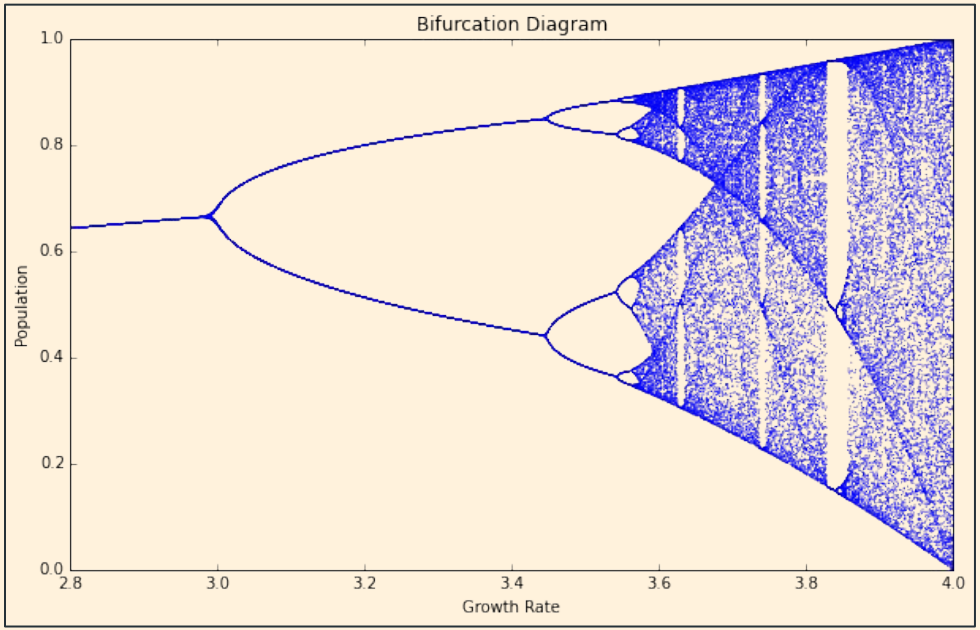
Hyper-Dynamics

Orbit Analysis & Cycle Structures in 4-Dimensional Permutation Groups.

Overview

Introduction Theory MEthodology Results Conclusion

1D & 2D SYSTEMS



In class, we explored systems like the logistic map x_{n+1} = rx_n(1-x_n) and the tent map.

- Systems evolve over time steps.
- Behavior ranges from fixed points to chaos.
- Orbits define the trajectory of a state.

A brief Introduction to Rubik’s Cubes

- A Rubik’s cube is a 3D combination puzzle, typically a 3x3x3 cube, where each of the six faces is covered by nine stickers in one of six solid colors. The goal is to take a scrambled cube and return it to a solved state.

History:

- Invented in 1974 by Hungarian professor of architecture and sculptor Erno Rubik. He originally created it as a teaching tool to help his students understand three-dimensional movement and the independence of parts connected by a shared mechanism.
- It was launched as a toy and has become the most popular toy in existence

- To a mathematician, the Rubik's Cube is a visual representation of a non-abelian group with 4.3 quintillion Discrete Dynamical System: The "state" is the permutation of 26 cubies; the "rules" are the face rotations.
  The "Solved" State: This is the identity element of the group (e). Solving the puzzle is simply finding a path through the state space back to e.
  Relevance: We use the standard 3D cube as our "control group" to measure baseline cycle lengths before testing the exponential growth in 4D

The Rubik’s Cube as a Dynamical System

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Distcrete Dynamical Systems

Permutation Groups are Discrete

Company Name

State Space:

In state space, the space is a finite set of states wherh the function is a permutation of the cube.

The Tesseract

Entering the 4th Dimension:

Tesseract is the 4D analogue of a cube. Just as a cube is bounded by 6 square faces, a tesseract is bounded by 8 cubic "cells".In our project, we explore the dynamics of a puzzle built on this 4D geometry.

Key capabilities

1

Feature 1

Explain what your product does. Give your audience an overview of the main features or capabilities.

2

Feature 2

Mention another feature. Think about what your audience might find uniquely interesting about your product.

3

Feature 3

Mention another feature. Explain how it helps users. What concrete, everyday benefit does it provide?

4

Feature 4

You can list everything your product does. But you might want to focus on what is newest, most impressive, etc.

5

Feature 5

Add as many features or capabilities as you want. You can duplicate this slide if you need more space.

Research Goal:

To Analyze how adding a spatial dimension changes the cycle length (recurrence time) of the system.

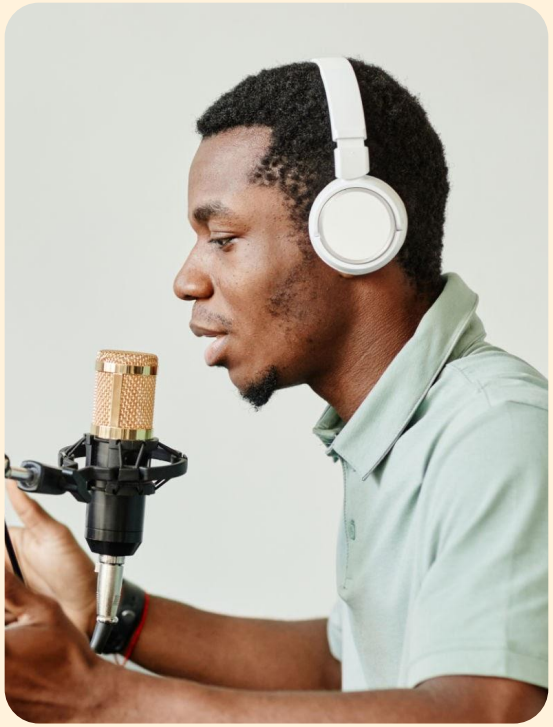
Comparing Rotations in different dimensions

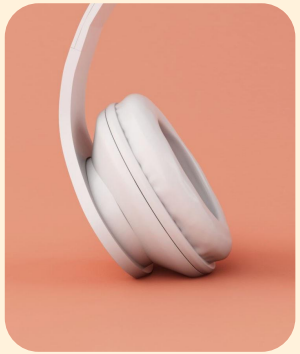
3D rotation

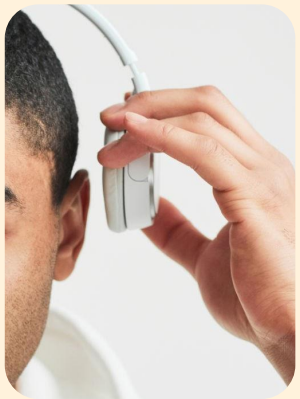
4d rotation

Stereographic Projection

Since we cannot see in 4 Dimensions, we project it into 3 dimension.







Dynamical Orbits

Understanding cycles in discrete sysetms

Defining an orbit

- State
- Function
- Orbit
- periodicity

Cycle length an period

- Period in context of rubiks cubes
- f^k(xo)=(xo)
- K is the period

00

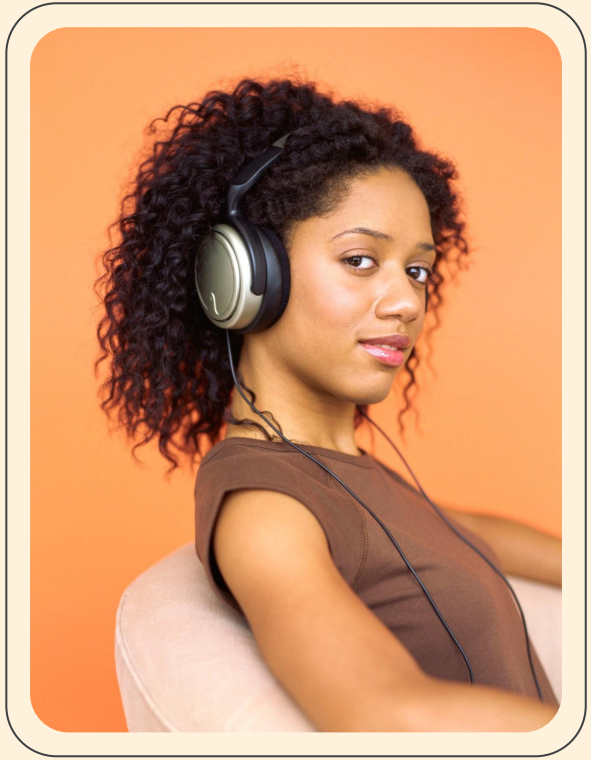
Metric description

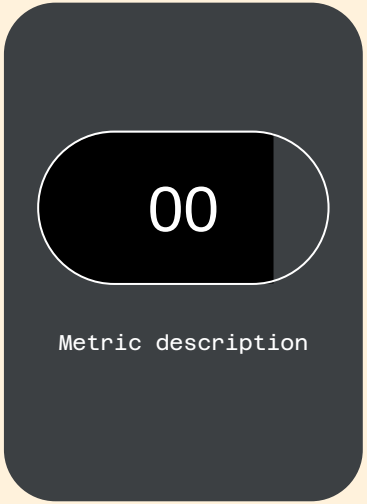
00

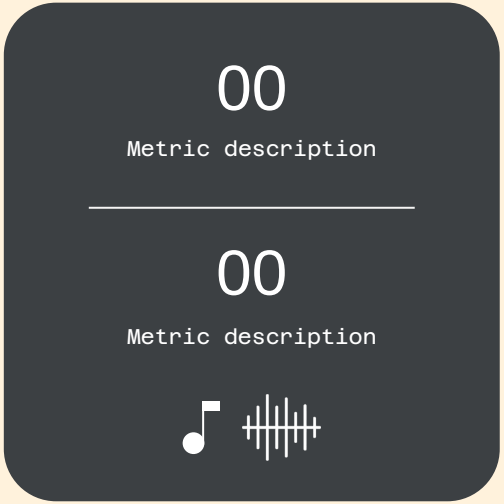
Metric description

00

Metric description







Group theory

Commutators vs ergodicity

Affecting few pieces vs many

Hyperspeedcube

Application

Point to an aspect of this feature in the photo, then describe it here.

Simulation of a 4d cube

Point to an aspect of this feature in the photo, then describe it here.

Detail 3

Point to an aspect of this feature in the photo, then describe it here.

Our experiment

`variable`

Spatial dimenesion

`Iterator a`

`Iterator b`

`metric`

Cycle dimension

Tracking the state

Tracking using the logs on hyper speed cube

Checking the identity

Cycle detection algorithm

Set state to solved
Apply move sequence
- Using macros in a python script

Check state
- In the logs

Record
- The cycles length

Neural Network solving the cube

Training a nn on 4d states

Describe a hypothetical product user. This can be an individual persona or broad audience segment. Mention their interests, needs, and pain points. You can also add biographical information, such as their age range, profession, education, and skills.

Audience 2

Describe a hypothetical product user. This can be an individual persona or broad audience segment. Mention their interests, needs, and pain points. You can also add biographical information, such as their age range, profession, education, and skills.

Results and Simulation

Sequence: R U

2x2 cube

Describe a hypothetical user or audience segment. Mention their interests, needs, and pain points. You can also add their age range, profession, education, and skills.

3x3 cube

Describe a hypothetical user or audience segment. Mention their interests, needs, and pain points. You can also add their age range, profession, education, and skills.

3x3x3x3

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Describe a hypothetical user or audience segment. Mention their interests, needs, and pain points. You can also add their age range, profession, education, and skills.

Chart illustrating k

Name, Age

Location

Education

Interests

Job

Analyze a user behavior. For example, you might describe where they discover products and how frequently they shop.

Continue your analysis. Think about how users interact with brands. What touchpoints or platforms do they engage with?

“Quote this hypothetical user on their everyday needs, motivations, and pain points. You can also share a reaction to your product or solution.”

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Phase space visualization/orbit graphs

	YOUR PRODUCT	COMPETITOR	COMPETITOR
FEATURE OR BENEFIT	Min/Max	Min/Max	Min/Max
FEATURE OR BENEFIT	-	-	✓
FEATURE OR BENEFIT	✓	-	✓
FEATURE OR BENEFIT	-	✓	✓
FEATURE OR BENEFIT	✓	-	✓

Conclusion:

1

Spatial dimensions increase complexity

Wrap up the demo with your final thoughts on the product. You can restate the value proposition or remind your audience about key features.

2

Chaos

In writing these takeaways, answer the question, “Why would someone buy this product?” This is what your audience will remember about the demo.

3

Takeaway 3

Think about your target audience and what they would find compelling about your product. Go beyond specific features and consider high-level benefits.

4

Takeaway 4

Add as many takeaways as you need. Duplicate this slide if necessary, and make your last takeaway the most compelling.

Questions?
Please reach out to
name@example.com

Thank you!

For the images

sources

The end

Any questions