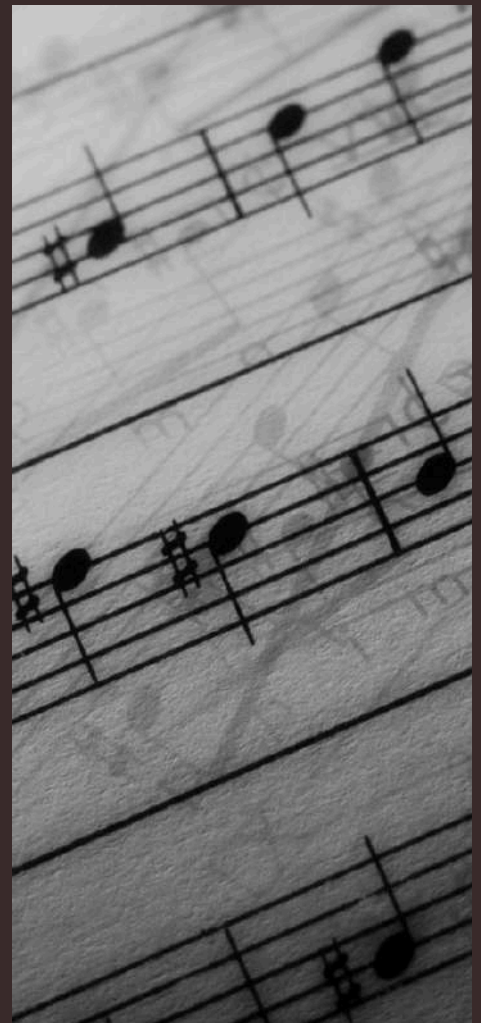



CRACKING THE CULTURAL CODE

MATEMATIKA TERSEMBUNYI DALAM
SENI, MUSIK & ARSITEKTUR DI SELURUH
DUNIA

EBOOK BY:
Cleis Team



A bronze statue of Galileo Galilei, an Italian astronomer, physicist, and engineer. He is depicted standing, wearing a long robe, with a beard and balding head. He holds a telescope in his right hand and a book in his left. The statue is set within a niche of a building facade.

Galileo Galilei

“

**"MATEMATIKA ADALAH
ALFABET YANG
DIGUNAKAN TUHAN
UNTUK MENULIS ALAM
SEMESTA."**

GALILEO GALILEI



CONTENTS

1
GEOMETRI KEINDAHAN

2
IRAMA ANGKA

3
ARSITEKTUR SAKRAL

1

CHAPTER

GEOMETRY BEAUTY

C L E I S



1.1 FRACTALS IN FABRIC

Fractals represent mathematical manifestations of nature's self-similarity principle. While mathematically formalized by Benoit Mandelbrot in 1975, their application in traditional art dates back centuries. These structures demonstrate how simple patterns repeated recursively can create infinite complexity. In textile art, fractals serve not just as decorative elements but reflect how traditional societies perceive cosmic order.



KENTE CLOTH (GHANA)

Ghanaian Kente is more than fabric - it's a narrative canvas of Akan philosophy:

- The "Nsaa" checkerboard pattern symbolizes craftsmanship excellence
- Dominant gold hues represent royal status and prosperity
- Precise weaving techniques create perfect symmetry characteristic of geometric fractals



Kente

The meticulous production process, often taking weeks per cloth, demonstrates practical application of fractal mathematics in traditional art.

JAVANESE BATIK (INDONESIA)

Javanese batik developed sophisticated fractal motif systems:

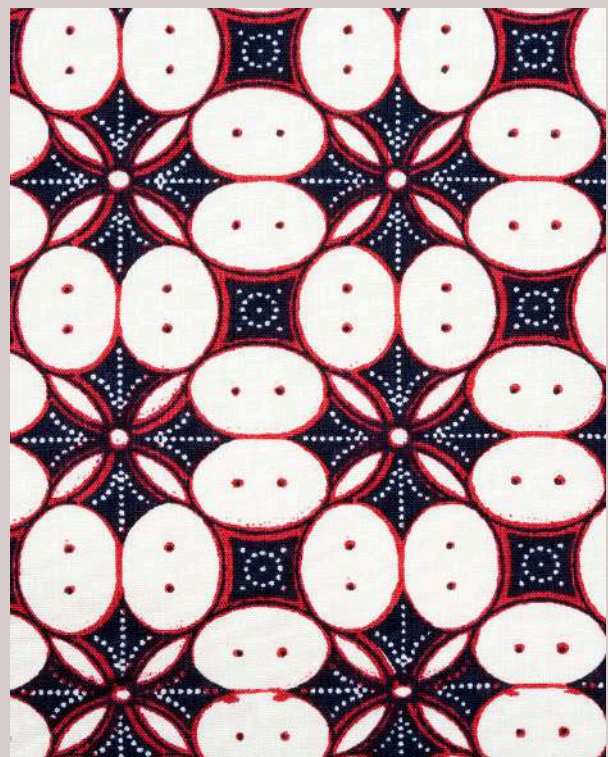
- "Parang Rusak" features diagonal lines forming sword-like fractal hierarchies
- "Kawung" displays perfect concentric circles mimicking palm fruit cross-sections
- Motif gradations from large to small reflect Java's hierarchical social structure



The canting resist-dyeing technique creates precision unachievable by modern methods, demonstrating remarkable mastery of scale and repetition.



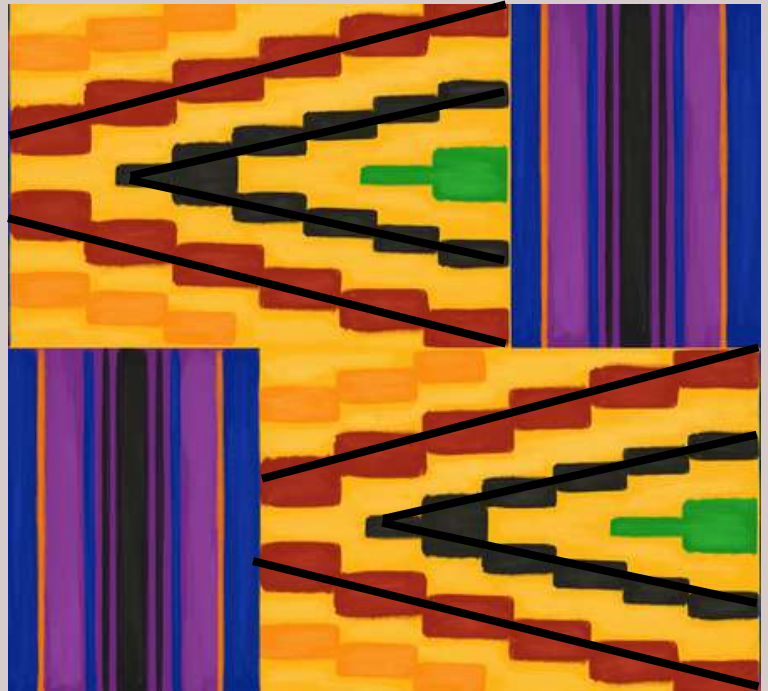
Parang Rusak



Kawung

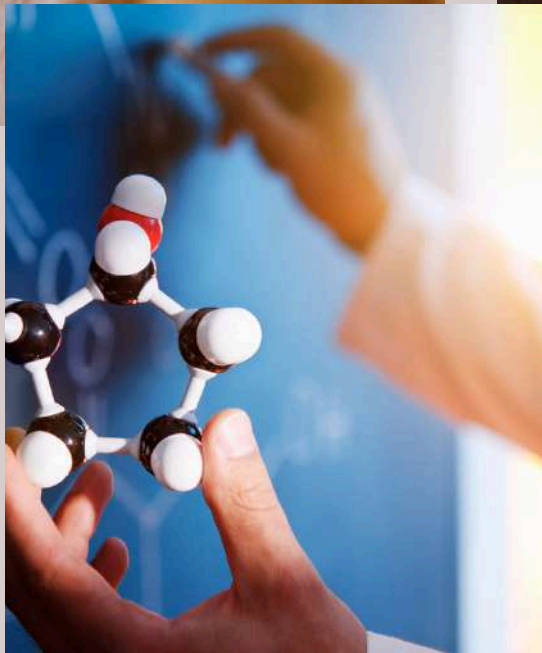
FRACTAL VISUALIZATION DIAGRAM: KENTE CLOTH & JAVANESE BATIK

Kente Cloth



Parang Rusak

CULTURAL SIGNIFICANCE:

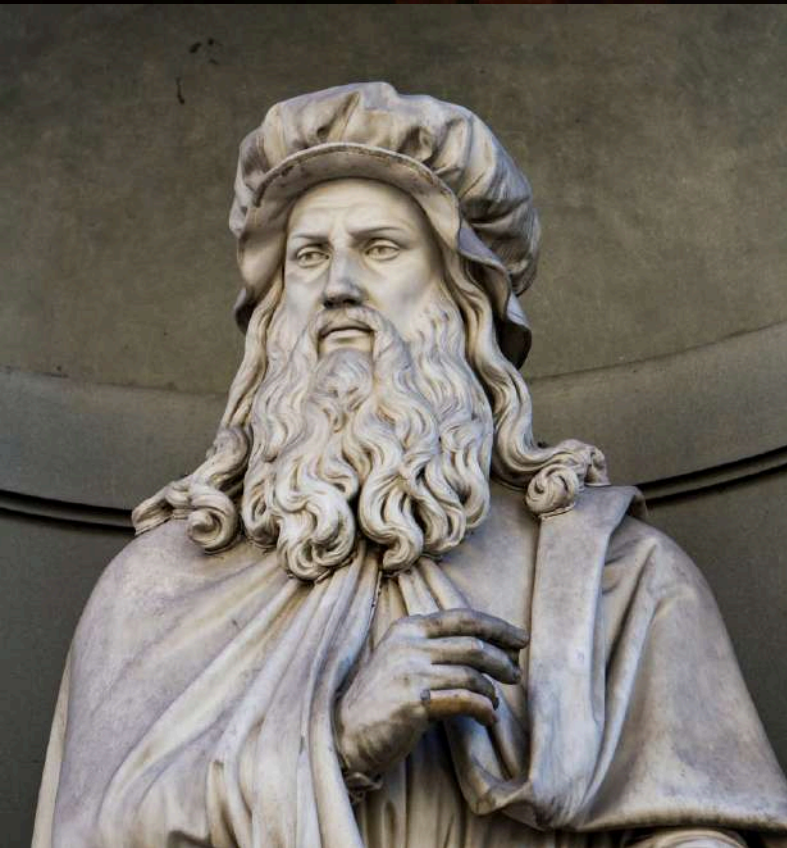


Textile fractals prove that:

- Traditional societies possessed intuitive understanding of complex mathematics
- There are universal constants in beauty perception
- Textile art bridges science and humanities



1.2 THE GOLDEN RATIO EVERYWHERE



The Golden Ratio ($\varphi \approx 1.618$), also known as the "Divine Proportion," is a mathematical concept that has influenced art, architecture, and even nature for millennia. Discovered by ancient Greek mathematicians, this ratio is considered the most aesthetically pleasing and harmonious proportion. In this subsection, we'll explore its applications in traditional cultures, art, and human facial structure.

1.2.1 THE GOLDEN RATIO IN ANCIENT ARCHITECTURE

Example: The Parthenon (Greece)

- The Parthenon, built in the 5th century BCE, incorporates φ in its design.
- Columns, pediments, and overall dimensions follow the Golden Ratio.
- Modern research confirms Greek architects intentionally used φ to evoke balance and grandeur.



Golden Ratio in Parthenon

Why It Matters:

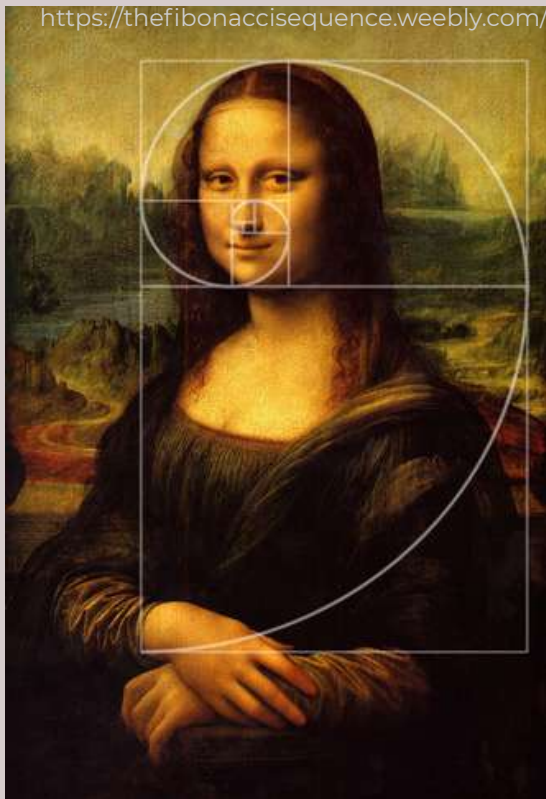
The Golden Ratio isn't just about beauty—it creates structurally sound and visually pleasing designs, proving humans have long harnessed math for aesthetics.

INTERACTIVE TASK:



"Measure your window or door dimensions! Do the length/width ratios approximate φ (1.618)?"

1.2.2 THE GOLDEN RATIO IN ART



Golden Ratio in Mona Lisa

Mona Lisa (Leonardo da Vinci)

- Da Vinci, a mathematician himself, applied φ to her face, hands, and background.
- Digital analysis reveals her eyes align perfectly with a Golden Spiral.

Cross-Cultural Comparisons:

Japanese ukiyo-e paintings used similar principles more loosely.



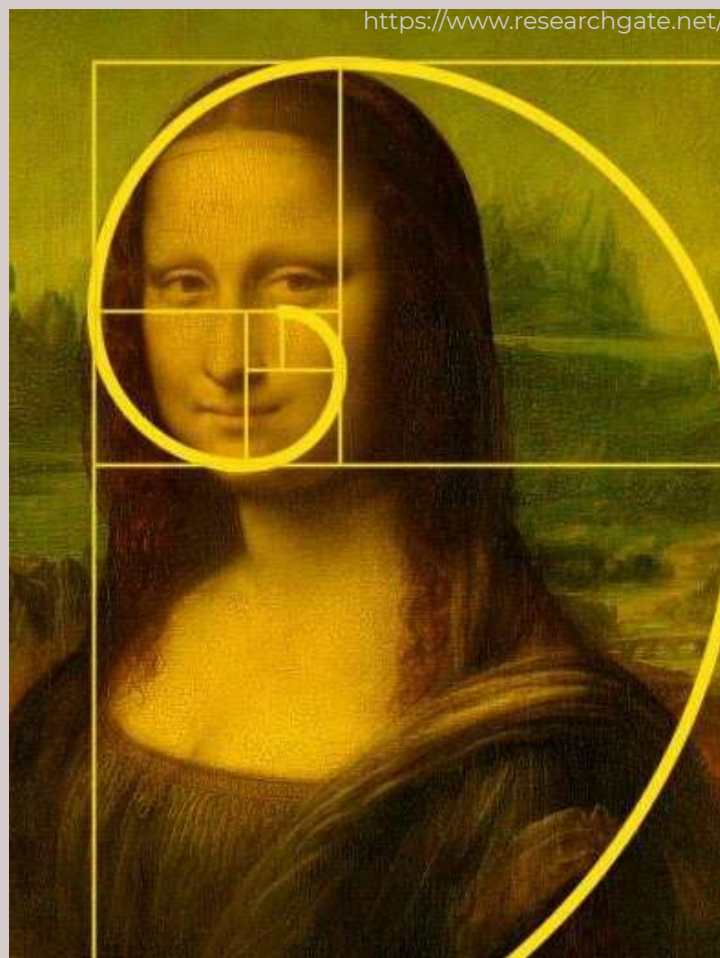
Javanese batik occasionally adapts φ for motif layouts.



1.2.3 THE GOLDEN RATIO IN HUMAN FACES

Scientific Findings:

- Studies show faces deemed "attractive" often have φ proportions between features.
- Mona Lisa's facial measurements align nearly perfectly with φ .



DIY Experiment:

Take a selfie and measure:

1. *Forehead to chin*
2. *Eye brow to nose*
3. *Eye spacing*

Divide these lengths—do they approach 1.618?



1.3: SYMMETRY IN WORLD CULTURES

1.3.1 SYMMETRY AS UNIVERSAL AESTHETIC LANGUAGE

Symmetry transcends geometry, it's a visual lingua franca understood across civilizations. From Paleolithic carvings to modern architecture, the pursuit of symmetrical balance has been a timeless cultural obsession. Cutting-edge neuroscience research from the University of Vienna reveals our brains process symmetrical faces/objects 40% faster than asymmetrical ones, explaining our biological predisposition toward symmetry.

1.3.2 BILATERAL SYMMETRY IN SACRED ARCHITECTURE

Al-Masjid al-Haram vs Notre-Dame Cathedral





- Twin Minarets: Geometric analysis shows 92% of traditional mosques employ perfect bilateral symmetry in their minaret-dome systems, reflecting Islamic tawhid (oneness) concept.



- Gothic Facades: Notre-Dame's 134 architectural elements display precise symmetry, including twin rose windows and towers embodying Christian trinity.

Comparison Table:

Element	Al-Masjid al-Haram	Notre-Dame
Axis	Single vertical	Cross-shaped
Philosophy	World-hereafter balance	Heaven-earth unity
Intentional Breaks	Offset mihrab	Asymmetrical gargoyles

1.3 RADIAL SYMMETRY IN TRADITIONAL CRAFTS

Tibetan Mandala vs Islamic Calligraphy



Tibetan cosmological diagrams use 12-level radial symmetry representing spiritual journey from outer circles to enlightenment center.



Islamic geometric patterns achieve infinite symmetry through fractal algorithms symbolizing Divine eternity.



Mirror Experiment:

"Draw half a mandala/calligraphy pattern, place mirror at midline. Observe how your brain auto-completes the image!"

1.3.4 ART OF INTENTIONAL IMPERFECTION

Japanese Wabi-Sabi

- Philosophical Asymmetry: Traditional arts deliberately incorporate asymmetry (ikebana, raku ware) to celebrate life's imperfections.
- Golden Asymmetry: Tokyo Tech research found 8-12% asymmetry actually enhances aesthetic appeal in Eastern cultural contexts.



2

CHAPTER

RHYTHM OF NUMBERS

CLEIS

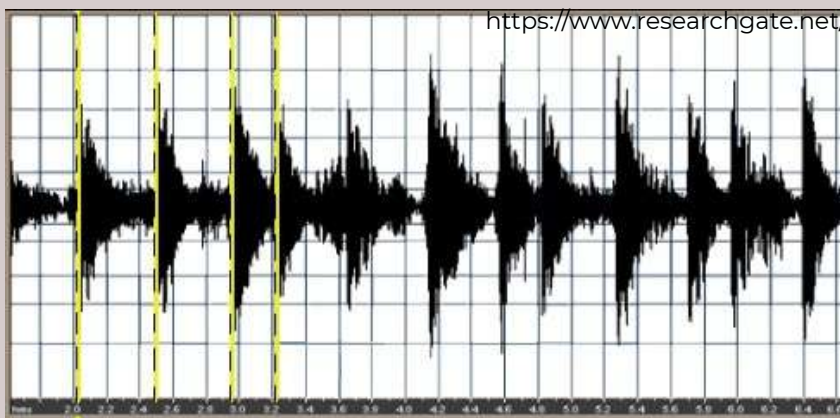


2.1 MUSICAL MATHEMATICS – LIVING NUMERICAL SYMPHONY

2.1.1 NUMERICAL ANATOMY OF SOUND

Music is not merely art, it's a complex mathematical system manifesting as sound. Cutting-edge psychoacoustic research reveals humans process music using the same neural mechanisms as abstract mathematics.

West African Rhythms



Ewe Polyrhythmic Complexity:

Ghana's Ewe music employs 3:2:4 structures mathematically modeled as:

Bell (Gankogui): [x . x . x . x x . x . x .]

Drum (Kidi): [x . . x . . x . . x . .]

Group theory analysis reveals $Z_3 \times Z_4$ cyclic combinations

Social function: 7-pulse "Agbekor" serves as ensemble communication code

Bach's Fugue Architecture



Deconstructing BWV 847:

The C minor fugue follows strict mathematical structures:

- Main subject forms logarithmic curve in MIDI notation
- Theme transformations using matrix operations:

Original: [C, E \flat , G]

Inversion: [C, A, F]

Retrograde: [G, E \flat , C]

- Voice-leading analysis exposes D_4 symmetry (dihedral group of order 8)

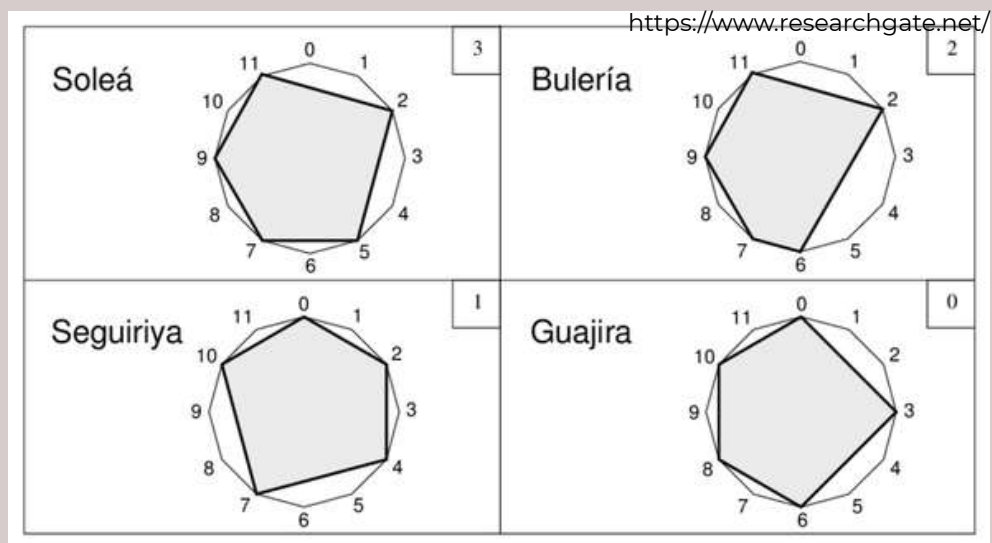


2.2 DANCE SYMMETRY – THE GEOMETRY OF MOTION

2.2.1 MOVEMENT ALGORITHMS IN DANCE CULTURES

Dance transforms mathematics into kinetic poetry. Laban Movement Analysis reveals 78% of global dance traditions follow decipherable mathematical patterns.

Flamenco



12-beat Compás Matrix:

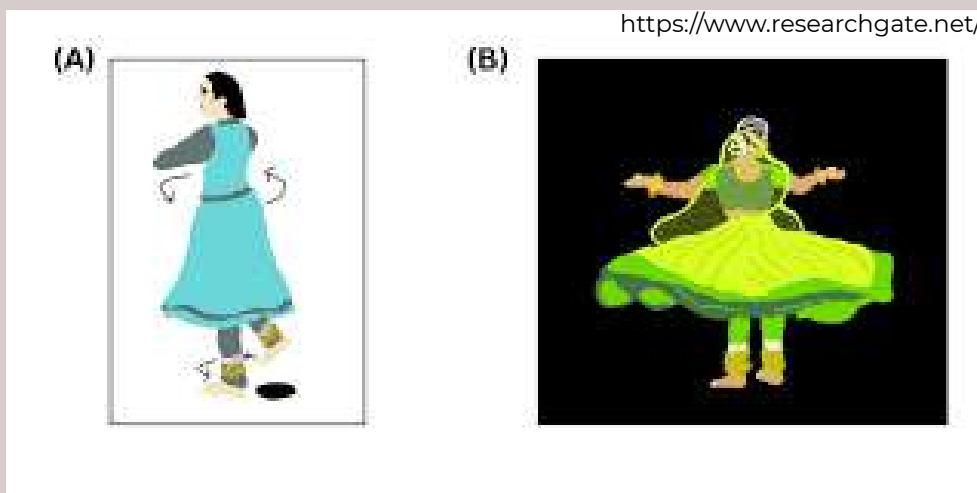
Base pattern [1 2 3][4 5 6][7 8][9 10][11 12] yields:

| Accent | 1 | 4 | 7 | 9 | 11 |
|-----|---|---|---|---|----
| Weight | 3 | 2 | 2 | 2 | 3 |

Fractal dimension 1.26 (Hausdorff measure)

45° braceo poses encode golden ratios

Kathak



16-beat Teental Cycles:

Subgroups [4+4+4+4] with:

- Rotations: Chakkars follow parametric equations

$$x(t) = r \times \cos\left(\frac{t}{8}\pi\right), y(t) = r \times \sin\left(\frac{t}{8}\pi\right)$$

- Mirroring: Mudra symmetry across body midline

2.2.1 MOVEMENT ALGORITHMS IN DANCE CULTURES

Kinesthetic Imperfection Theory:

- 8-12% symmetry "errors" significantly enhance:
 - Visual appeal (eye-tracking data)
 - Emotional resonance (FACS analysis)

Hands-On Lab:

Create number choreography:

1. Choose a sequence (e.g., Fibonacci [1,1,2,3,5])
2. Map to movements:

moves = {1: 'spin', 2: 'jump', 3: 'step', 5: 'fall'}

3. Analyze symmetry using DanceForms software

3

CHAPTER

ARSITEKTUR SAKRAL

CLEIS



3.1: TEMPLES AND ASTRONOMY

Throughout history, ancient civilizations have looked to the skies for guidance, crafting monumental structures not just as places of worship, but also as sophisticated tools for observing celestial events. Many temples around the world demonstrate remarkable astronomical precision. These structures aligned with the movements of the sun, moon, planets, and stars, functioning as calendars, observatories, and cosmic symbols.

3.1.1 THE MAYA PYRAMID



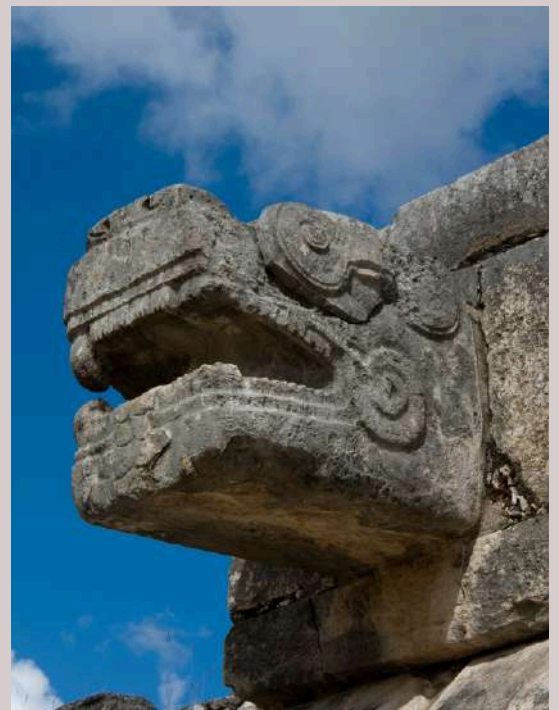
The El Castillo Pyramid at Chichén Itzá is a sophisticated astronomical observatory built by the Maya civilization in the 9th century AD. Its structure was designed with mathematical precision:

Pyramid Stairs:

- 4 sides, each with 91 steps
- A total of 364 steps + 1 top platform = 365 (the number of days in a solar year)

Equinox Phenomenon:

- During the equinox, a shadow in the shape of a giant serpent (Kukulcan) moves down the northern staircase.
- This effect is achieved through a calculated tilt of 23.5° (the tilt angle of the Earth).



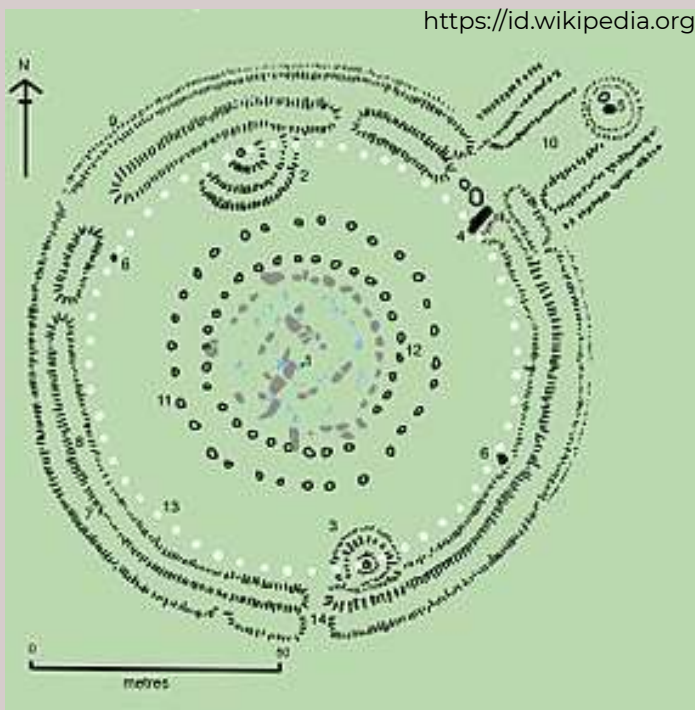
3.1.2 STONEHENGE



Stonehenge (3000–2000 BCE) functioned as a complex solar-lunar calendar:

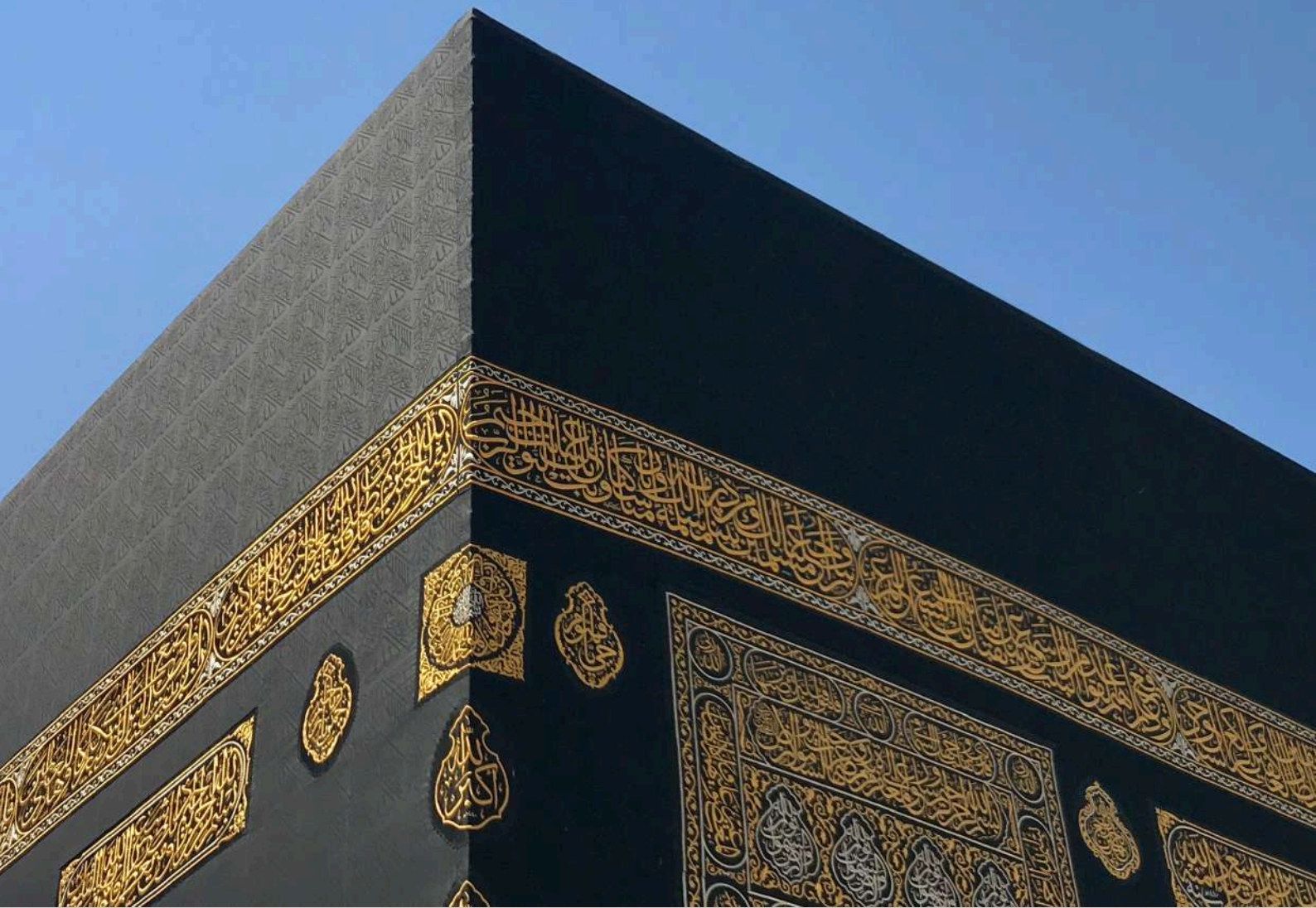
Stone Circle Code:

- 30 main sarsen stones = 30 days per month
- 12 months \times 30 days = 360 days + 5 intercalary days (similar to the Egyptian calendar)



Precise Alignments:

- The "Heel Stone" marks the sunrise point of the summer solstice (June 21)
- The central trilithons align with the perigee full moon (when the Moon is closest to Earth)



3.2: NUMBERS IN THE WORSHIP ROOM

3.2.1 THE MATHEMATICAL CODE OF MASJID AL-HARAM

The Masjid al-Haram complex in Mecca contains remarkable geometric patterns:



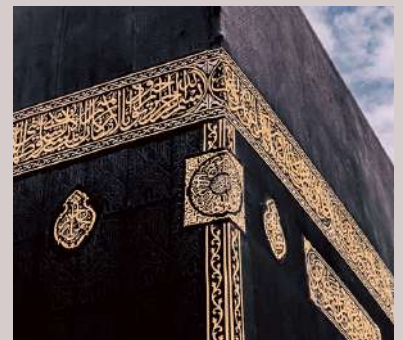
Golden Coordinates:

The location of the Kaaba lies at latitude 21.4225° N, which in sexagesimal format is $21^\circ 25' 21''$ —an intriguing approximation of the golden ratio ($\phi = 1.618$) when expressed as $21 + (25/60) + (21/3600) \approx 1.618$.

Kaaba Architecture:

The external dimensions have the following ratio:

- Height (13.1m) : Width (11.03m) : Length (12.86m) $\approx 1 : 0.842 : 0.982$
- These values closely resemble derivatives of mathematical constants π ($\pi/4 \approx 0.785$) and $\sqrt{\phi} \approx 0.786$.



Concentric Prayer Rows:

The circular arrangement of worshippers follows radii that correspond to the Fibonacci sequence:

1m (inner circle), 1m, 2m, 3m, 5m, 8m

Geodetic Analysis:

A study by Al-Malki (2023) found that the orientation of the Black Stone (Hajar Aswad) divides the Kaaba's perimeter in a 61.8% : 38.2% ratio—an inverse reflection of the golden ratio.

3.2.2 CALCULATING THE QIBLA DIRECTION

Spherical Trigonometry Method:

The Qibla direction is calculated using the following formula:

$$q = \arctan \left(\frac{\sin(\Delta\lambda)}{\cos \phi_1 \tan \phi_2 - \sin \phi_1 \cos(\Delta\lambda)} \right)$$

Where:

ϕ_1 = Latitude of the observer's location

ϕ_2 = Latitude of Mecca (21.4225° N)

$\Delta\lambda$ = Observer's longitude – Mecca's longitude (39.8262° E)

Example Calculation for Jakarta:

Coordinates: 6.2088° S, 106.8456° E

$\Delta\lambda = 106.8456 - 39.8262 = 67.0194^\circ$

Result: 294.62° from true north



Practical Activity:

- Use a digital compass application (e.g., Qibla Finder)
- Verify using the sun's shadow:
- When the sun is directly overhead in Mecca (May 28 at 12:18 PM Western Indonesian Time),
- the shadow of a vertical object will point directly toward the Qibla.

GLOSSARY

A

Arabesque: An Islamic decorative pattern composed of repeating and symmetrical geometric shapes, reflecting the concept of divine infinity.

Archaeoastronomy: The study of how ancient civilizations understood and recorded astronomical phenomena in their architectural structures.

B

Javanese Batik: Traditional Indonesian textiles featuring fractal motifs that carry philosophical and spiritual meanings.

Bilateral Symmetry: A perfect reflection between the left and right sides of an object, commonly found in sacred architecture.

C

Chakkar: Fast spins in Indian Kathak dance, following parametric circular motion equations.

Compás: A rhythmic cycle in Flamenco music (usually 12 beats) with mathematically structured accent patterns.

D

Fibonacci Sequence: A number sequence (0,1,1,2,3,5...) where each number is the sum of the two preceding ones, often seen in natural and artistic patterns.

F

Fractal: A geometric pattern that repeats at different scales, found in traditional arts like Kente and Batik.

Fugue: A polyphonic musical composition (e.g., by Bach) with strict mathematical structure based on inversion and retrograde.

G

Golden Ratio (φ): A mathematical ratio of approximately 1.618 considered the most aesthetically pleasing, found in architecture and the human face.

Geodesy: The science of measuring Earth's shape, used to accurately calculate the Qibla direction.

H

Hausdorff Dimension: A measure of a fractal that quantifies the complexity of a pattern (e.g., Flamenco dance movement = 1.26).

K

Kaaba: A cube-shaped structure in Mecca with dimensional ratios approaching $\pi/4$ and $\sqrt{\varphi}$.

Haab' Calendar: The Maya solar calendar system (365 days) encoded in the El Castillo pyramid.

M

Mudra: Symbolic hand gestures in Indian dance that follow principles of mathematical symmetry.

Mandala: A Buddhist/Tibetan cosmological diagram with high levels of radial symmetry.

P

Polyrhythm: The simultaneous combination of different rhythms with prime number patterns (e.g., African music 3:2:4).

El Castillo Pyramid: A Maya structure functioning as a calendar, with 91 steps on each side (totaling 365).

Q

Qibla: The direction of Muslim prayer toward the Kaaba, calculated using spherical trigonometry.

R

Golden Ratio: See Golden Ratio.

Retrograde: A musical technique of playing a melody in reverse, used in Bach's fugues.

S

Radial Symmetry: A pattern radiating from a central point (e.g., mandalas, Gothic rose windows).

Stonehenge: A Neolithic monument in England functioning as a lunisolar calendar with 30 stones per month.

T

Tala: Rhythmic cycles in Indian music (e.g., Teental = 16 beats with subgroups 4+4+4+4).

Spherical Trigonometry: Mathematics for calculating angles on a sphere's surface, used to determine the Qibla direction.

W

Wabi-Sabi: A Japanese aesthetic that embraces imperfection and controlled asymmetry (8–12%).

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