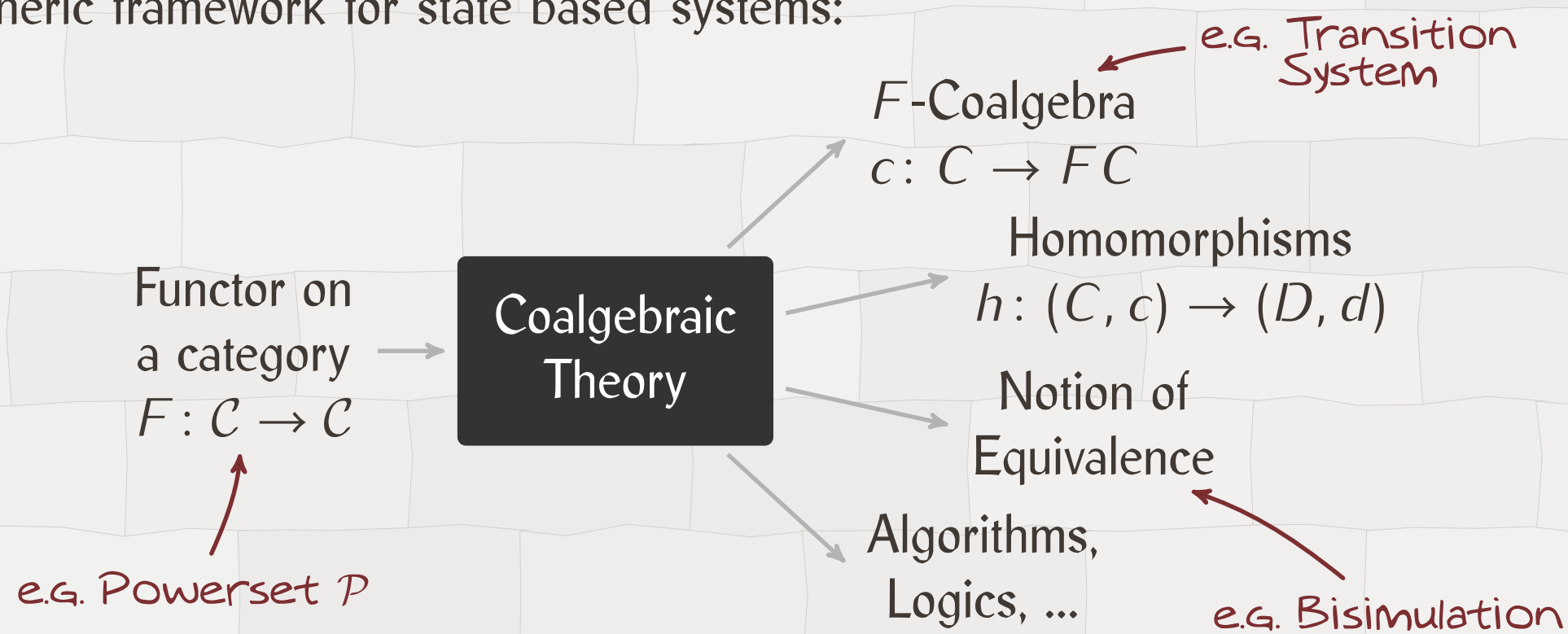
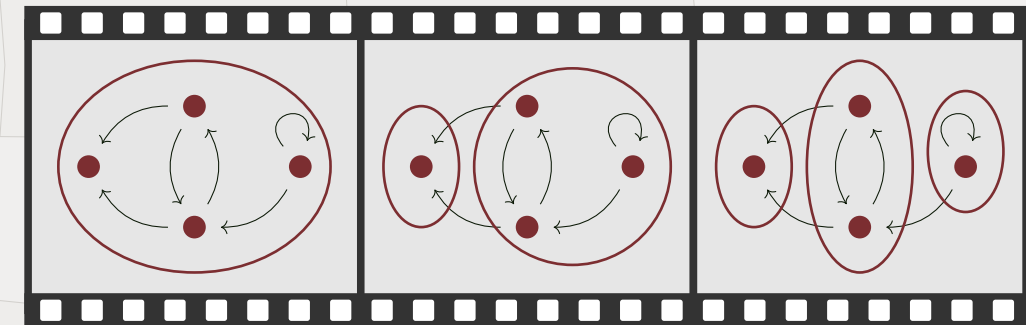


GENERICITY VIA COALGEBRA

Generic framework for state based systems:

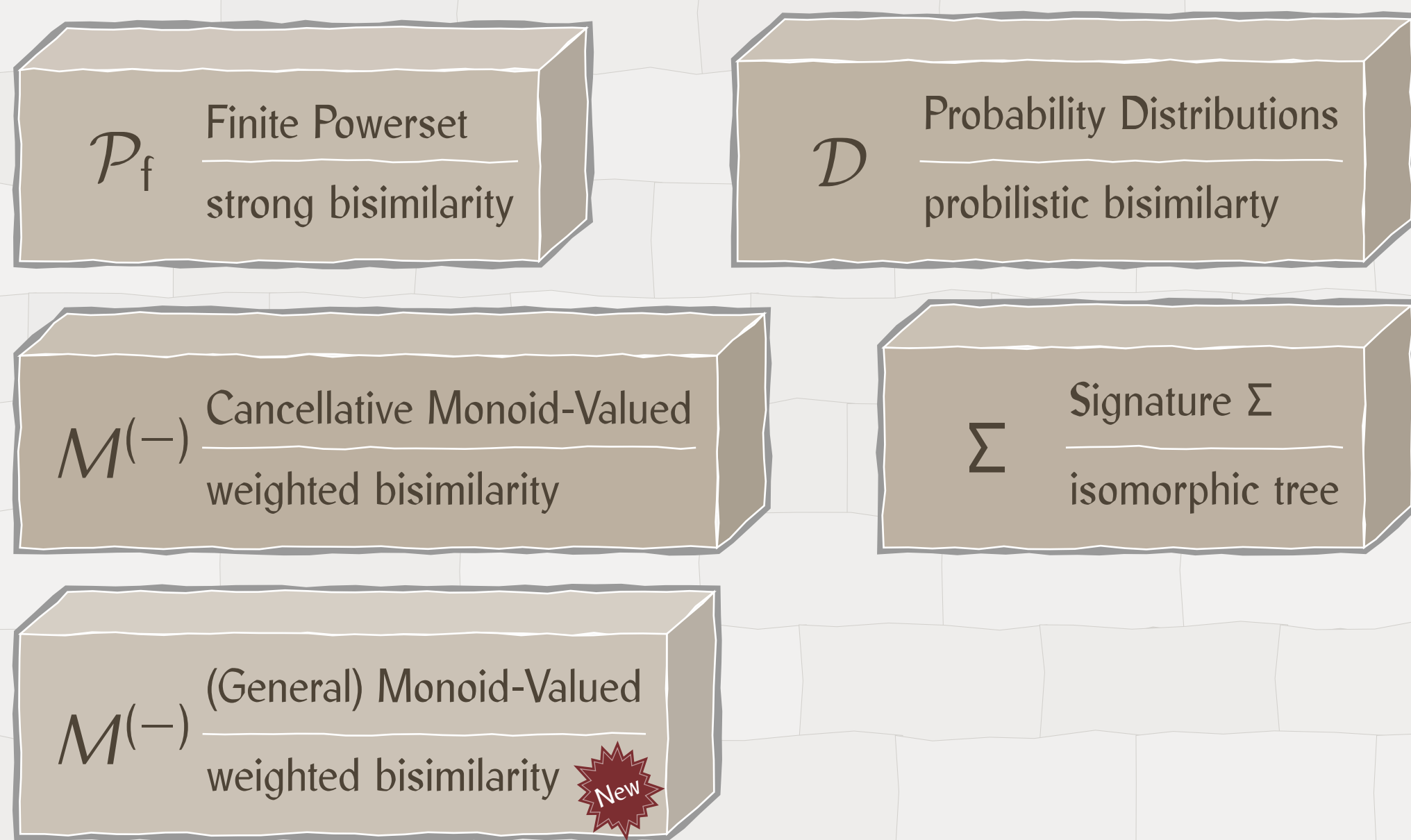


SPECIFIC PARTITION REFINEMENT ALGORITHMS



INPUT

Building blocks for system types and system equivalences:



1. Compose them for the desired system-type:

$$F ::= F \cdot F \mid \underbrace{F \times F \mid F + F \mid (-)^A}_{\text{Subsumes Signatures } \Sigma} \mid \underbrace{C}_{\text{Constant Set}} \mid \mathcal{P}_f \mid \mathcal{D} \mid M^{(-)}$$

2. Define an input F -coalgebra $c: C \rightarrow FC$

For example:

$(\mathbb{Z}, \max) \sim (X \times X)$

- a: $\{(b, a): 3, (a, a): 5\}$
- b: $\{(a, b): 5, (b, b): 2\}$
- c: $\{(b, a): 5, (c, a): 7\}$
- d: $\{(b, a): 5, (a, c): 7\}$

INSTANCES

F -Coalgebras	Functor FX	Run-Time ($m \geq n$)	Specific algorithm
Transition Systems	$\mathcal{P}_f X$	$m \cdot \log n =$	$m \cdot \log n$ Paige, Tarjan '87
Labelled Transition Systems	$\mathcal{P}_f(A \times X)$	$m \cdot \log m =$	$m \cdot \log m$ Dovier, Piazza, Policriti '04
		$>$	$m \cdot \log n$ Valmari '09
Markov Chains	$\mathbb{R}(X)$	$m \cdot \log n =$	$m \cdot \log n$ Valmari, Franceschinis '10
Deterministic Finite Automata	$2 \times X^A$	$n \cdot \log n =$	$n \cdot \log n$ for fixed A Hopcroft '71
Colour Refinement	$\mathbb{N}(X)$	$m \cdot \log n =$	$m \cdot \log n$ Berkholz, Bonsma, Grohe '17
Markov Decision Processes	$\mathcal{P}_f(A \times X) \cdot \mathcal{D}$	$m_{\mathcal{D}} \cdot \log m_{\mathcal{P}} \leq$	$m_{\mathcal{P}} \cdot n \cdot \log m_{\mathcal{P}}$ Baier, Engelen, Majster-Cederbaum '00
Segala Systems		$=$	$m_{\mathcal{D}} \cdot \log m_{\mathcal{P}}$ Groote, Verduzco, Vink '18
Weighted Tree Automata	$M \times M^{(\Sigma X)}$ <small>(M cancellative)</small>	$m \cdot \log^2 m <$ $m \cdot \log m \approx$	$m \cdot n$ Högberg (Björklund), Maletti, May '07 $m \cdot \log n$

- o Concur '17 / Logical Methods in Computer Science '20 (Categorical Constructions and Basic Algorithm)
- o Formal Methods '19 / Formal Aspects of Computing '21 (Implementation & General Monoid-Valued Functors)
- o Extensions: Reachability, Distributed, ...
- o Implementation: CoPaR
git8.cs.fau.de/software/copar

