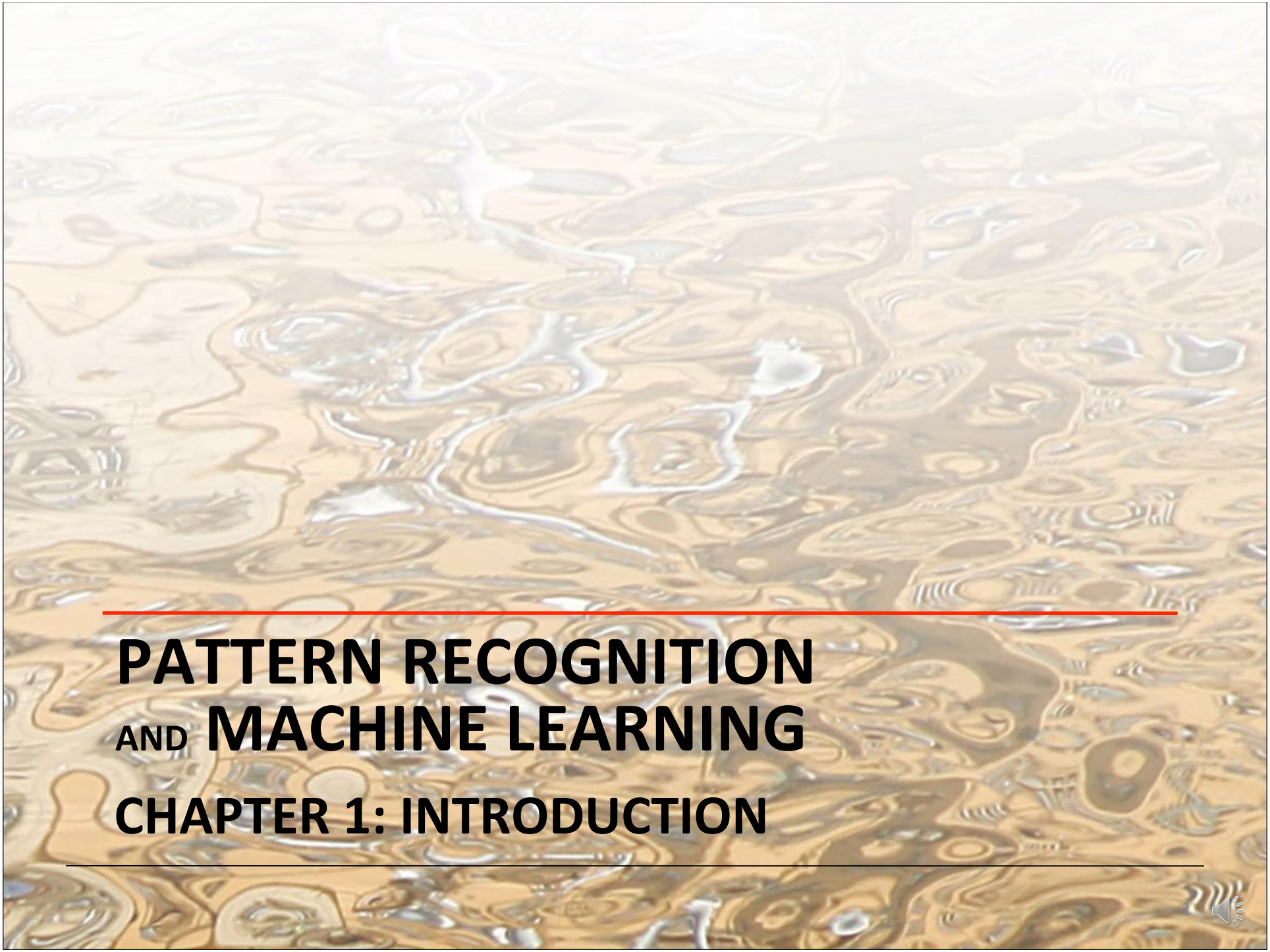
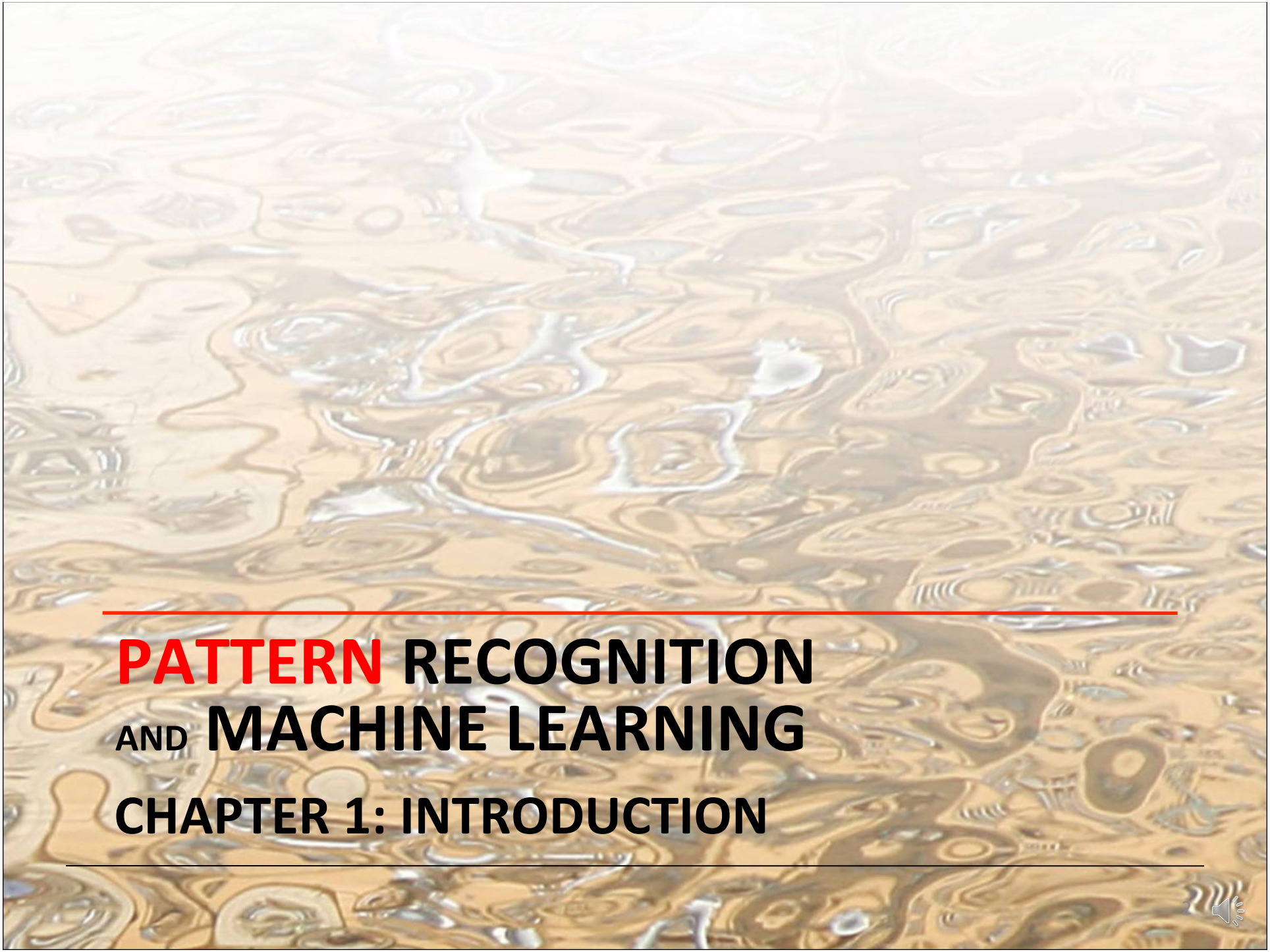


PATTERN RECOGNITION AND MACHINE LEARNING

CHAPTER 1: INTRODUCTION


PATTERN RECOGNITION
AND MACHINE LEARNING
CHAPTER 1: INTRODUCTION

I have a question for you

What is a PATTERN?

Answer this question on CANVAS now

Thanks for your prompt responses!

(1) Pattern (2) Recognition

From 2020 SPRING input (95), PATTERN is:

(sequence) repetitive ++++, **recurring++**, periodic, similar/common/shared (among its parts) +++, predictable (future), reproducible, regular, orderly, rules, …shows over and over again at a specific rate … appear more than once

What PATTERN is NOT:

anything that is purely random

(1) Pattern (2) Recognition

From 2019 SPRING students' input, **PATTERN** is:

+ **general, predictable, a rule, "*repeating*", periodic, reoccurring**

+ ***characteristically*** **(dis)similar, correlated/ consistent**

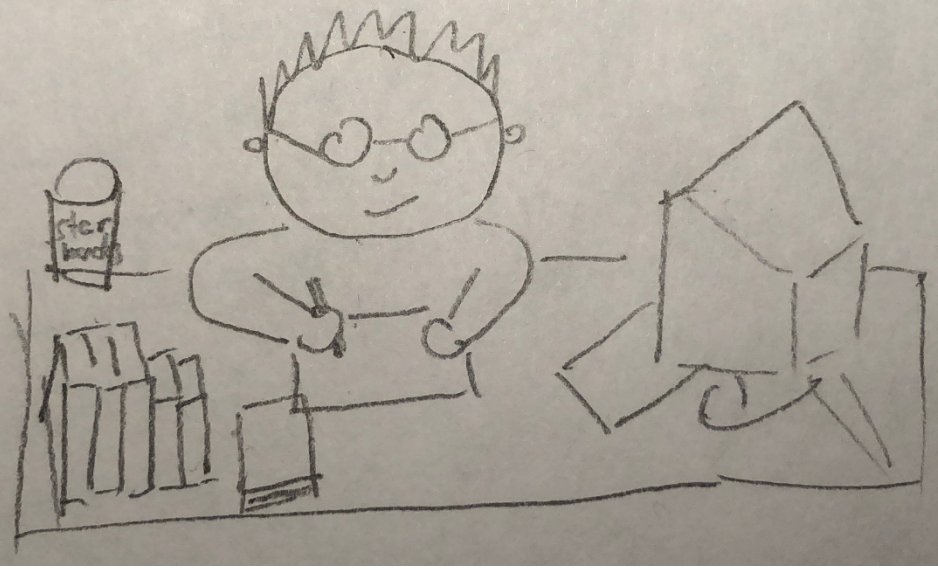
+ regularity, structured, organized

+ Everything (… ?)

What **PATTERN** is NOT:

- random, noise

A pattern is what I will try to figure out in the following 4 or 5 years.

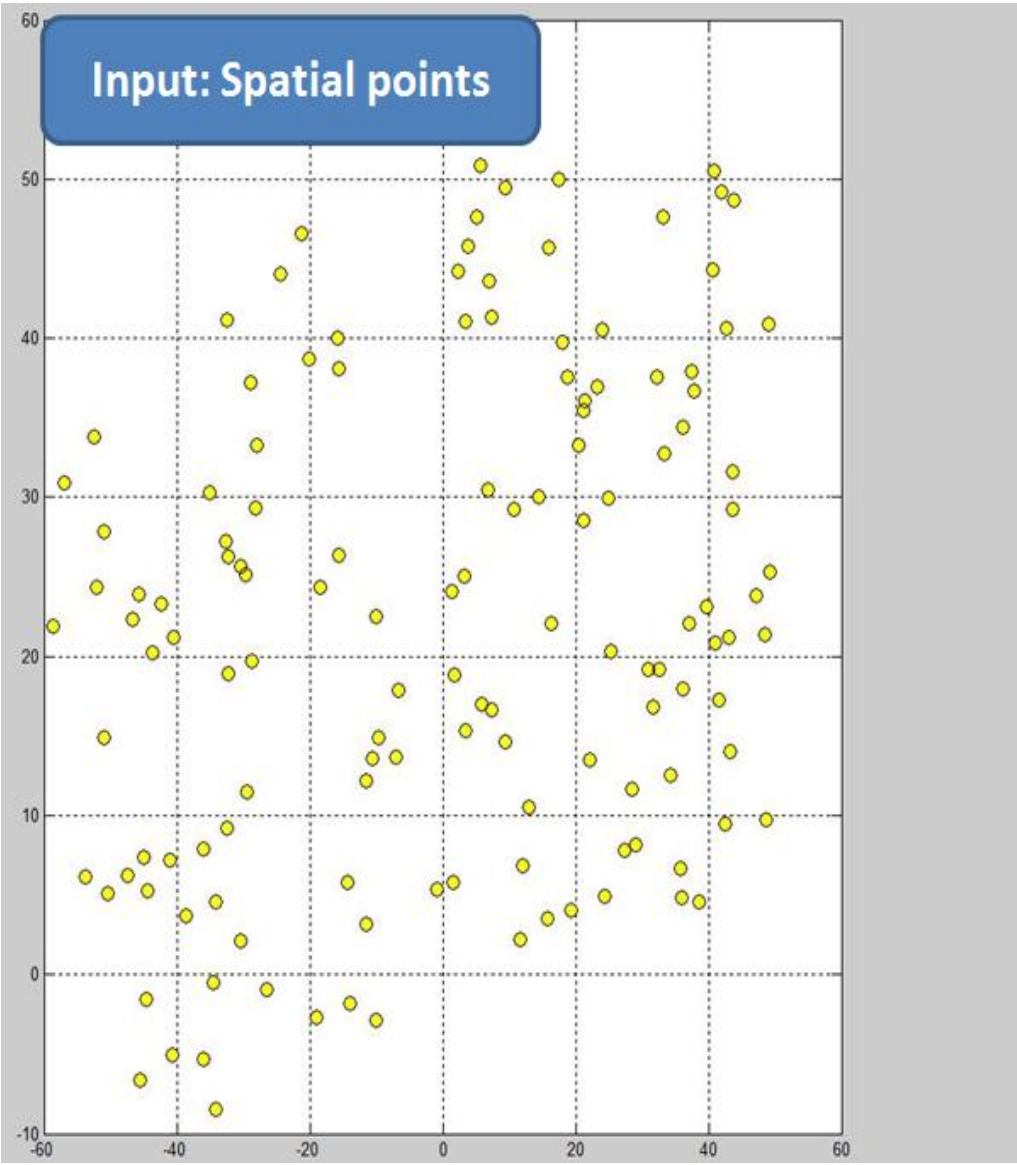


Pattern Recognition (what it is about)

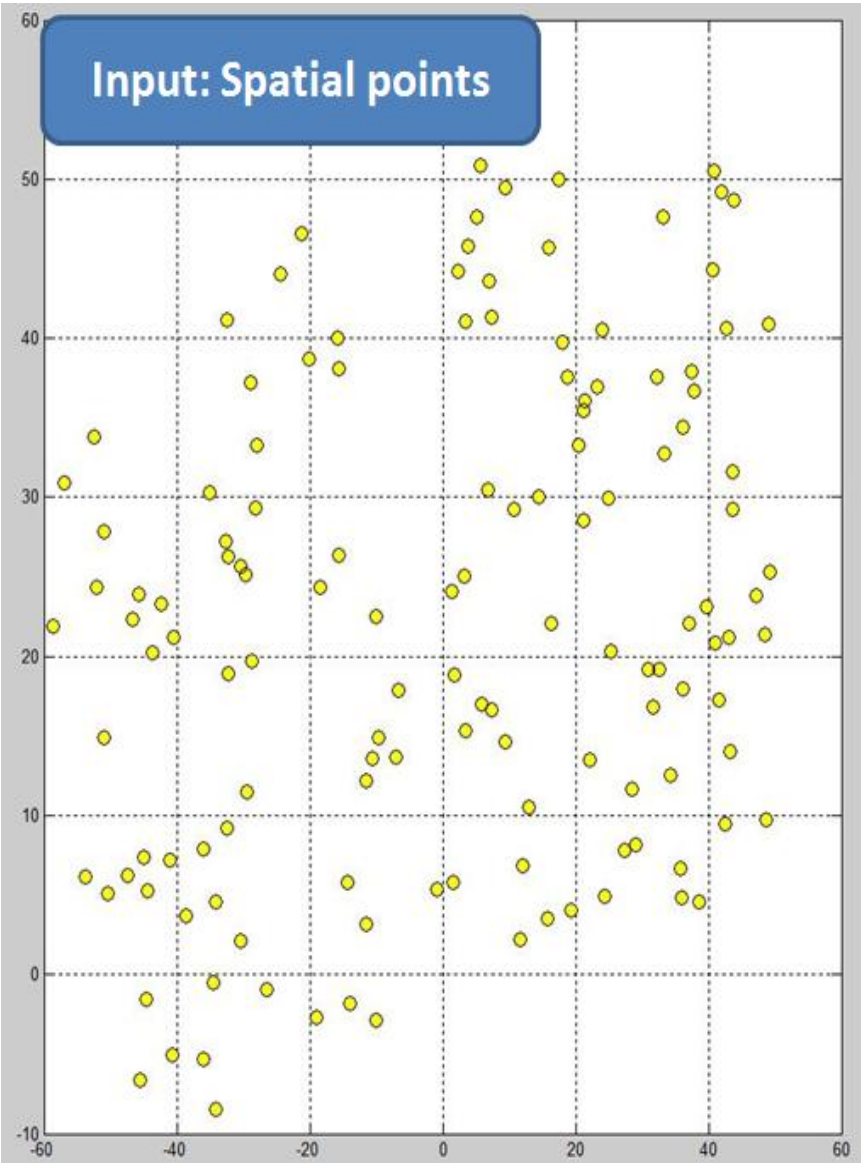
Discovery of patterns of regularities in data through the use of computer algorithms

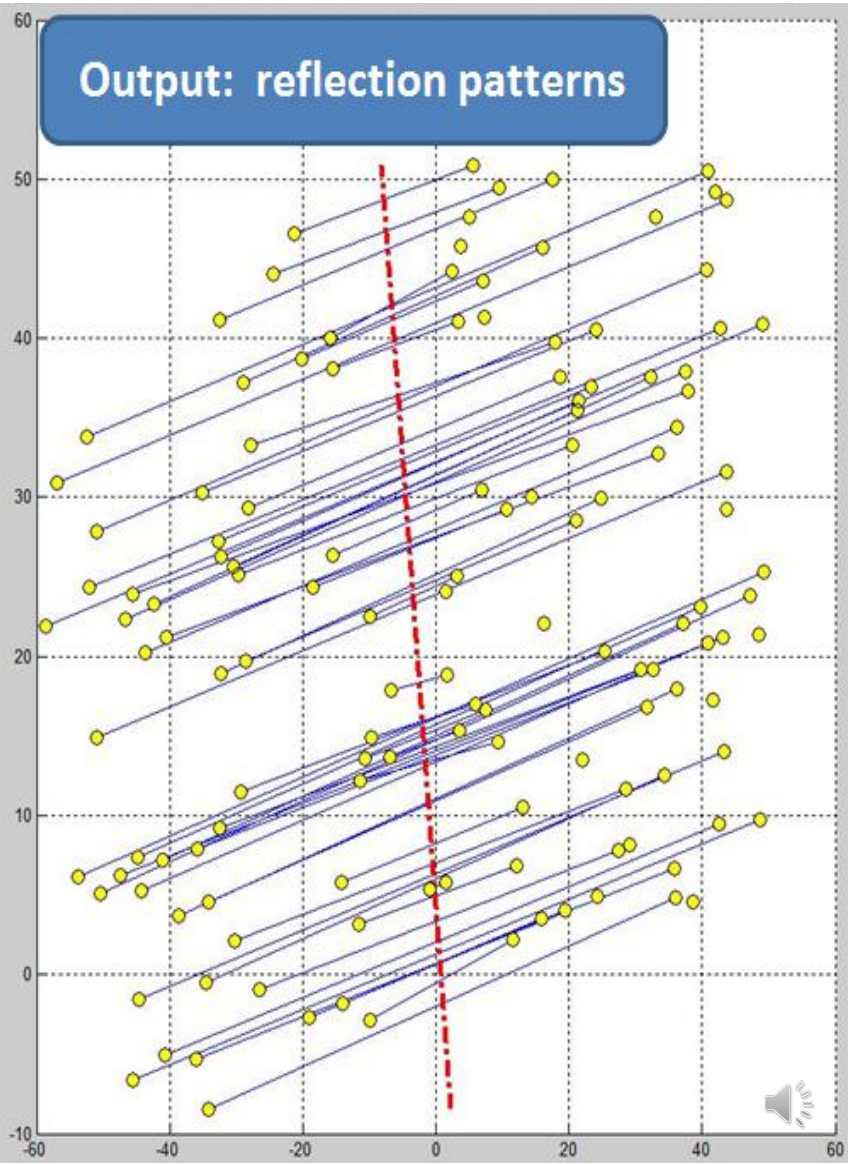
Use these learned regularities to take actions (classification, regression, modeling, compression … on unseen data)

What do you see from these points?



What do you see from these points?





WHAT IS THE **MOST REGULAR** FORM?

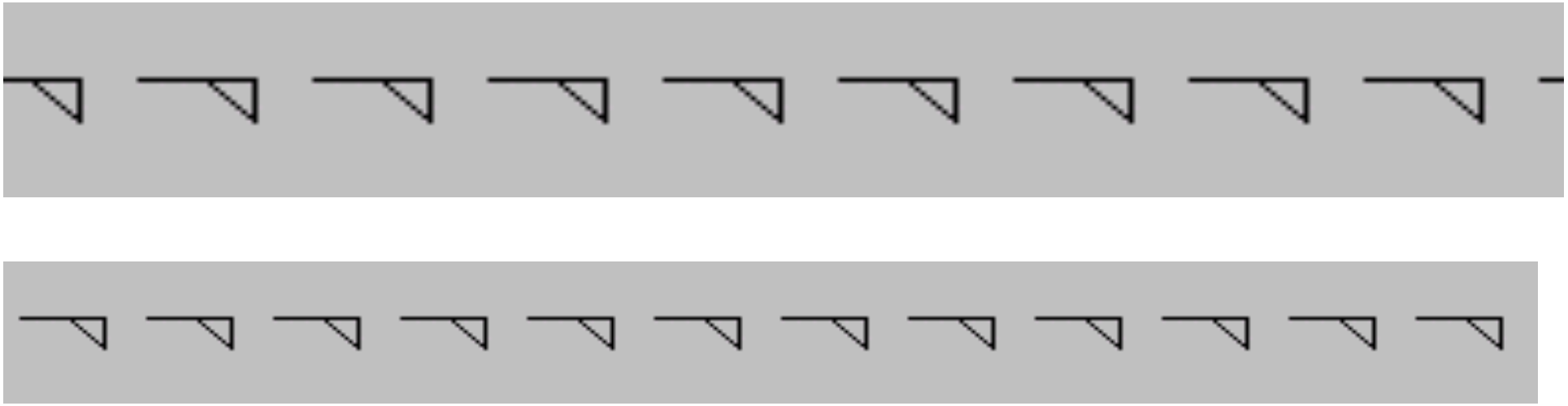
Any data modality

Any dimension

Any application domain

"… shows over and over again at a specific rate …"

AN IDEAL REPETITION (most regular)



TRANSLATION SYMMETRY

PATTERN ------ >> SYMMETRY

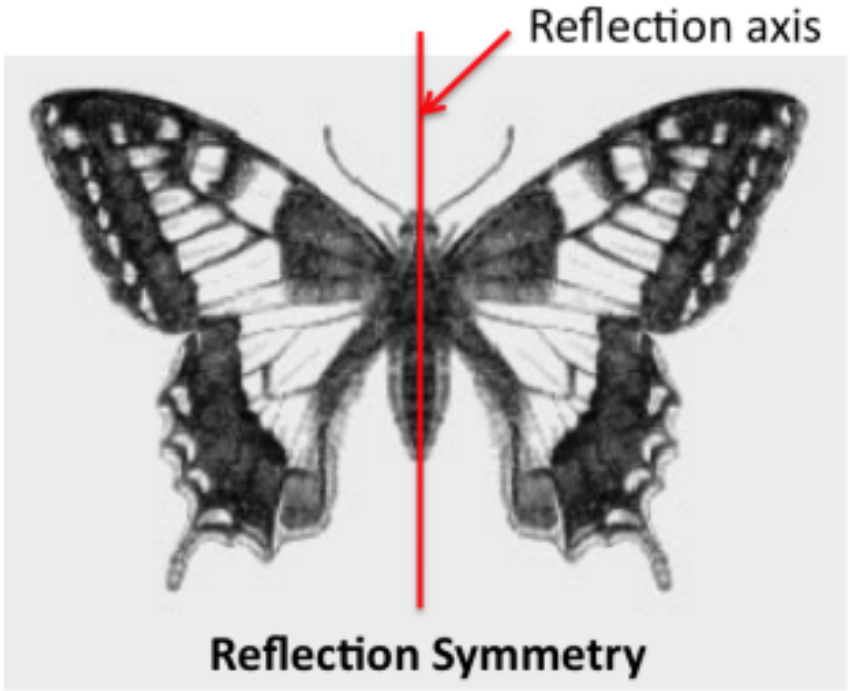
What is "**SYMMETRY**"???

A **transformation** g, a set S, if g(S) = S, g is a **symmetry** of S. All symmetries of S form a **symmetry group** of S (group theory).

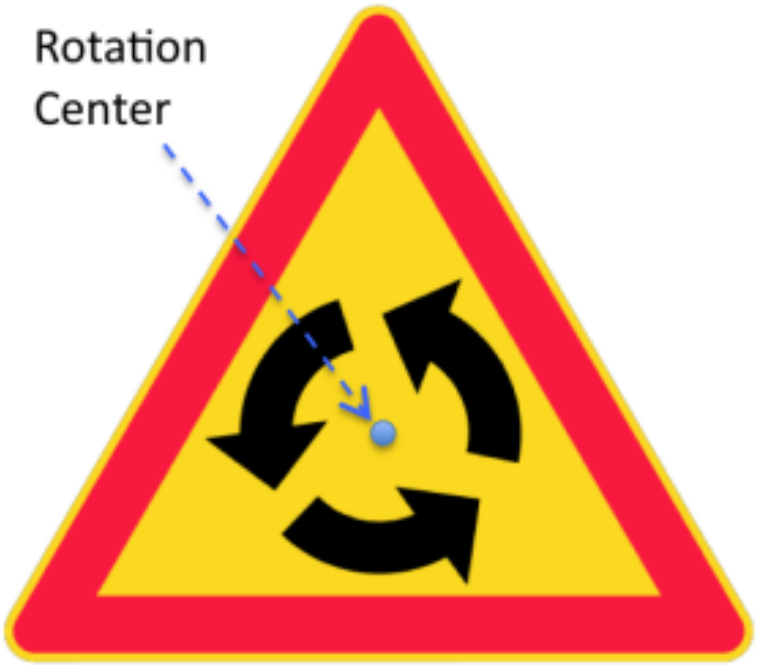
2D EUCLIDEAN SPACE (an example)

PRIMITIVE SYMMETRIES:

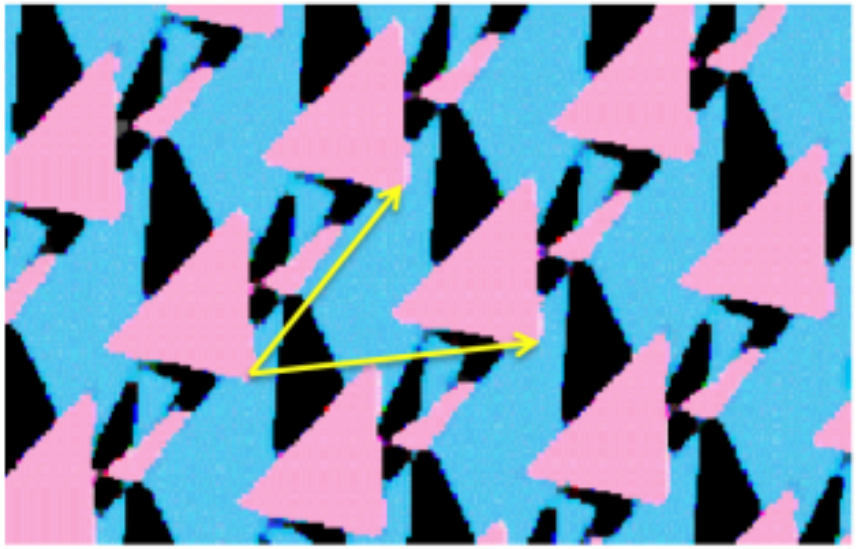
FOUR TYPES (ONLY!)



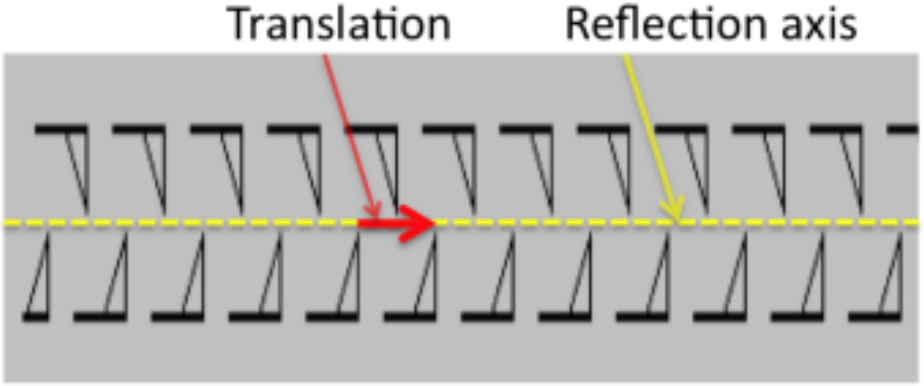
Reflection Symmetry



Rotation Symmetry



Translation Symmetry



Glide-Reflection Symmetry

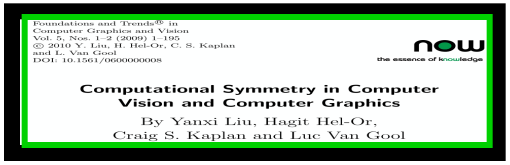
Reflection

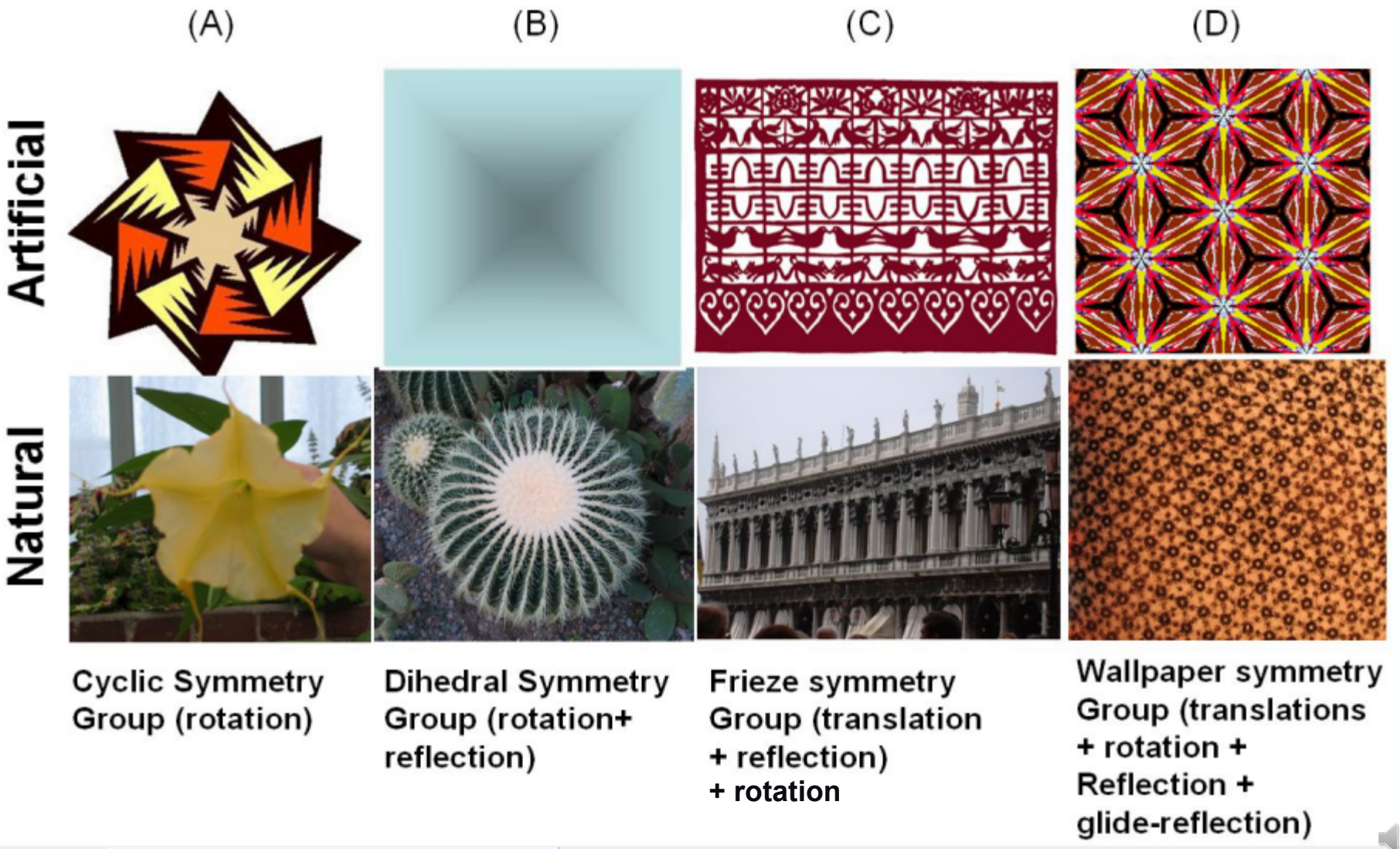
Rotation

Translation

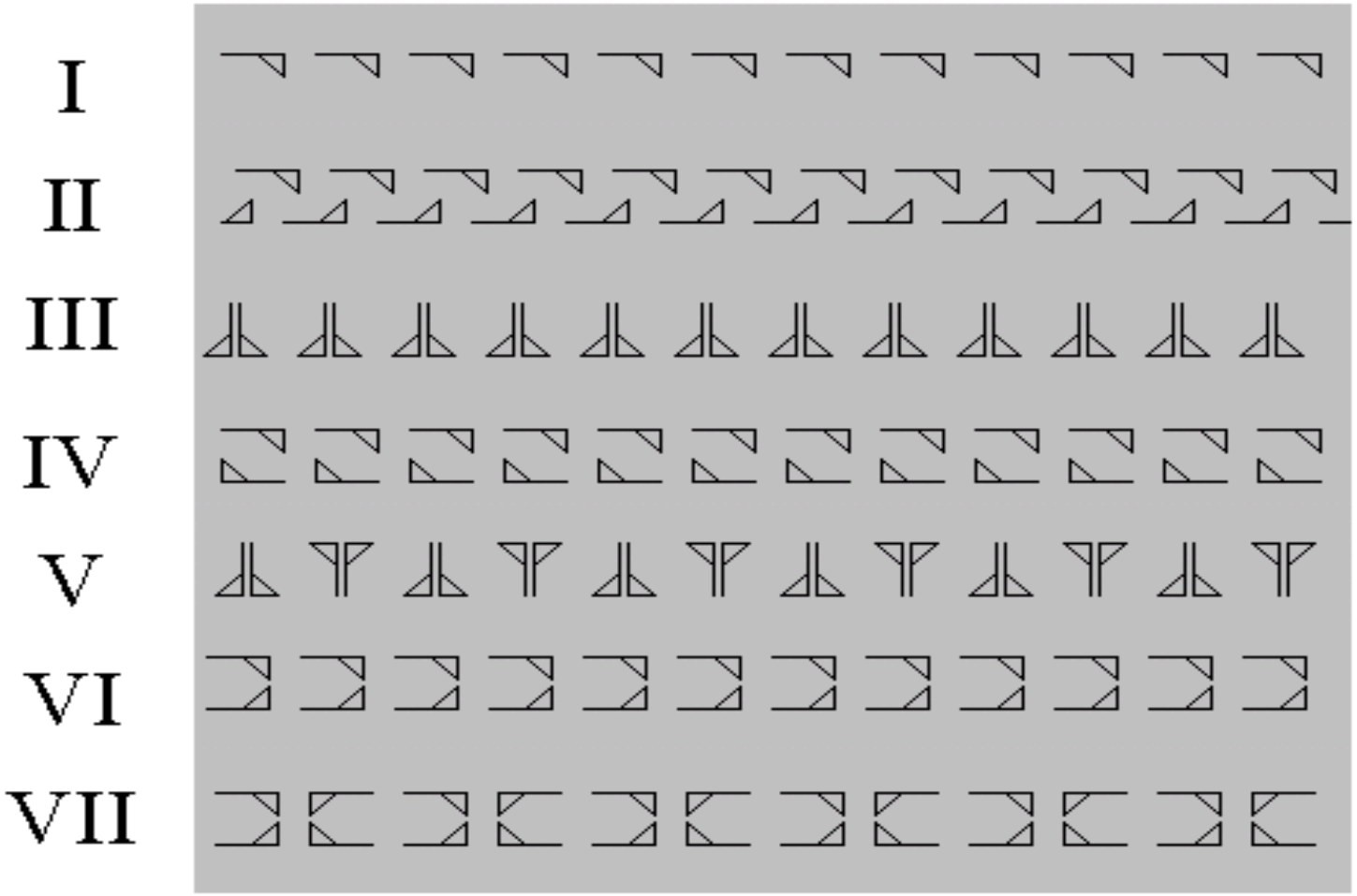
Glide Reflection

Four Types of Symmetry Groups in 2D Euclidean Space

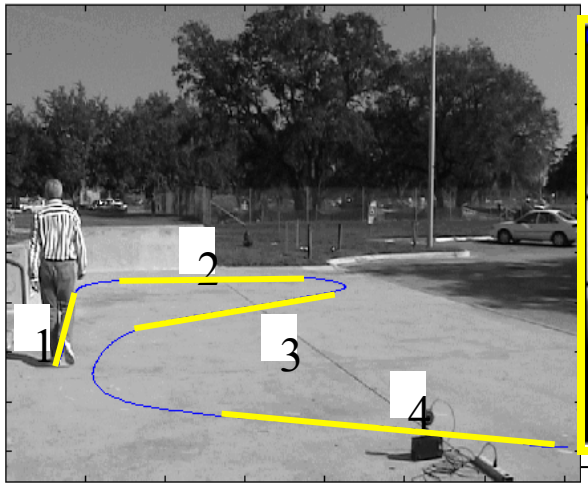


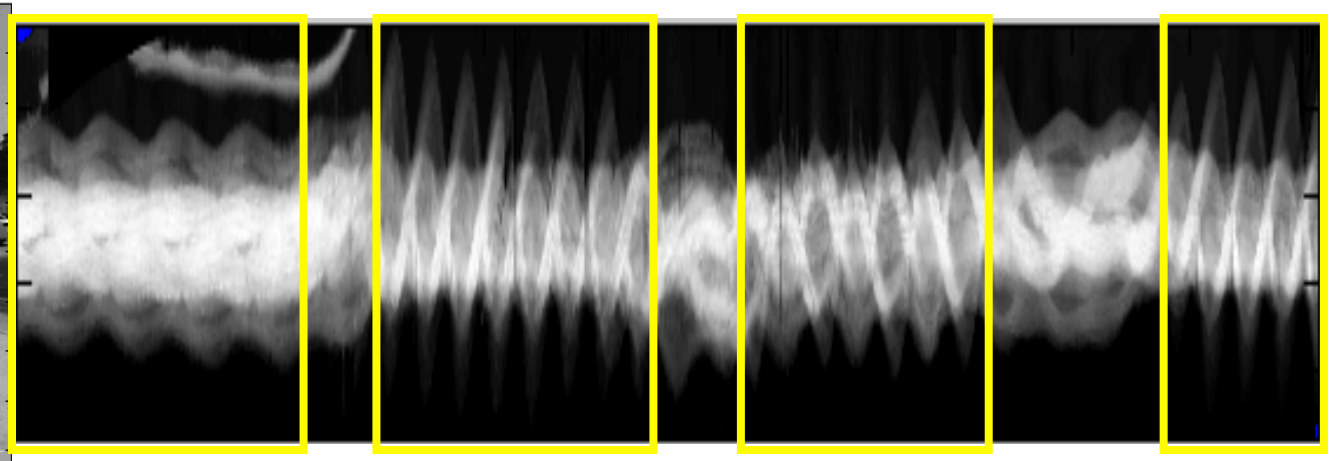


7 Frieze Groups (1 translation direction)

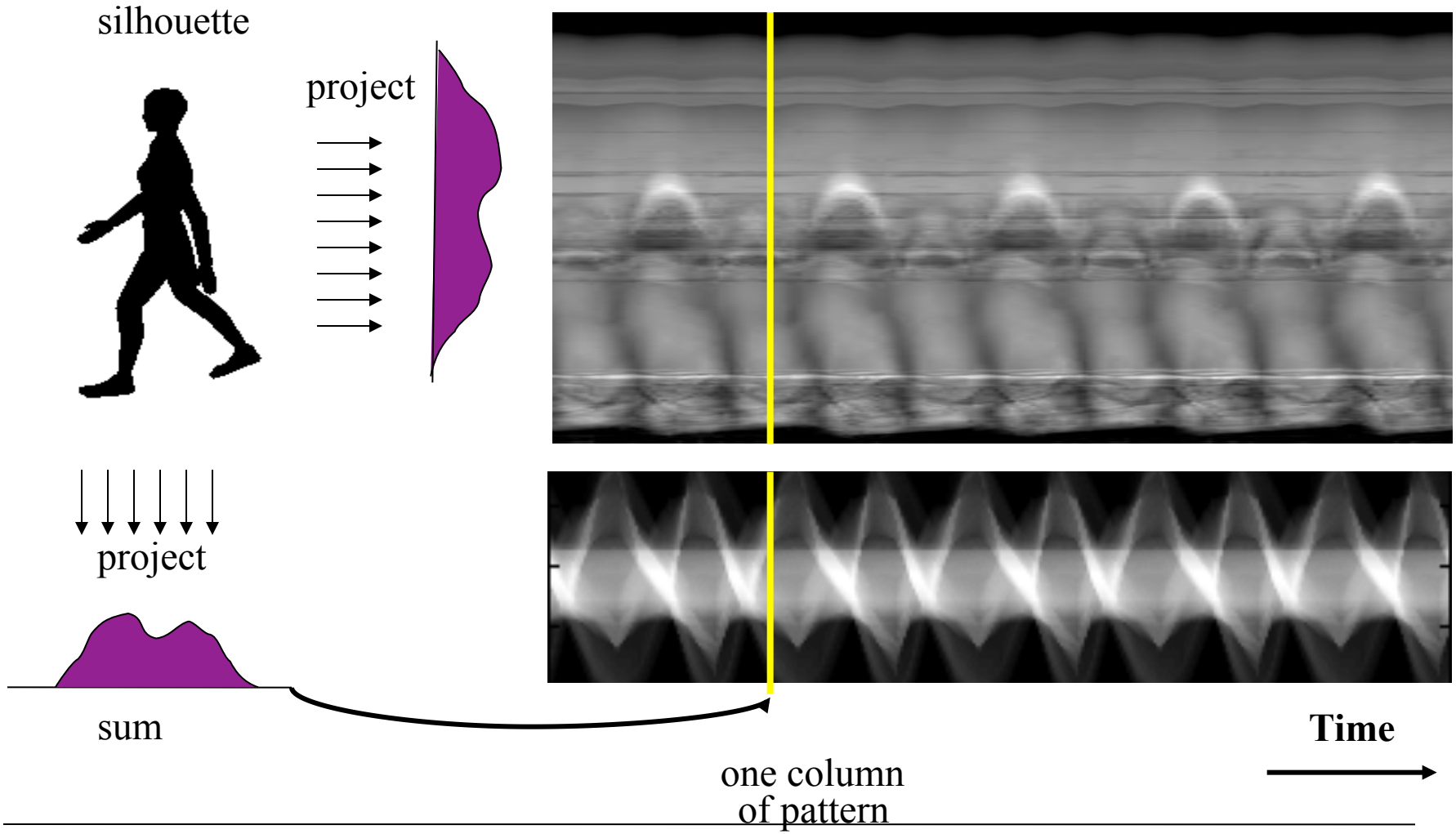


A walking human

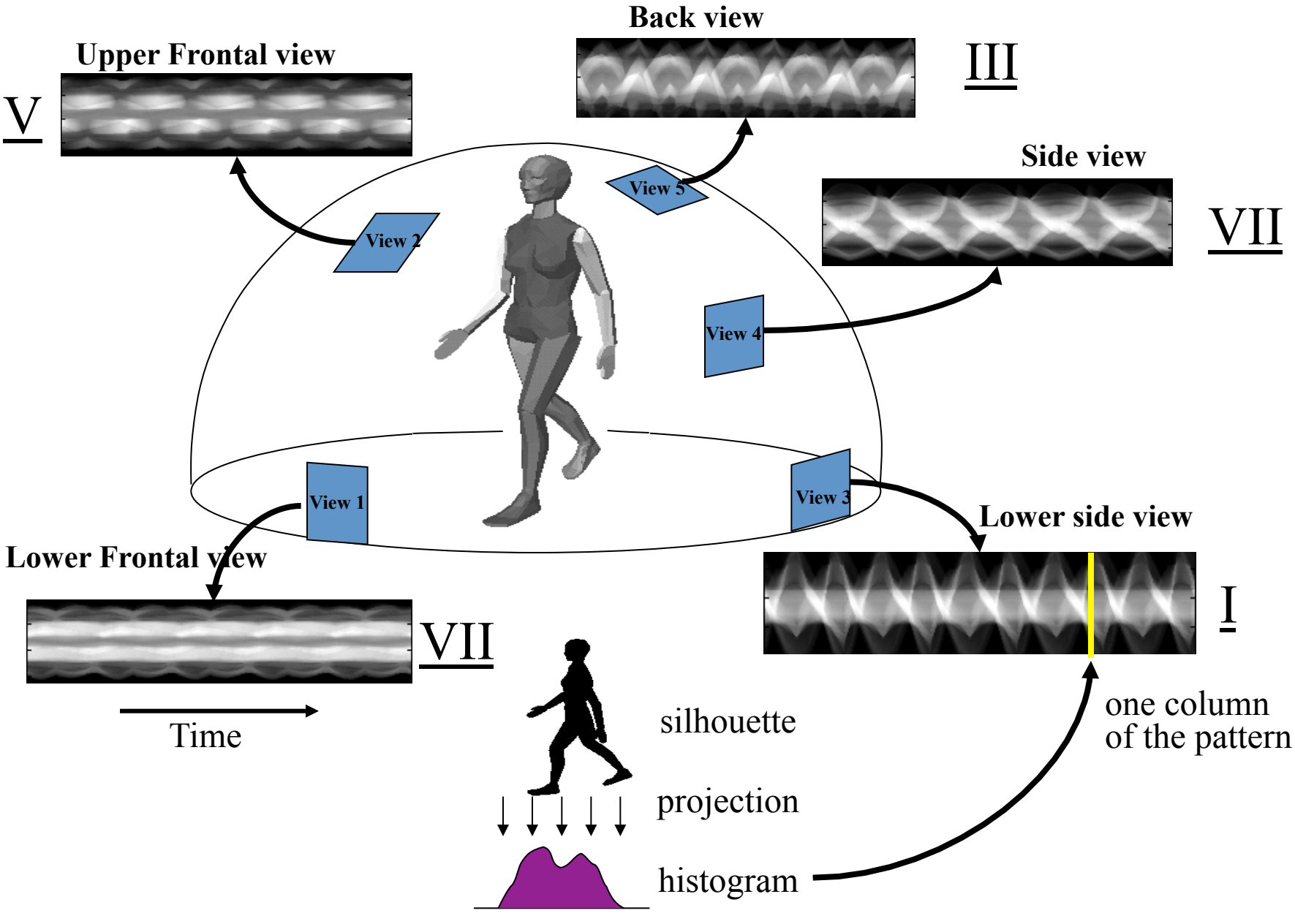




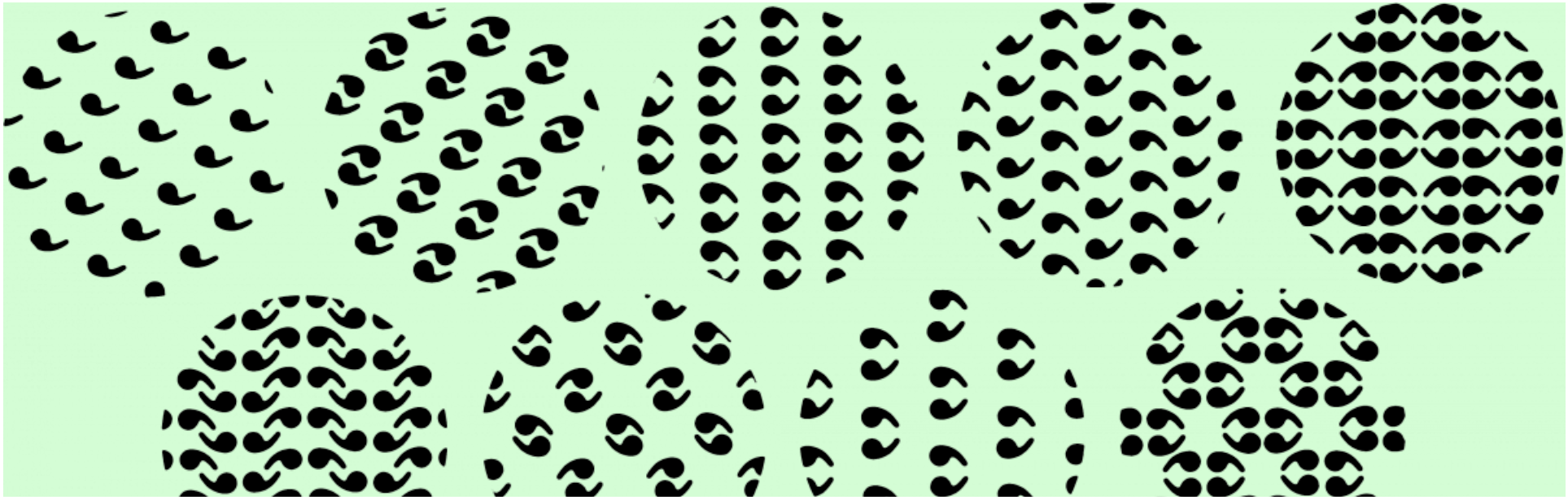
Spatiotemporal Projection into Frieze-like Patterns



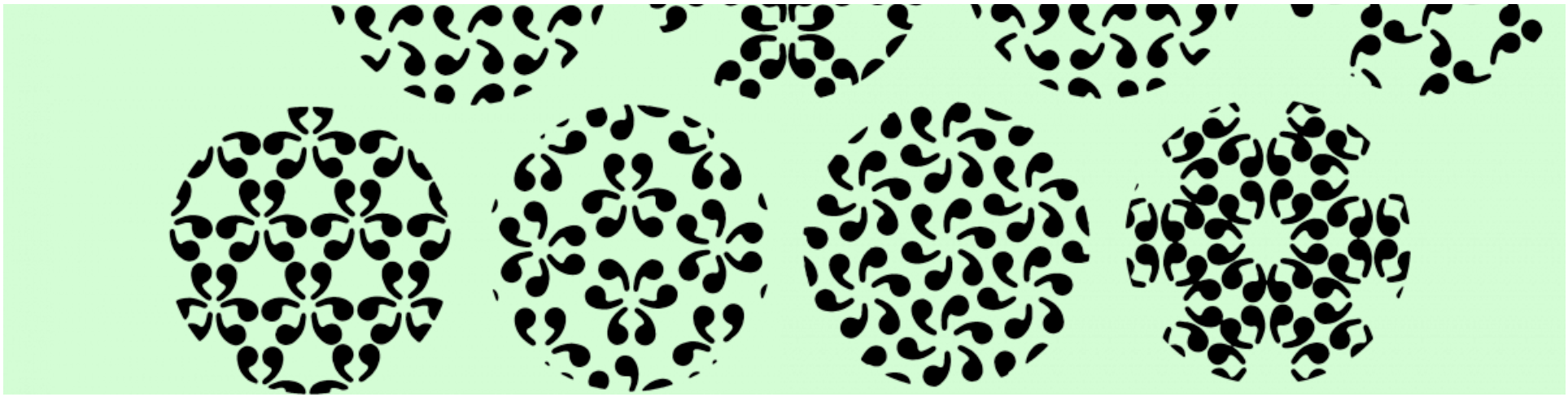
Observation #1:



17 WALLPAPER Groups
(2 translation directions)



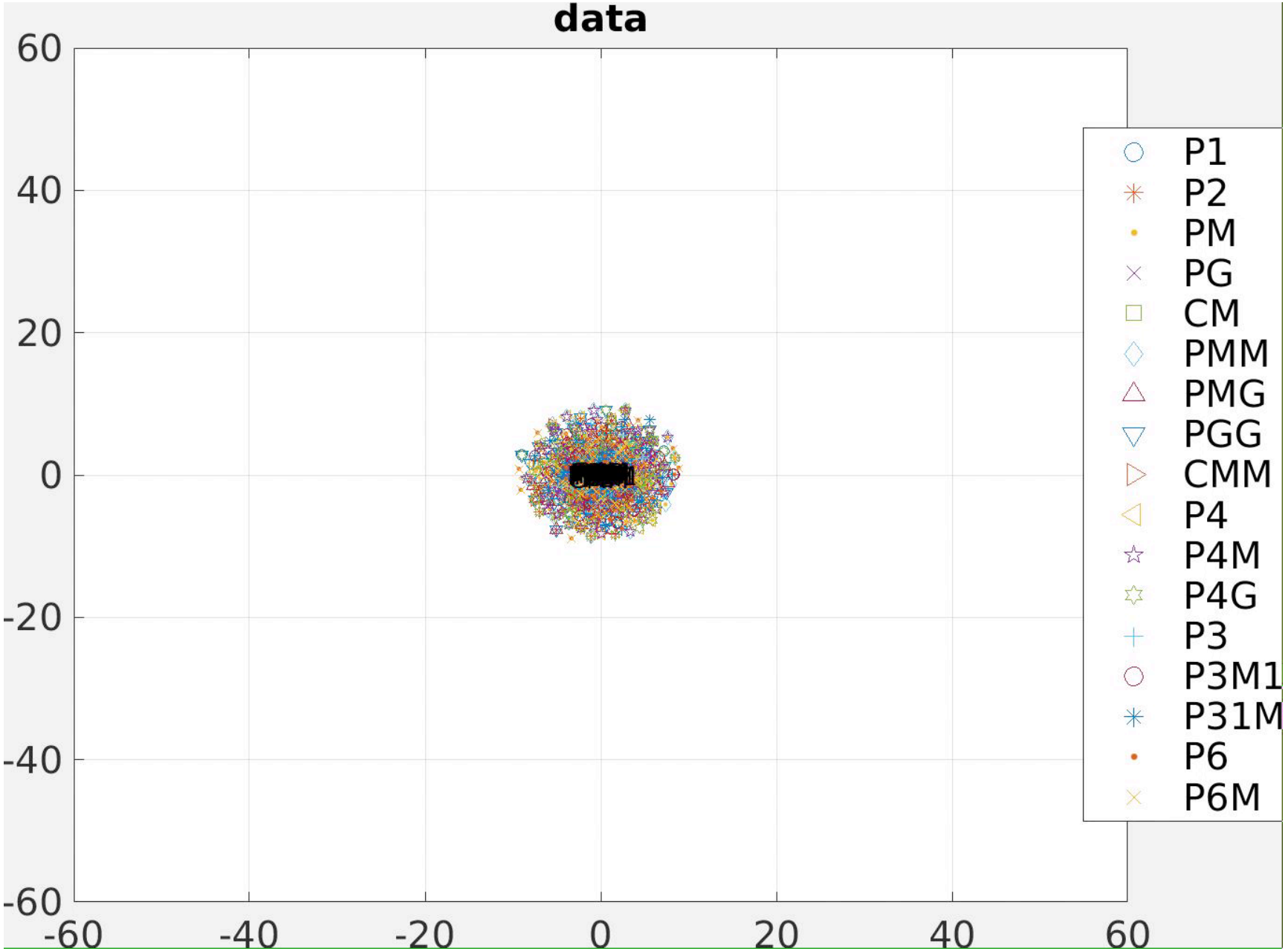
17 Wallpaper Groups (n=2)!



Good News for Computer Scientists!

Symmetry Group Theory serves as an effective organizaing principle for PATTERNS

- **Compact (no redundant patterns)**
- **Complete (no missing patterns)**
- **Constant (small) number of possible regular patterns**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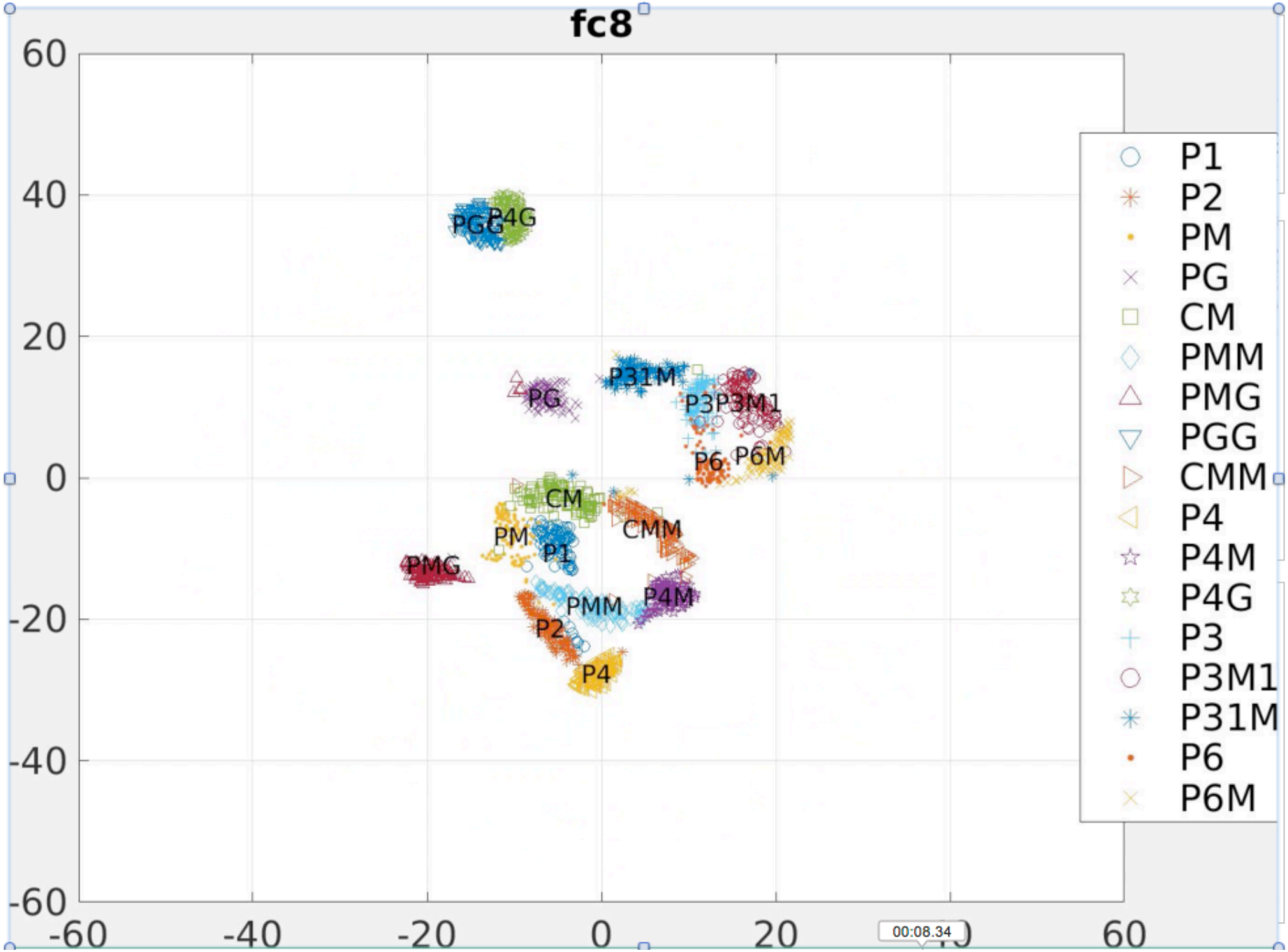
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the essence of knowledge

Computational Symmetry in Computer Vision and Computer Graphics

By Yanxi Liu, Hagit Hel-Or,
Craig S. Kaplan and Luc Van Gool

http://www.researchgate.net/publication/220427988_Computational_Symmetry_in_Computer_Vision_and_Computer_Graphics?ev=prf_pub

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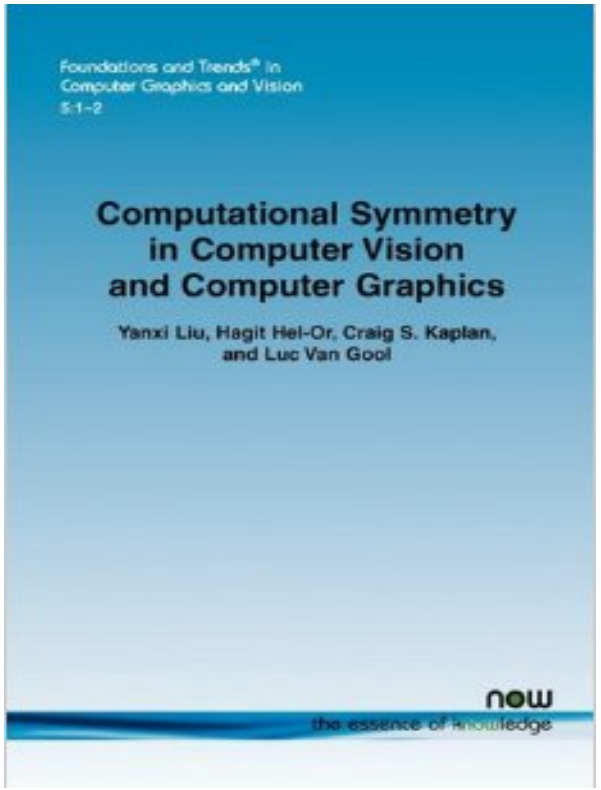
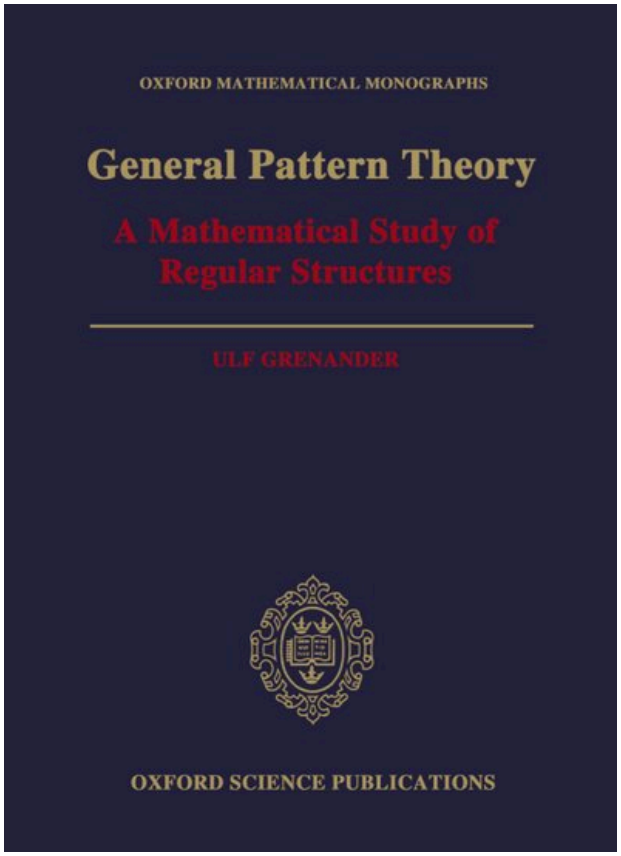
(1) Pattern (2) Recognition





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Liu, Y., Hagit Hel-Or, Craig S. Kaplan and Luc Van Gool (2010)

Computational Symmetry in Computer Vision and Computer Graphics (**pdf**)

Foundations and Trends® in Computer Graphics and Vision:

Vol. 5: No 1-2, pages 1-199.

Liu, Y., Collins, R.T. and Tsin, Y. (2004)

A Computational Model for Periodic Pattern Perception Based on Frieze and Wallpaper Groups (pdf)

*IEEE Transactions on Pattern Analysis and Machine Intelligence (**TPAMI**)*, Vol 26(3), pages 354-371.