

# A big ball of wibbly wobbly

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My problem with time	
Platonia	
Coalgebras	
Pop examples	

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St. Augustine

*What then is time? If no one asks me, I know what it is. If I wish to explain it to him who asks, I do not know.*

■

Tenth Doctor

*"People assume that time is a strict progression of cause to effect, but **actually** from a non-linear, non-subjective viewpoint - it's more like a big ball of wibbly wobbly... time-y wimey... stuff."*



Prior

*"...formal logic and general philosophy have more to bring to one another than is sometimes supposed."*

## Problem

What is the most general temporal structure that we could derive other temporal structures?

**Platonia**



# Platonica

## **Configuration $c$**

Three dimensional snapshot of the universe that captures the relative configuration of matter and fields in the universe.

# Platonia

## **Time capsule $t$**

Any fixed pattern that creates or encodes the appearance of motion, change or history.

Platonia

$$t \subseteq c$$

# Platonia

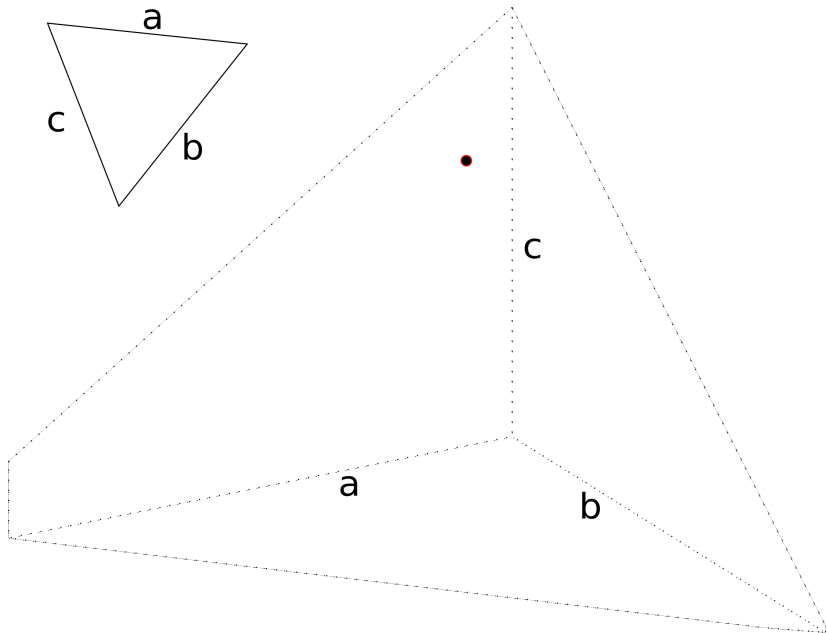
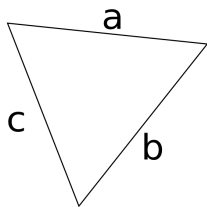
## **Platonia** $\mathcal{P}$

Collection of all *configurations*.

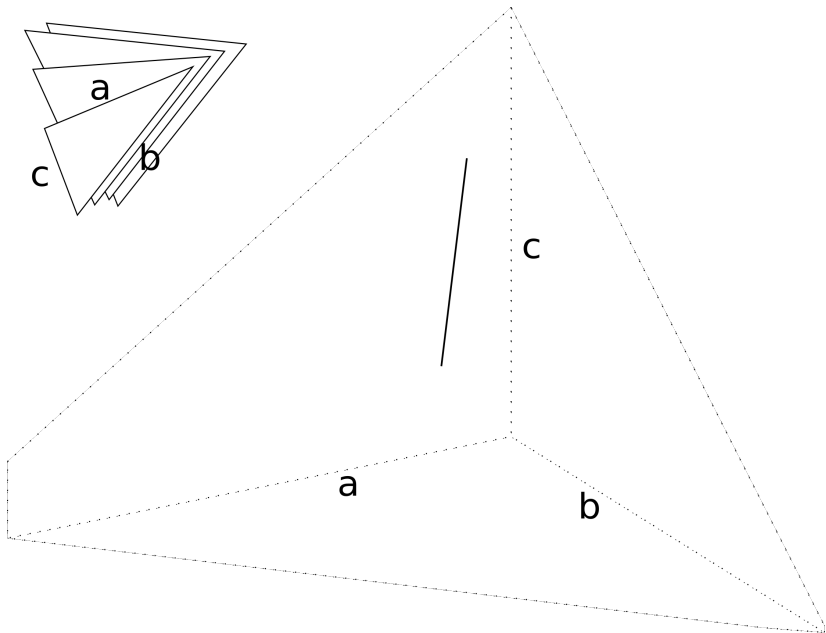
Platonia

$$c \in \mathcal{P}$$

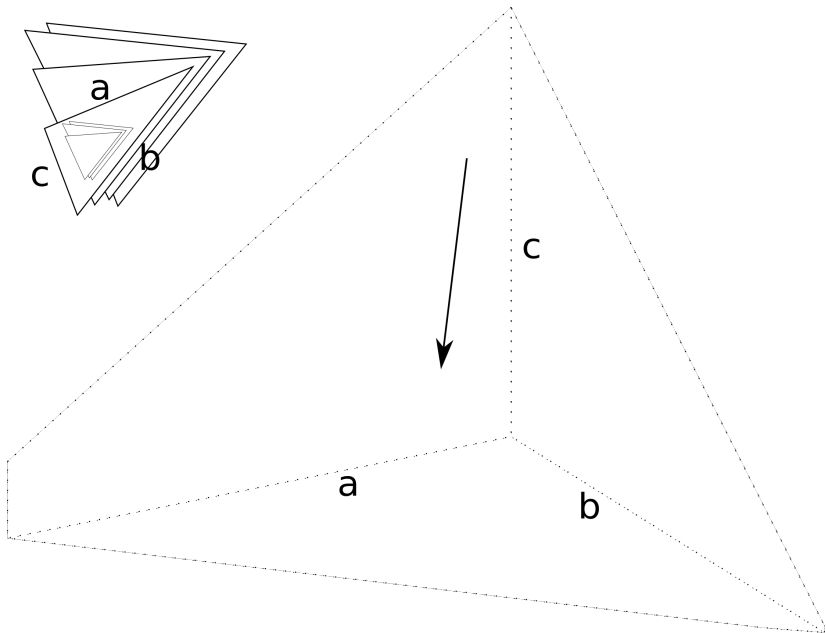
# Platonia



# Platonia

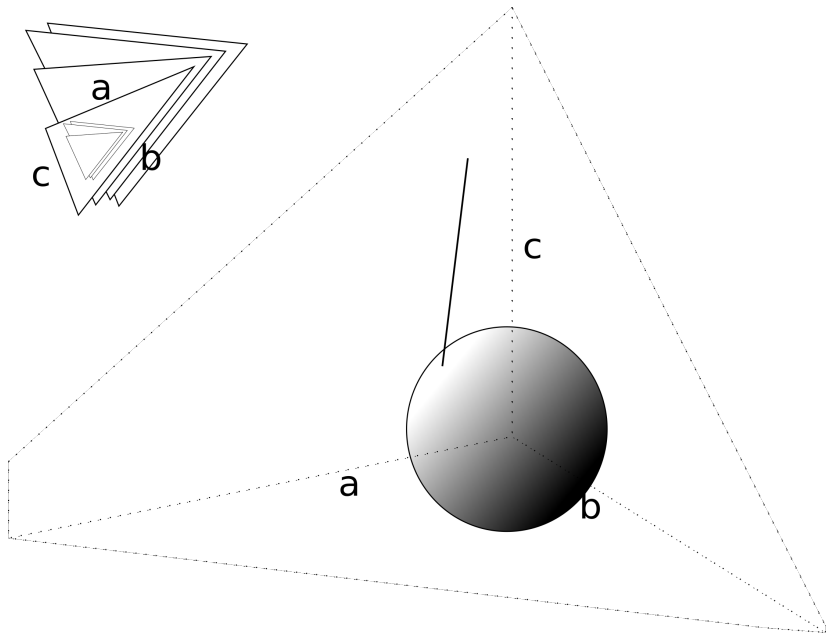


# Platonia





# Platonia



# Coalgebras

# Coalgebras

## Coalgebra

Given a category  $\mathcal{X}$  and a functor  $\Sigma : \mathcal{X} \rightarrow \mathcal{X}$ , a  $\Sigma$ -coalgebra  $((\mathcal{X}, \xi))$  is given by an arrow  $\xi : X \rightarrow \Sigma X$  in  $\mathcal{X}$ . A morphism between two coalgebras  $f : (\mathcal{X}, \xi) \rightarrow (\mathcal{X}', \xi')$  is an arrow such that  $\xi' \circ f = \Sigma f \circ \xi$ .

# Coalgebras

## **Basic**

$$\theta : \mathcal{P} \rightarrow \mathcal{P}$$

# Coalgebras

**Possible final state**

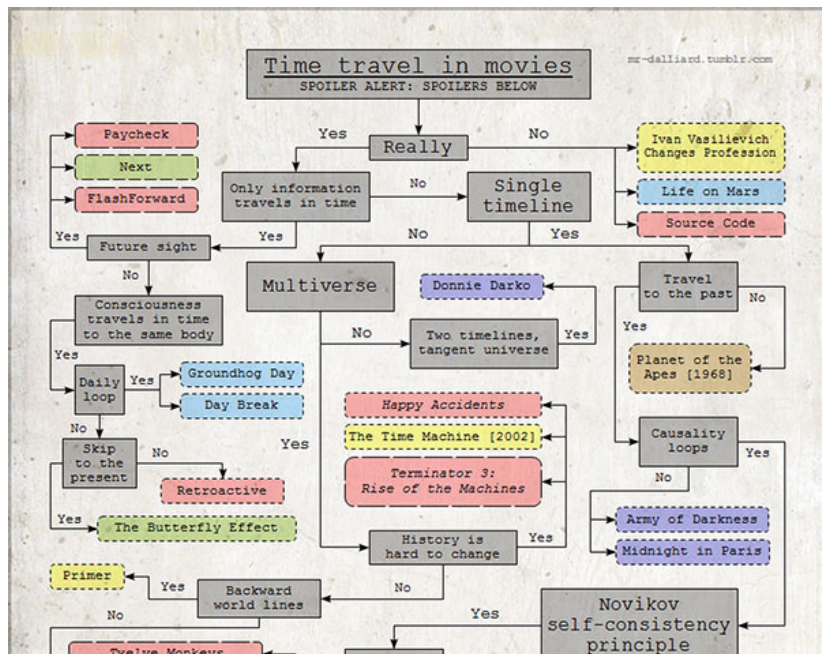
$$\theta : \mathcal{P} \rightarrow \mathcal{P} \cup \{\perp\}$$

# Coalgebras

## **Time capsule based**

$$\theta : \mathcal{P} \times t \rightarrow (\mathcal{P} \times t) \cup \{\perp\}$$

# Pop examples



# Pop examples

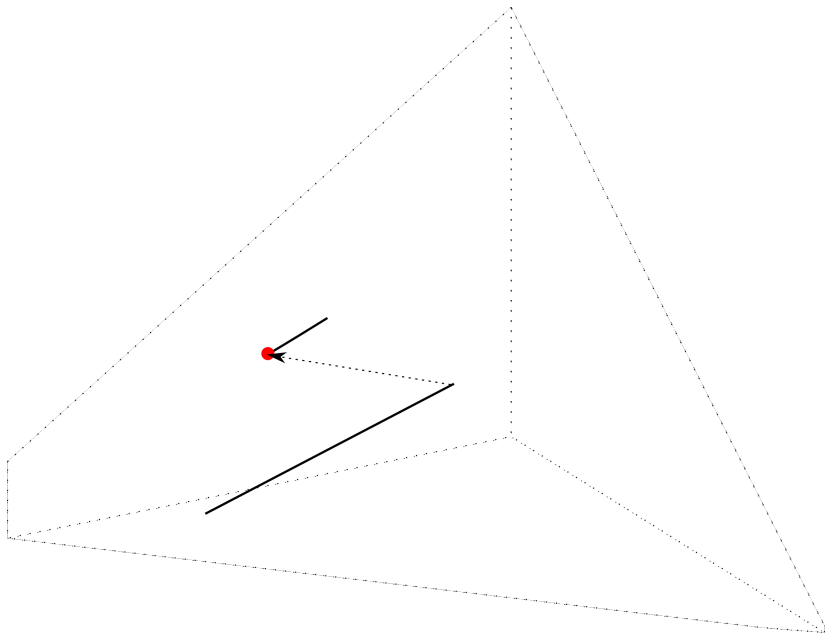
Go to  
While loop  
Object oriented



Go to



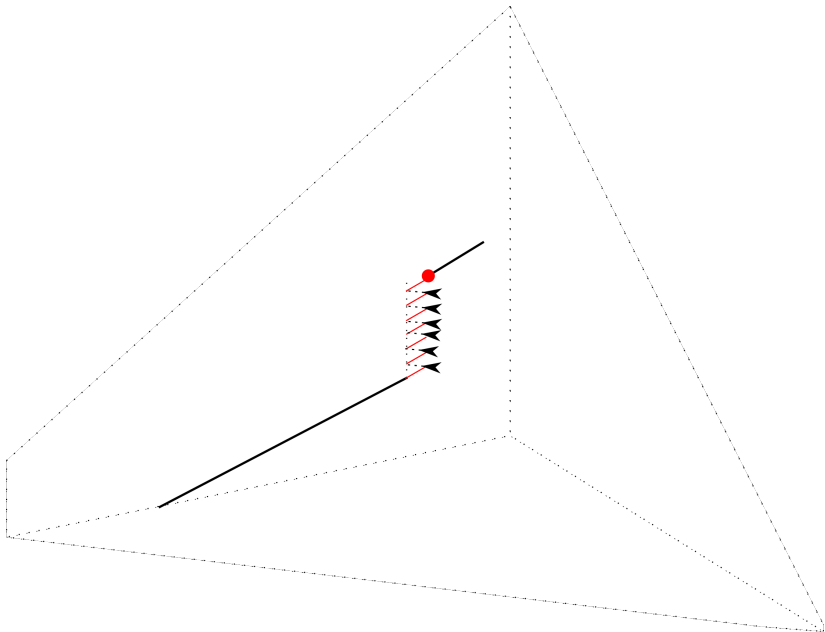
While loop



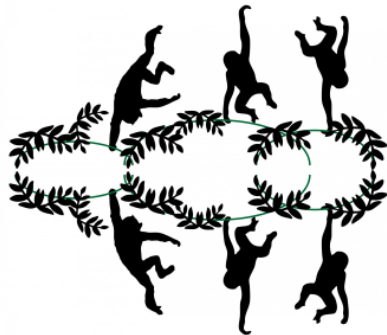
While loop



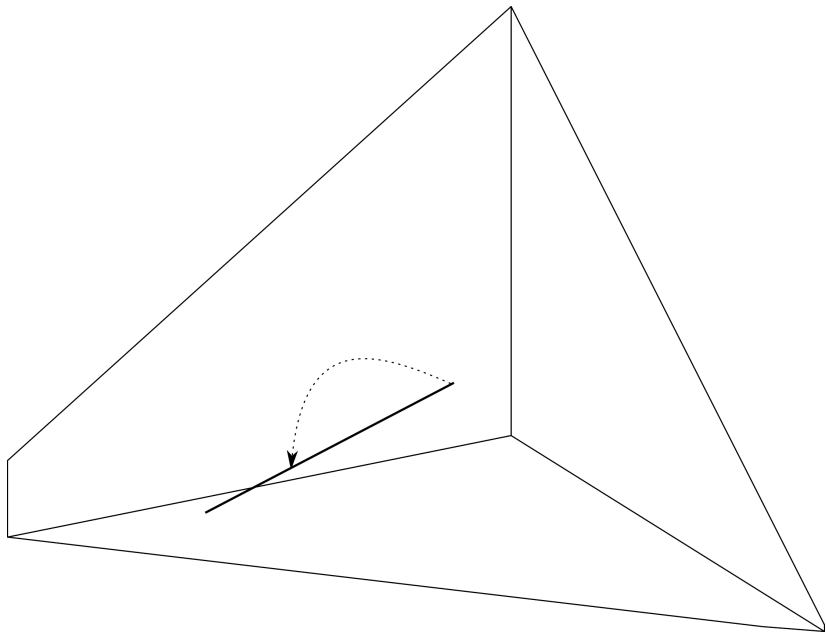
While loop



Object oriented



Object oriented



Take away message

Coalgebraic approach using Platonia





# Main references

- ▶ Barbour, J. (2000). The End of time.
- ▶ Běhounek L., Cintula P. (2006). From fuzzy logic to fuzzy mathematics
- ▶ Blackburn P., van Benthem J., Wolter F. (2007). Handbook of modal logic
- ▶ Cistercea, C. (2017). From Branching to Linear Time, Coalgebraically