Attribute Multiset Grammars for Global Explanations of Activities

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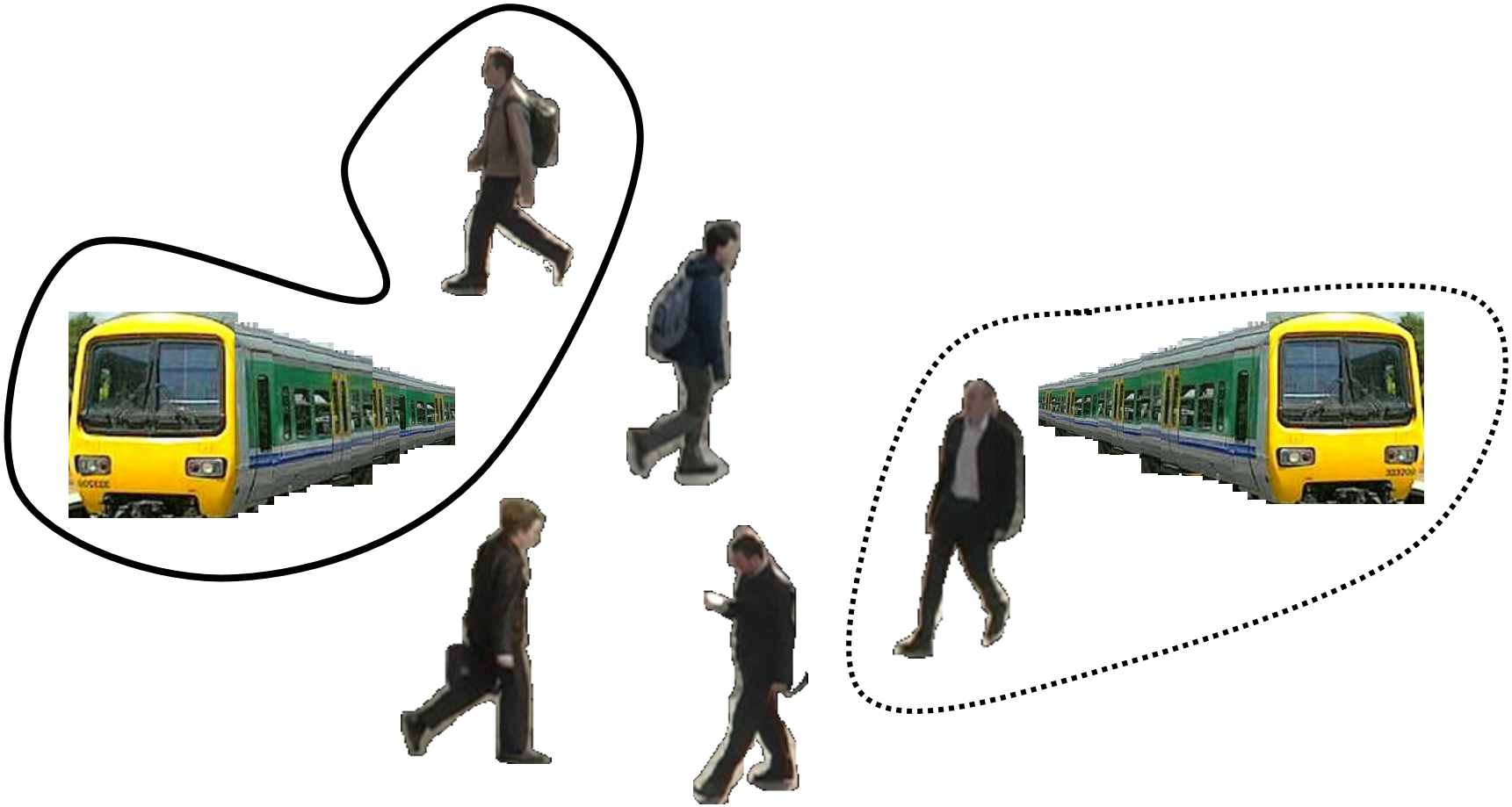
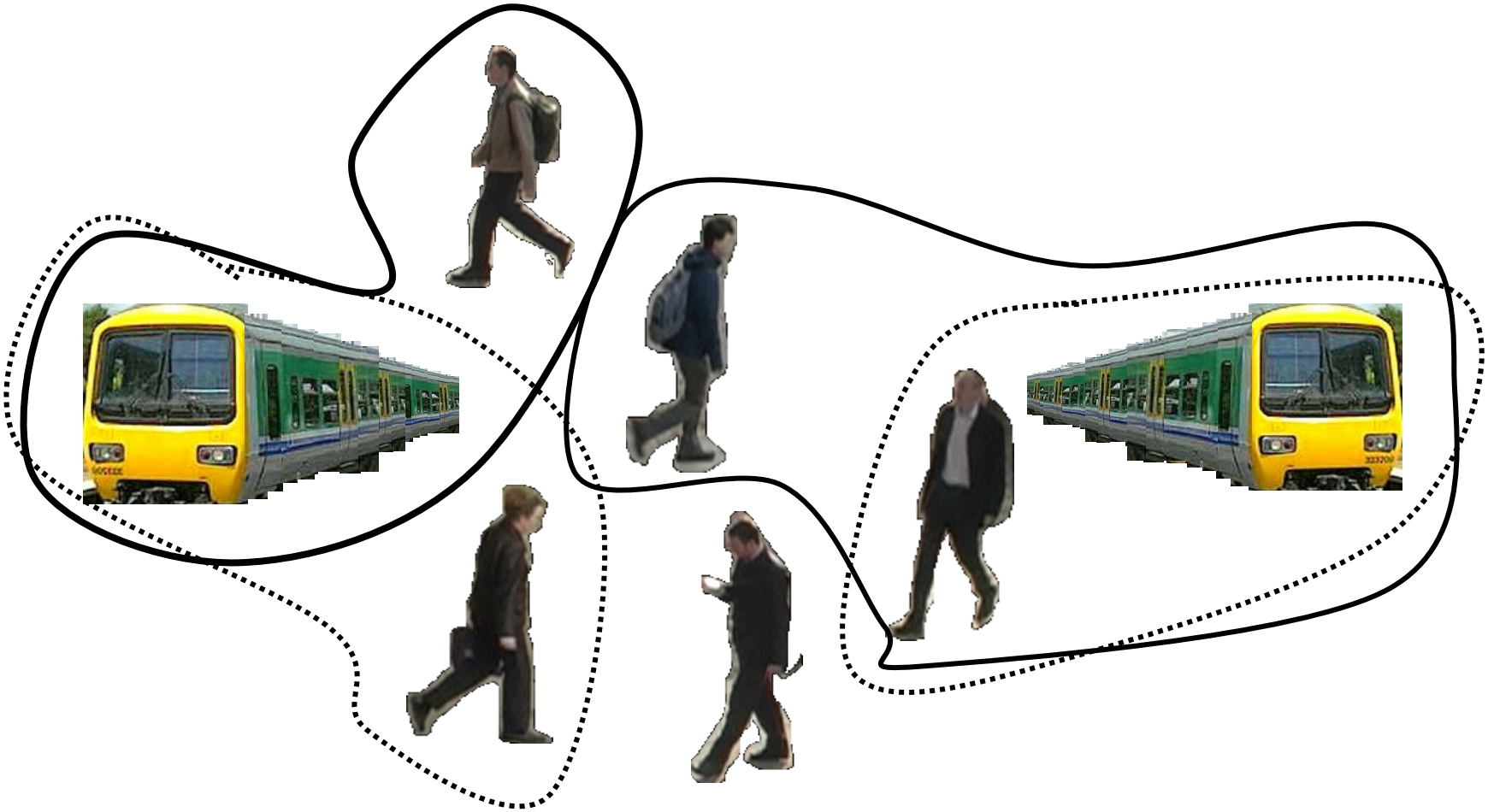
Activity Recognition

Activity Recognition

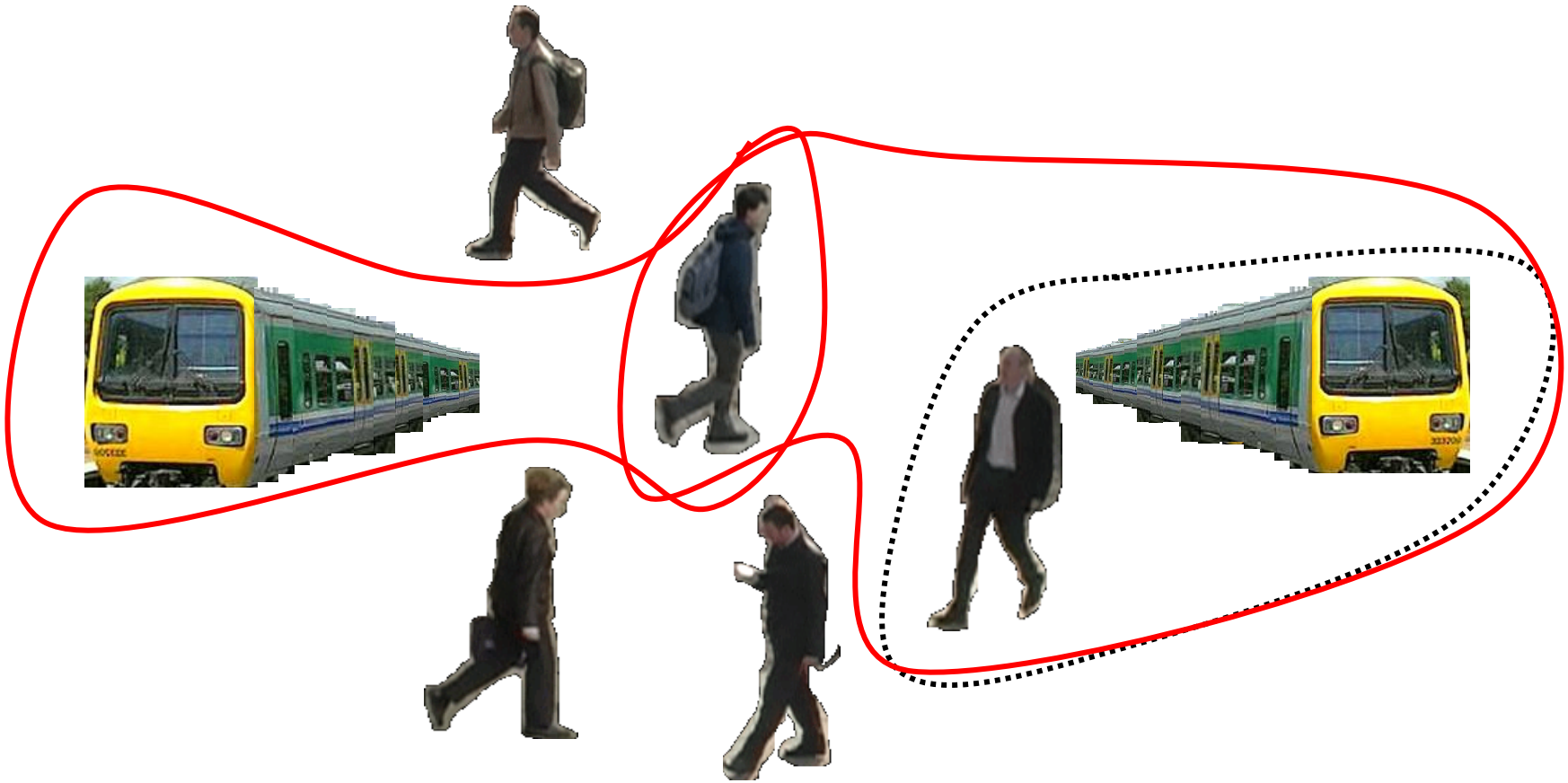
Activity Recognition



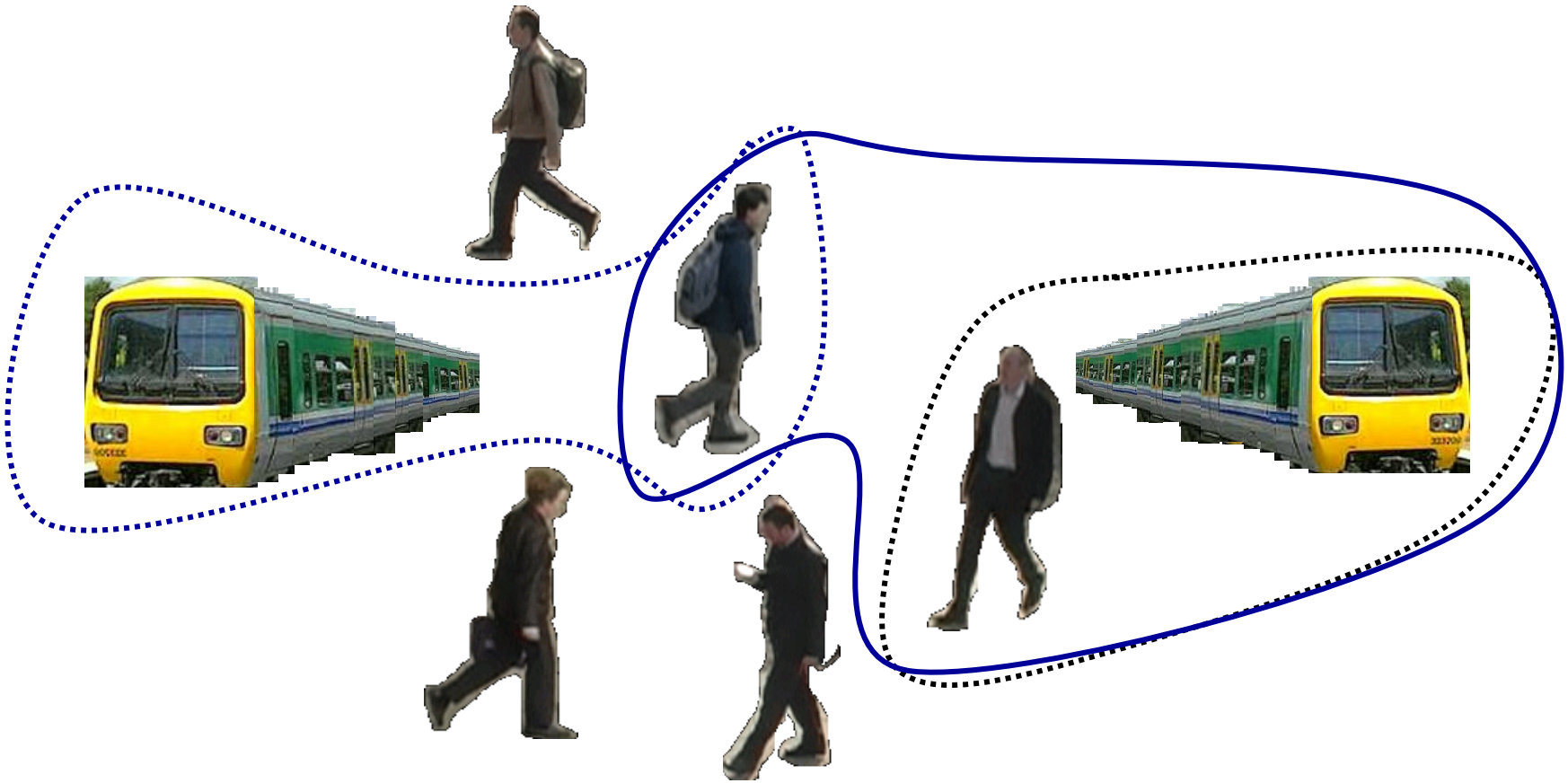
Activity Recognition



Activity Recognition



Activity Recognition

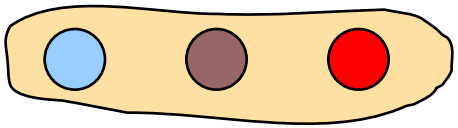


Contribution

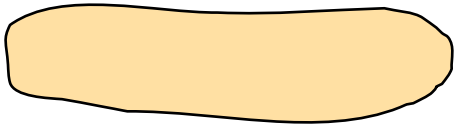
- Define global explanations using Attribute Multiset Grammars
- Parsing a set of detections →recognition
- Bayesian approach to finding the best parse tree
- Two case studies

Activity Recognition

Event Definition

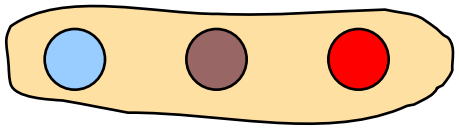


1 event

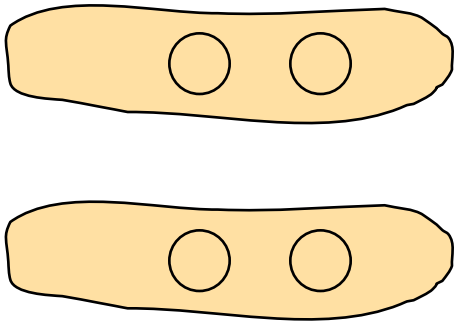


Activity Recognition

Event Definition



Event Threads



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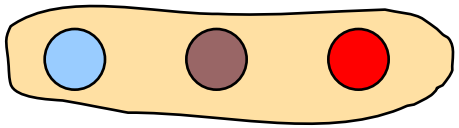
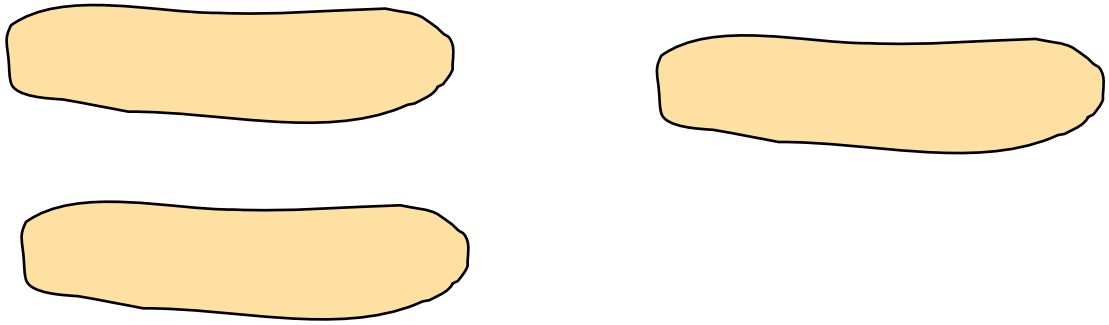
Activity Recognition

Event Definition

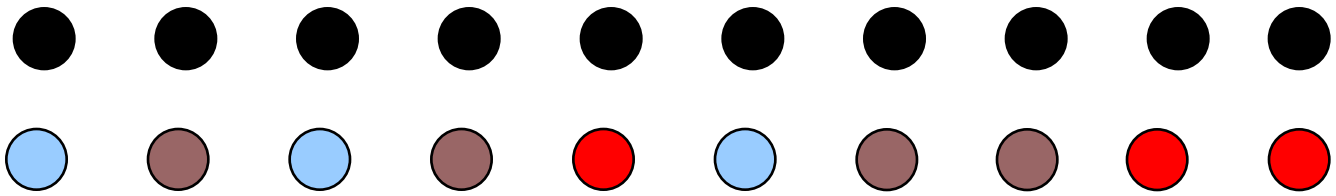


Global Explanation

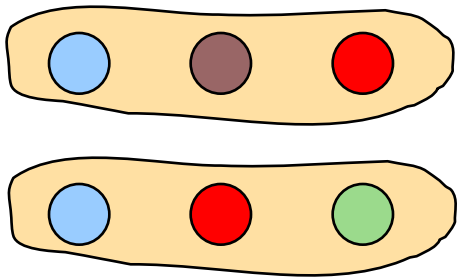


Activity Recognition

- Uncertain detections

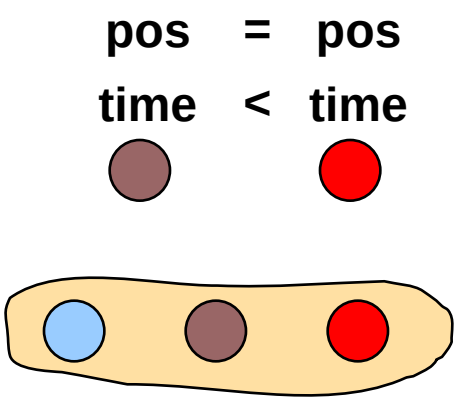


- Multiple definitions

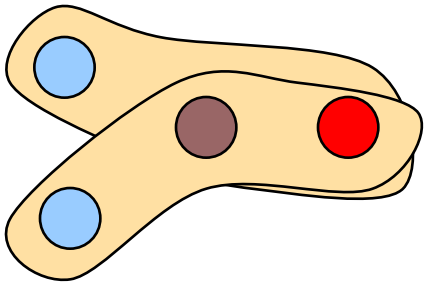


Activity Recognition

- Intra-activity constraints
  - Temporal Constraints
  - Spatial Constraints
  - Other Geometric Constraints

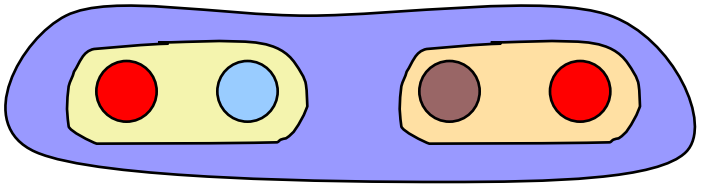


- Inter-activity constraints

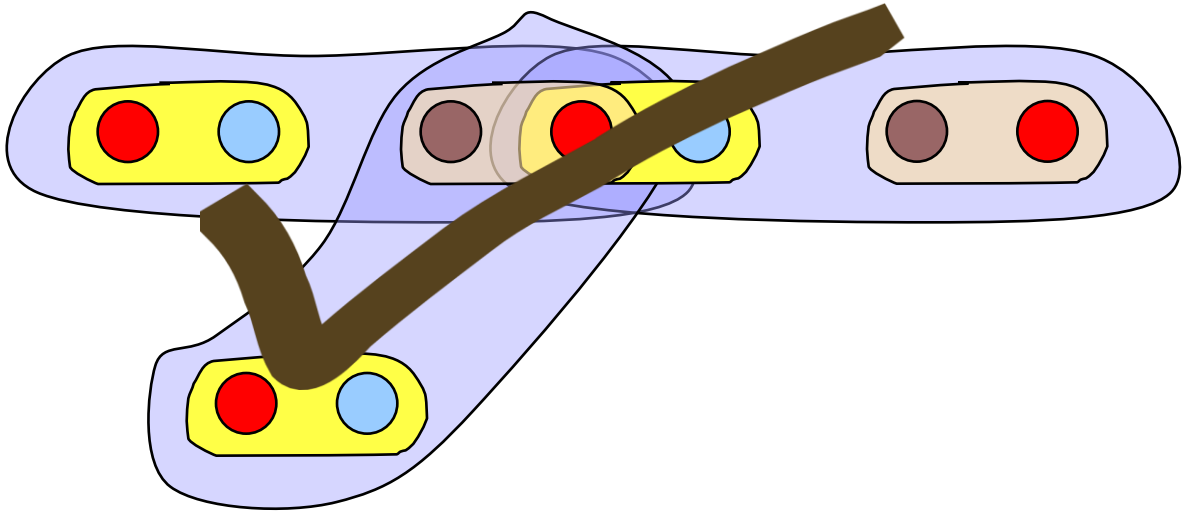


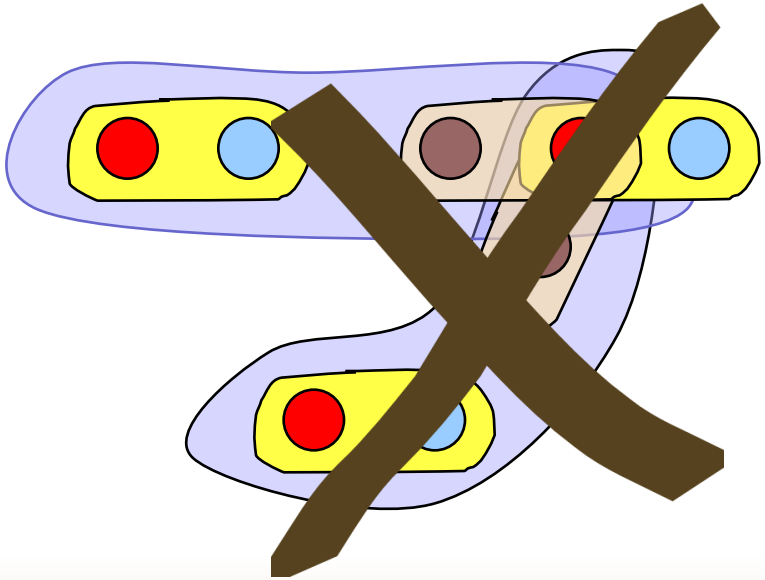
Activity Recognition

- Complex events

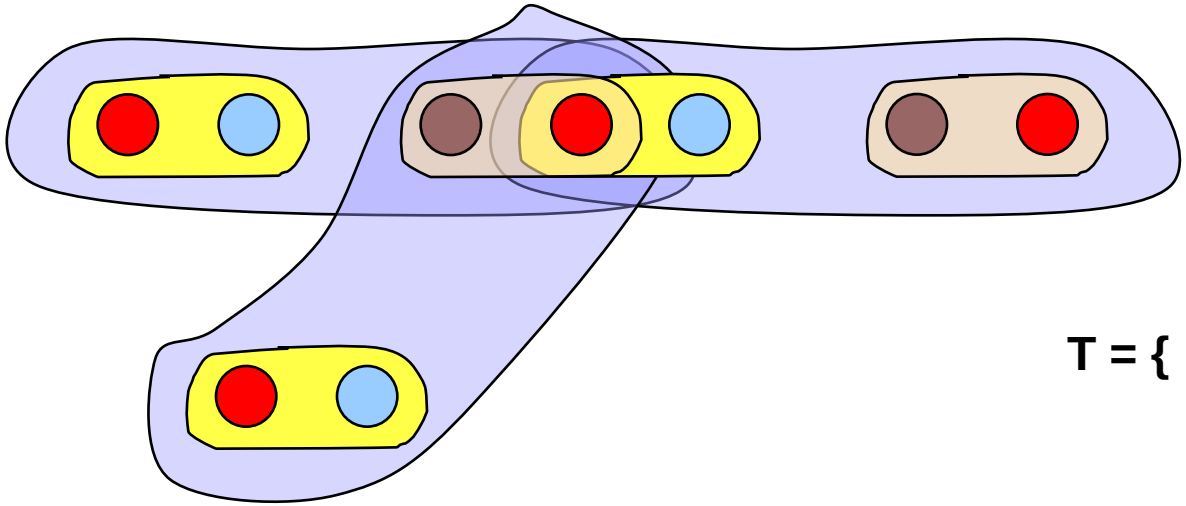


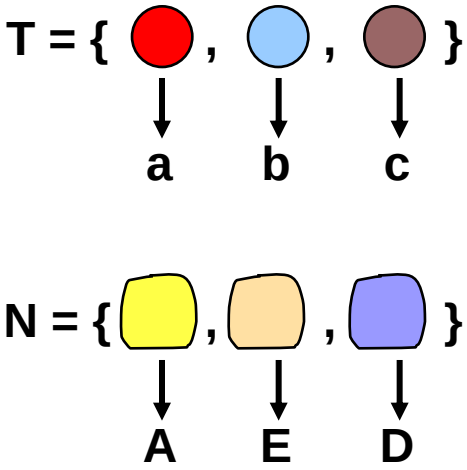
Definition using AMG





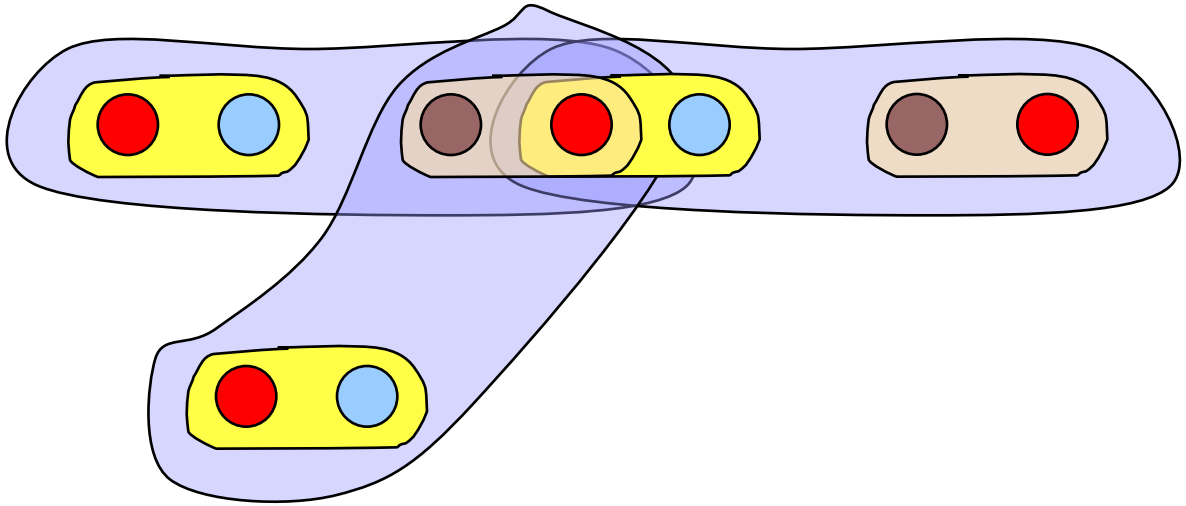
Definition using AMG





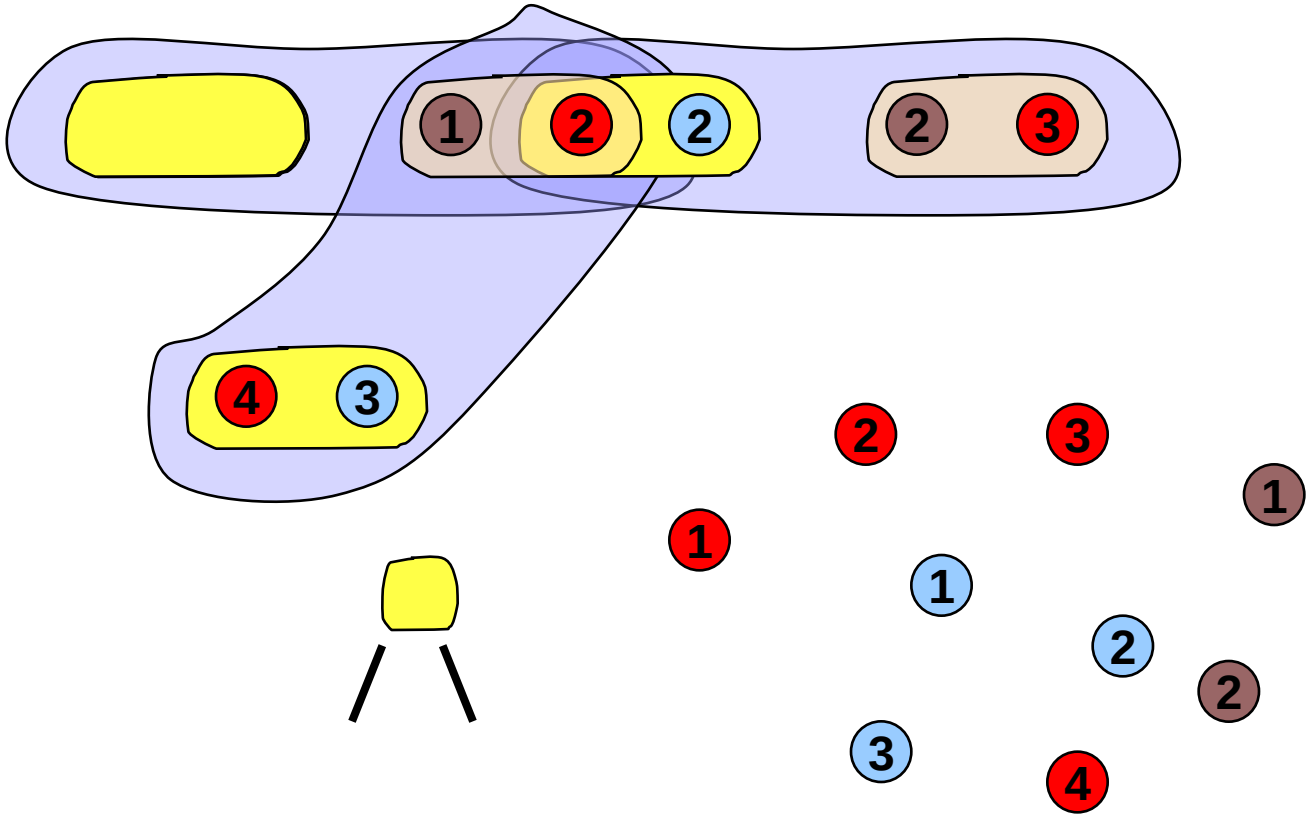
Synthetic Rule	Attribute Rule	Attribute Constraints
A → a, b	…	a.time < b.time

Definition using AMG

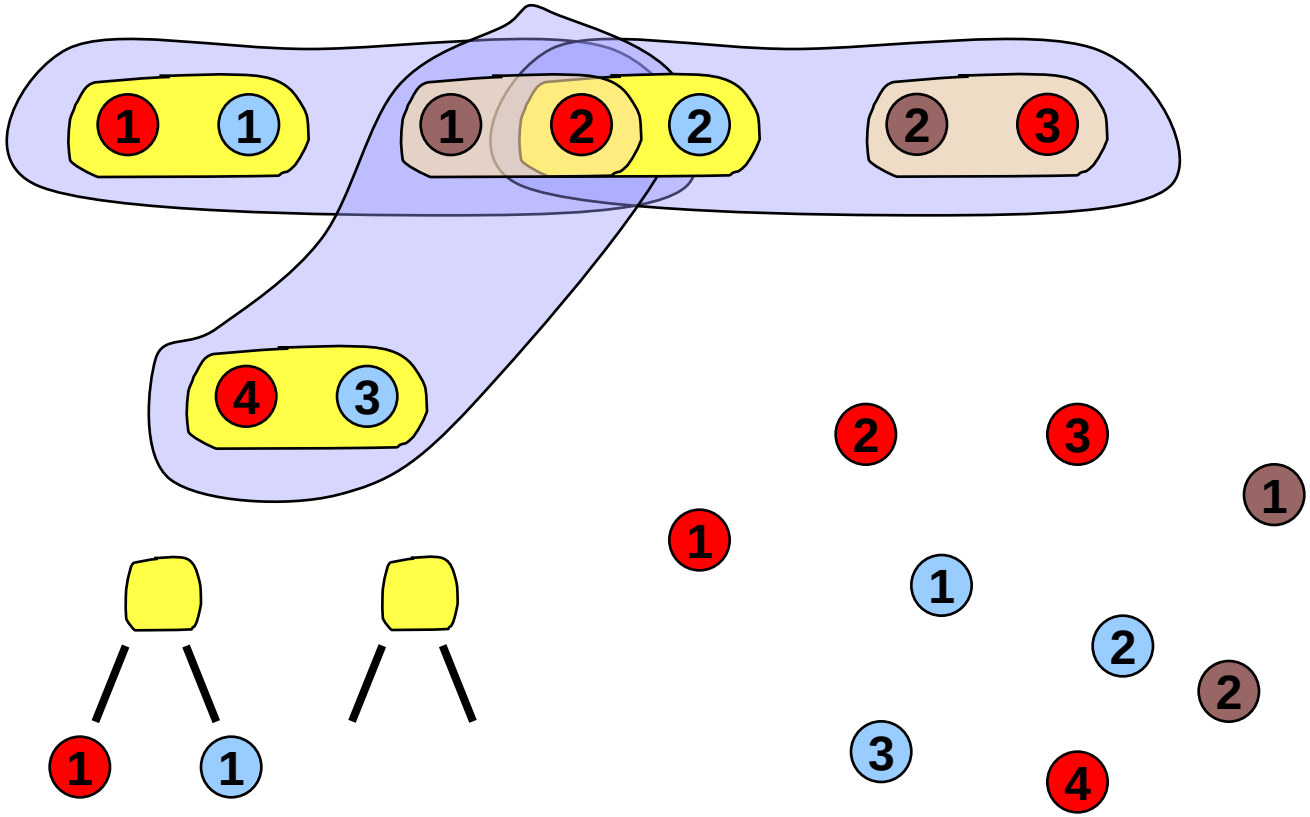


E → a, c		**c.count < 1**
D → A, E	**….**	
Synthetic Rule	**Attribute Rule**	**Attribute Constraints**
A → a, b	**…**	**a.time < b.time**

Definition using AMG



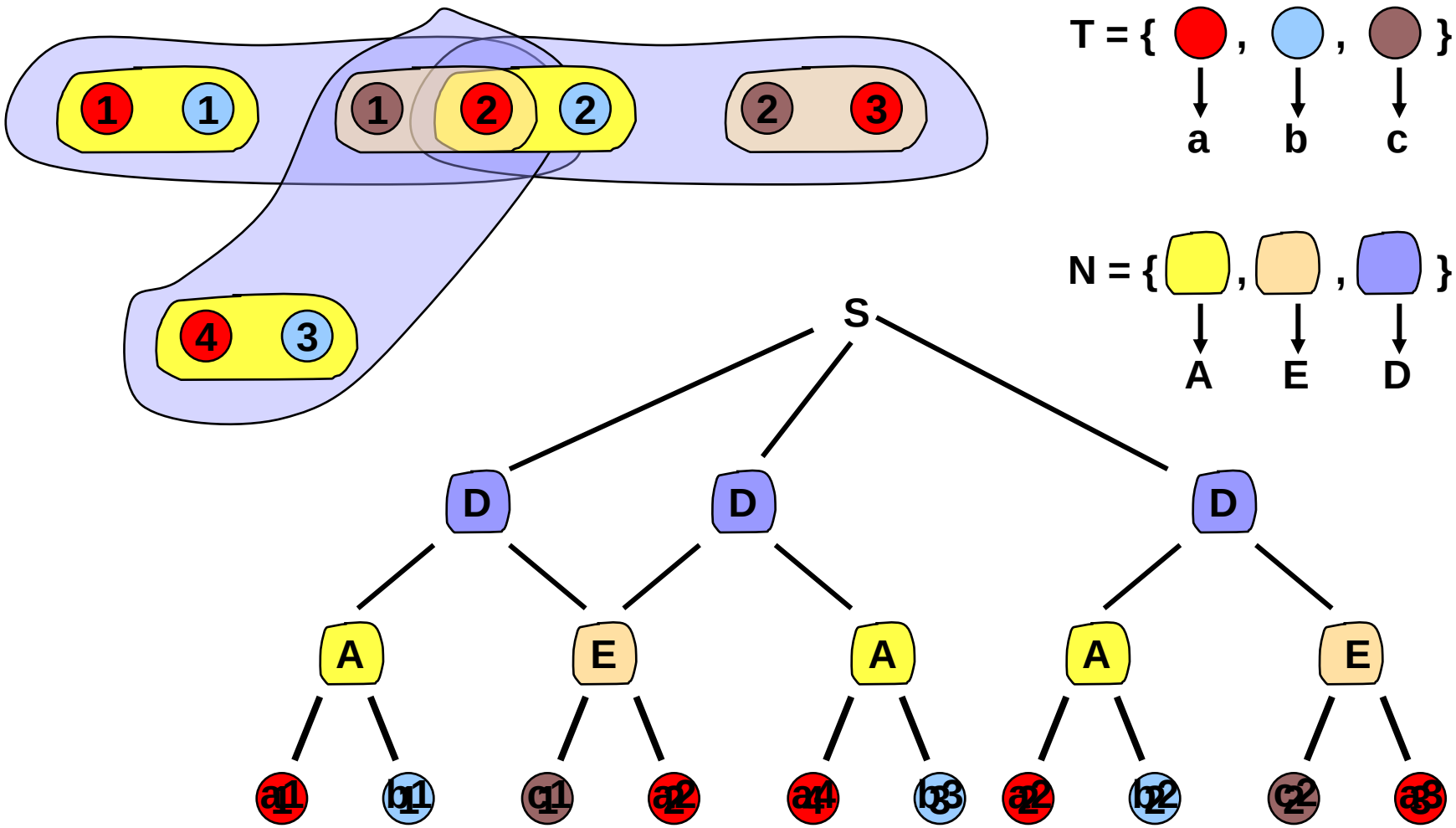
Definition using AMG



Synthetic Rule **Attribute Rule** **Attribute Constraints**

A → a, bA.dist = a.pos – b.pos **a.time < b.time**

Definition using AMG

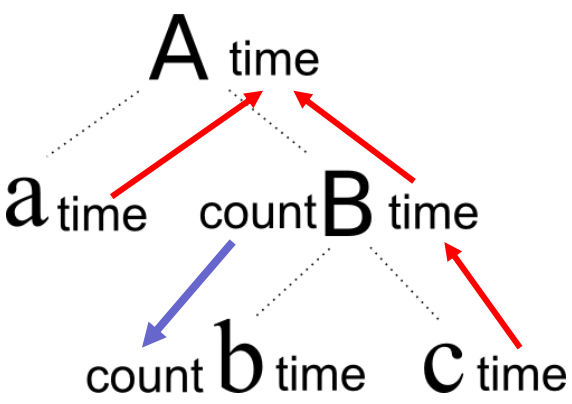


Definition using AMG

- Attribute Multiset Grammars

$$G = (N,\ T,\ S,\ A,\ P)$$

detections

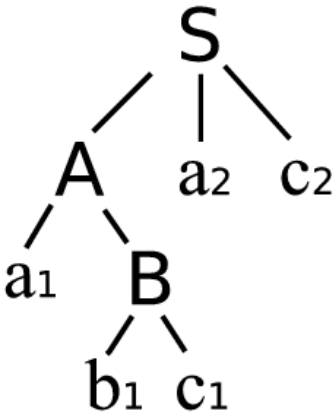


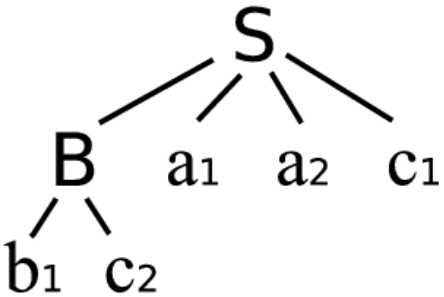
Production Rules (P):

rule	Syntactic Rule (r)			Attribute Rules (M)			Attribute Constraints (C)		
p_1	S	$\rightarrow$	$A^\star, B^\star, a^\star, c^\star$						
p_2	A	$\rightarrow$	a, B	A.time	=	a.time+B.time	a.time	$<$	B.time
				B.count	=	1	B.count	$\neq$	1
p_3	B	$\rightarrow$	b, c	B.time	=	c.time	b.time	$<$	c.time
				b.count	=	B.count	b.count	$\neq$	1

Recognition using AMG

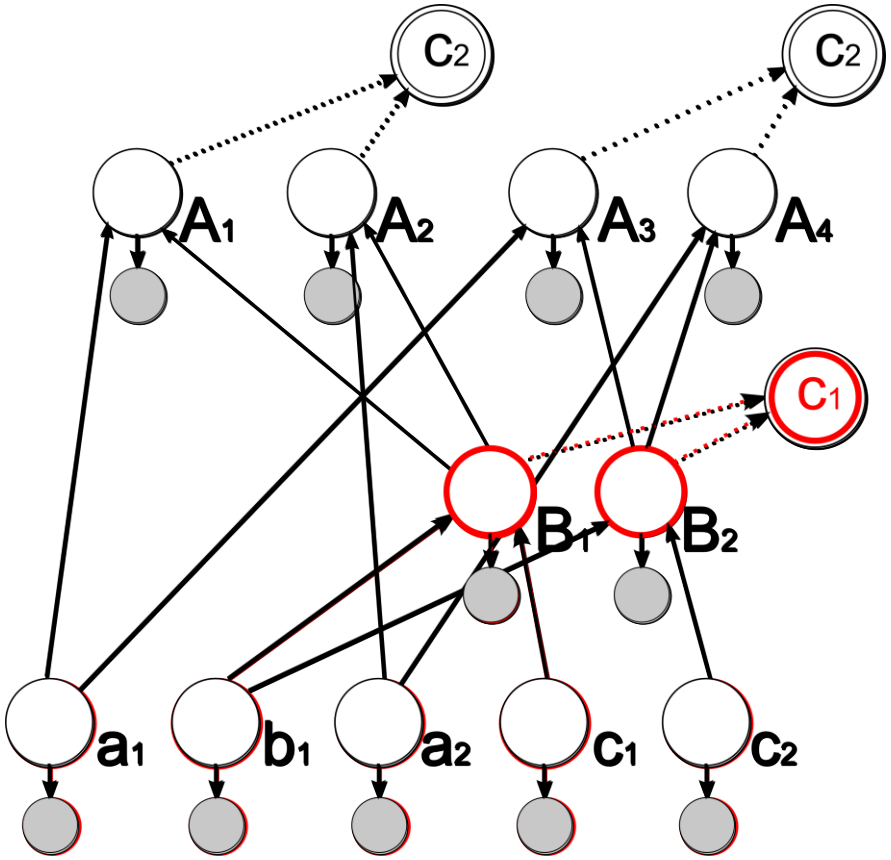
$D = \{a_1, a_2, b_1, c_1, c_2\}$





Recognition using AMG

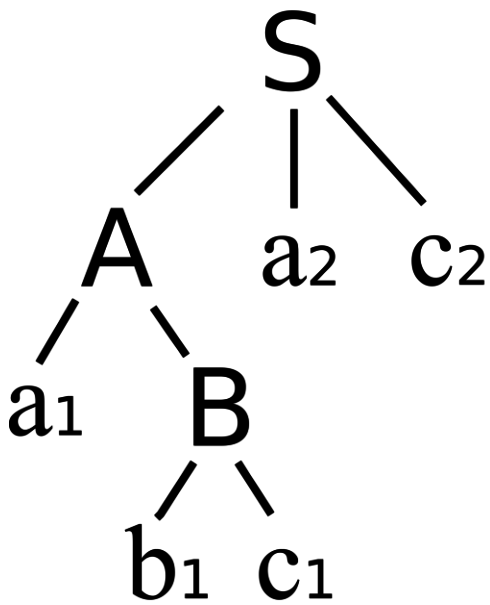
$D = \{a_1, a_2, b_1, c_1, c_2\}$

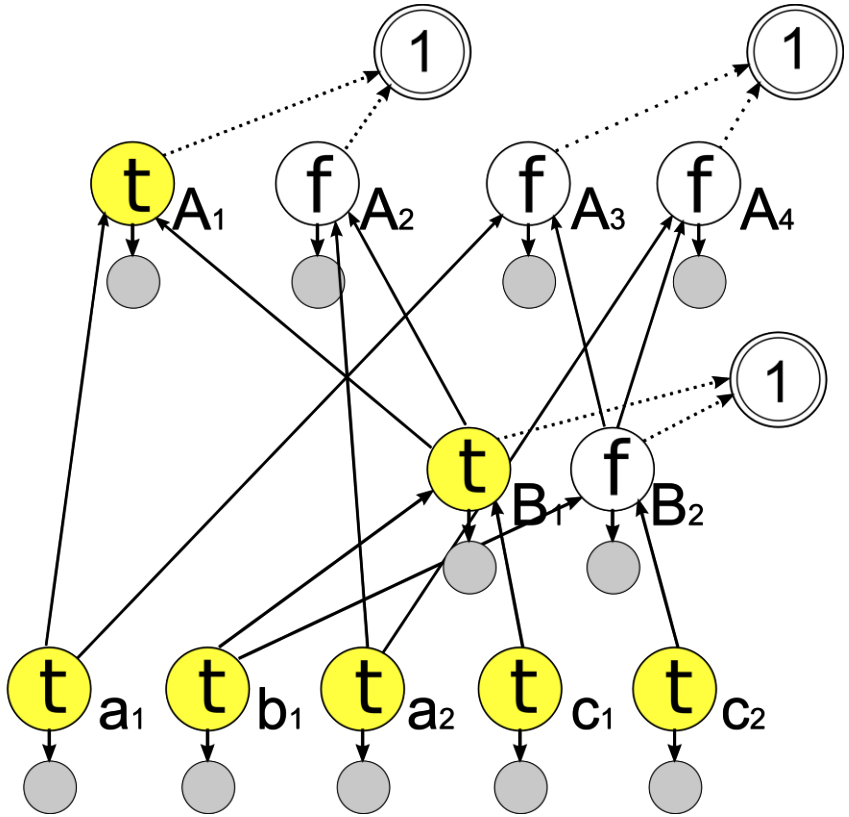


Algorithm in Paper

Recognition using AMG

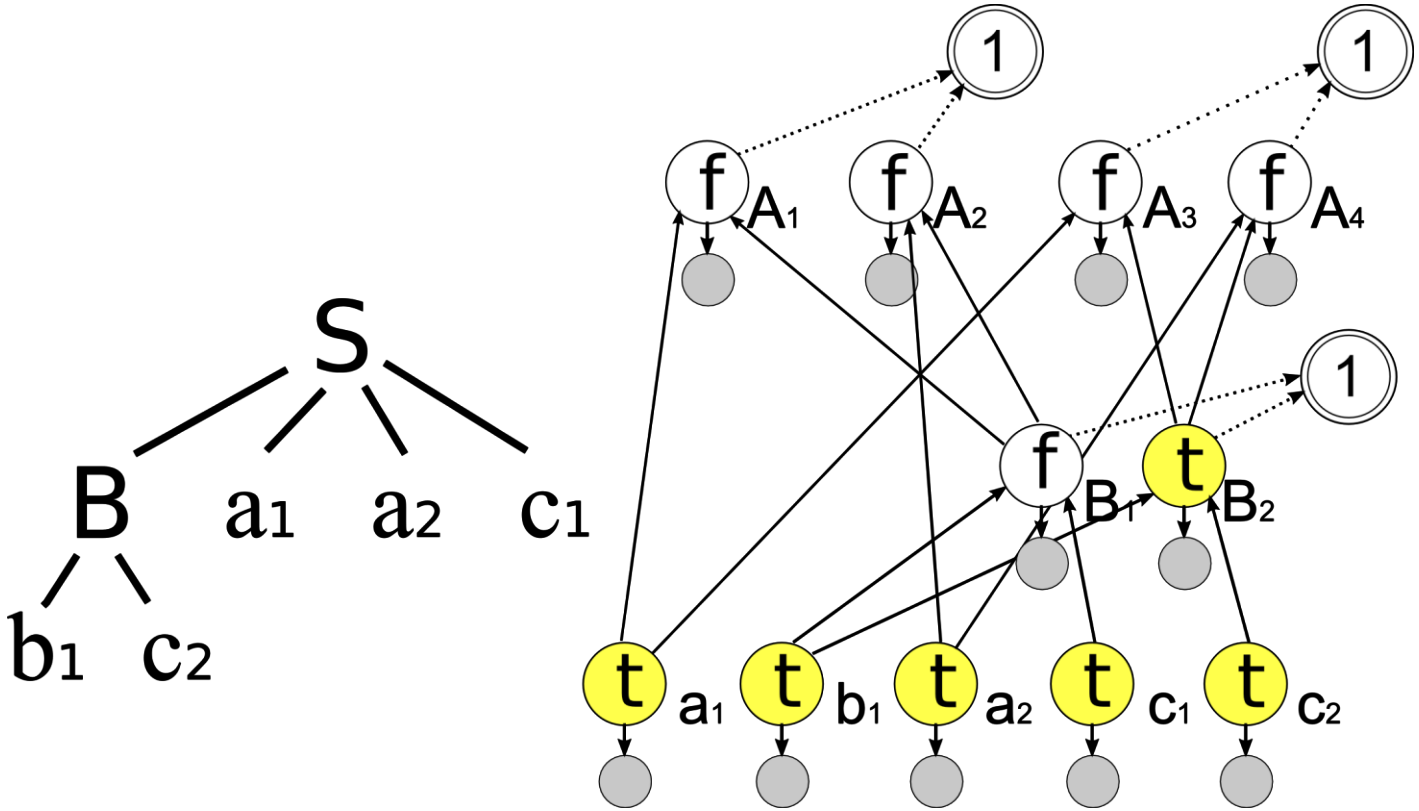
$D = \{a_1, a_2, b_1, c_1, c_2\}$



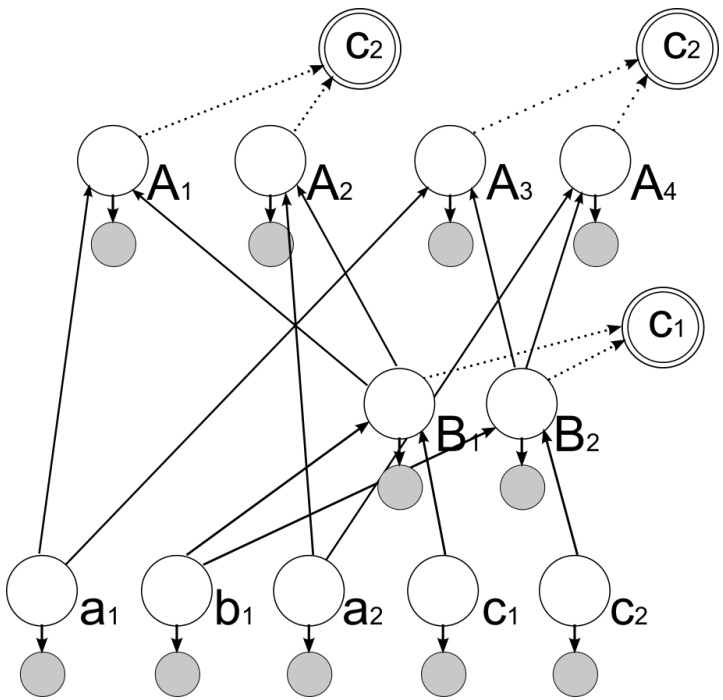


Recognition using AMG

$D = \{a_1, a_2, b_1, c_1, c_2\}$

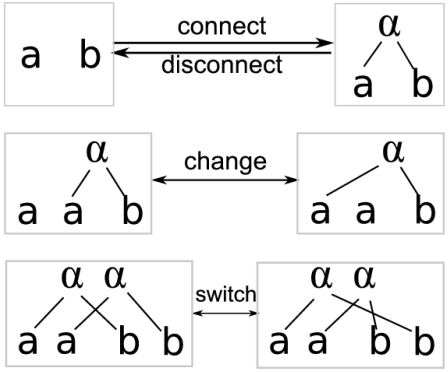


Recognition using AMG



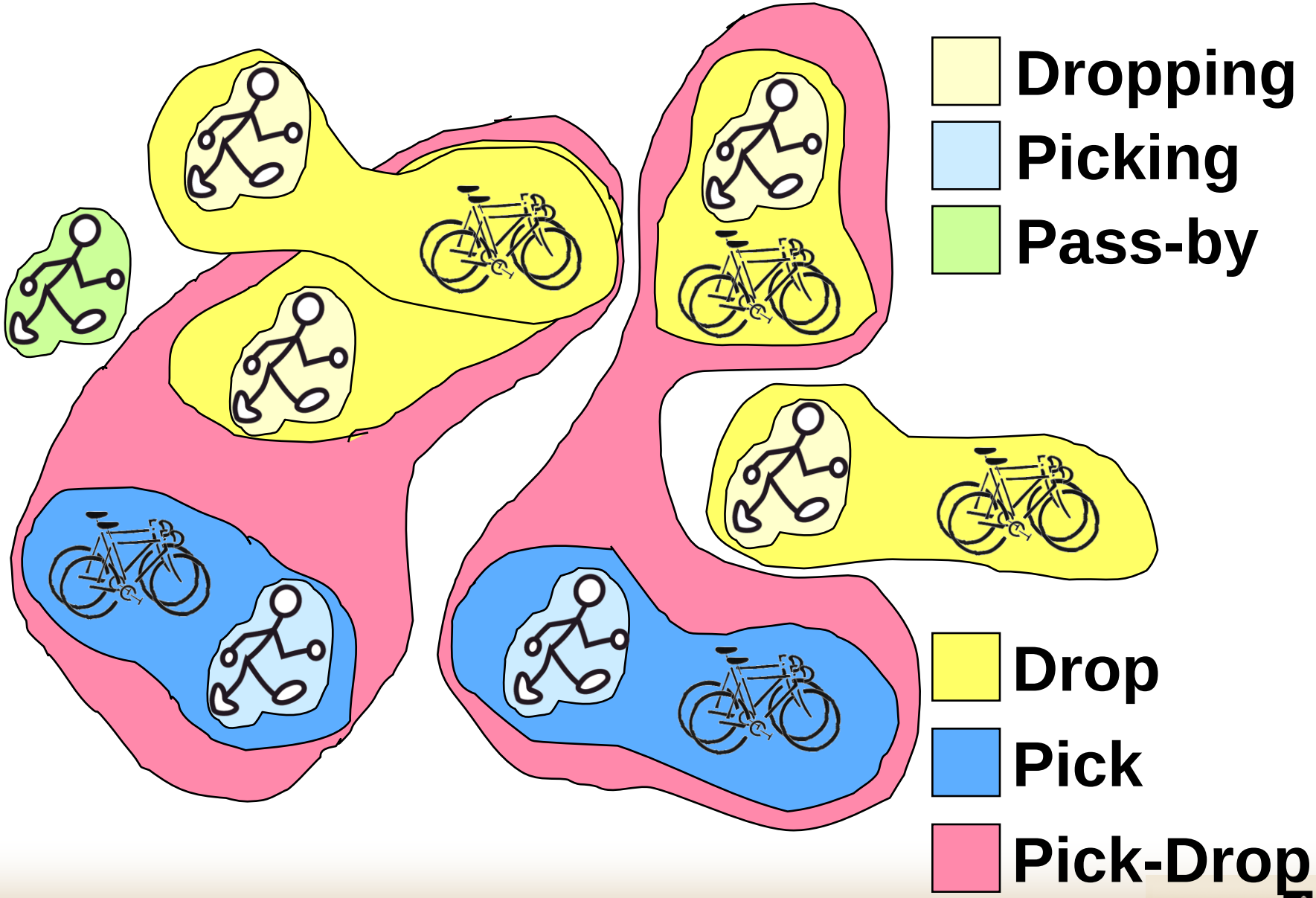
Searching the space of explanations [CVPR 09]

- **Greedy Search**
- **Multiple Hypotheses Tree [BMVC 07]**
- **Reversible Jump Markov Chain Monte Carlo**



Case I : The Bicycles Problem

The Bicycles Problem



The Bicycles AMG

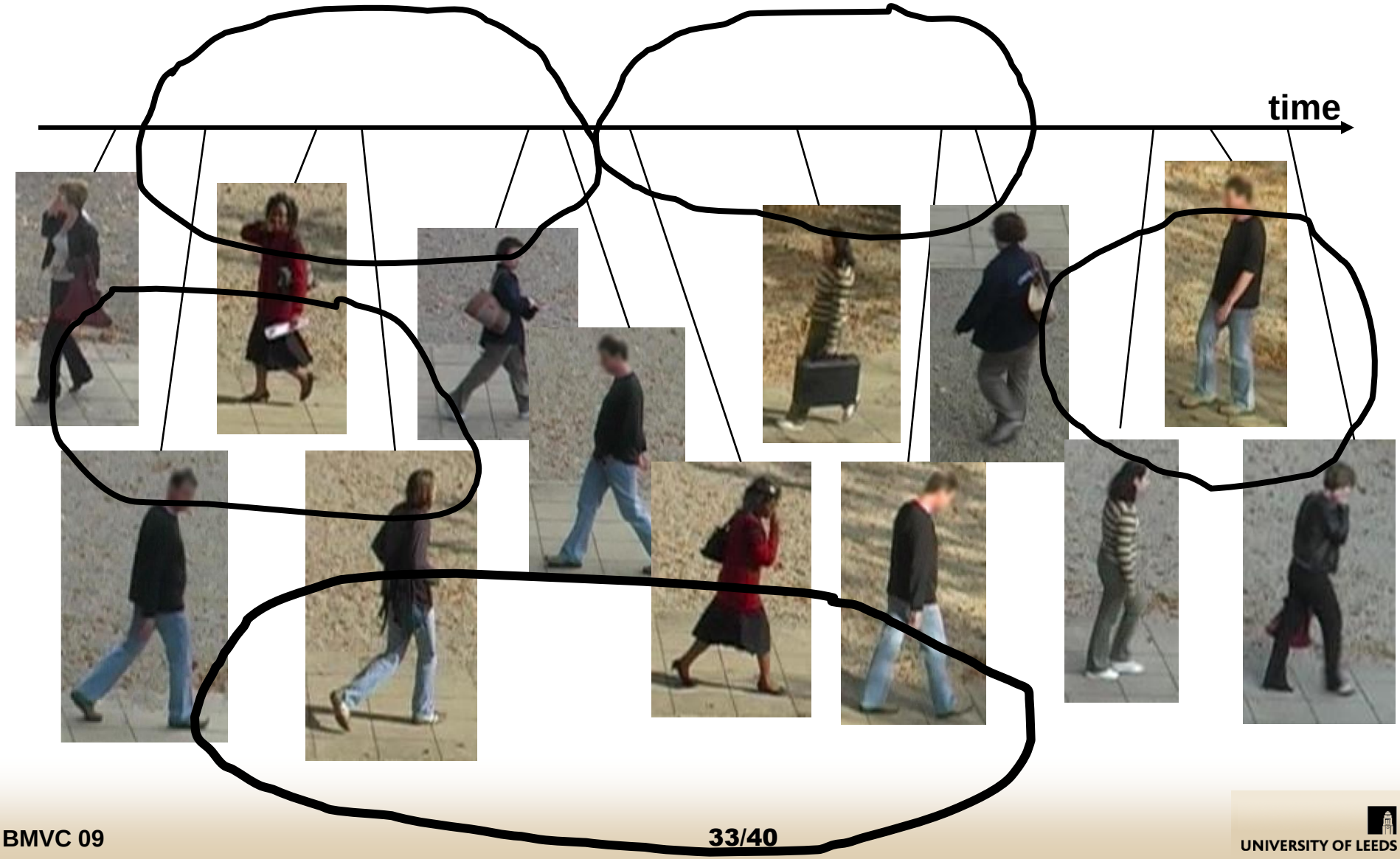
Syntactic Rule (r)				Attribute Rules (M)			Attribute Constraints (C)		
p_1	S	$\rightarrow$	$V^\star, x^\star, y^\star$	y.action	=	"noise"	y.count	$<$	1
				x.action	=	"pass-by"	x.count	$\neq$	1
p_2	V	$\rightarrow$	Z_1, Z_2	V.action	=	"drop-pick"	Z_1.au	$<$	Z_2.au
				Z_1.action	=	"drop"	Z_1.count	$\neq$	1
				Z_2.action	=	"pick"	Z_2.count	$\neq$	1
				V.match	=	ψ_V (Z_1.pos, Z_2.pos)			
				Z_1.count	=	Z_2.count = 1			
p_3	V	$\rightarrow$	Z, u	V.action	=	"drop-only"	Z.count	$\neq$	1
				Z.action	=	"drop"			
				Z.count	=	1			
p_4	V	$\rightarrow$	u, Z	V.action	=	"pick-only"	Z.count	$\neq$	1
				Z.action	=	"pick"			
				Z.count	=	1			
p_5	Z	$\rightarrow$	x, y	x.action	=	Z.action	x.au	=	y.au
				y.action	=	Z.action	x.count	$\neq$	1
				Z.au	=	x.au			
				Z.pos	=	y.pos			
				Z.match	=	ψ_Z (x.traj, y.pos)			
				x.count	=	1			
				y.count	=	y.count+1			

Case II: The Enter-Exit Problem

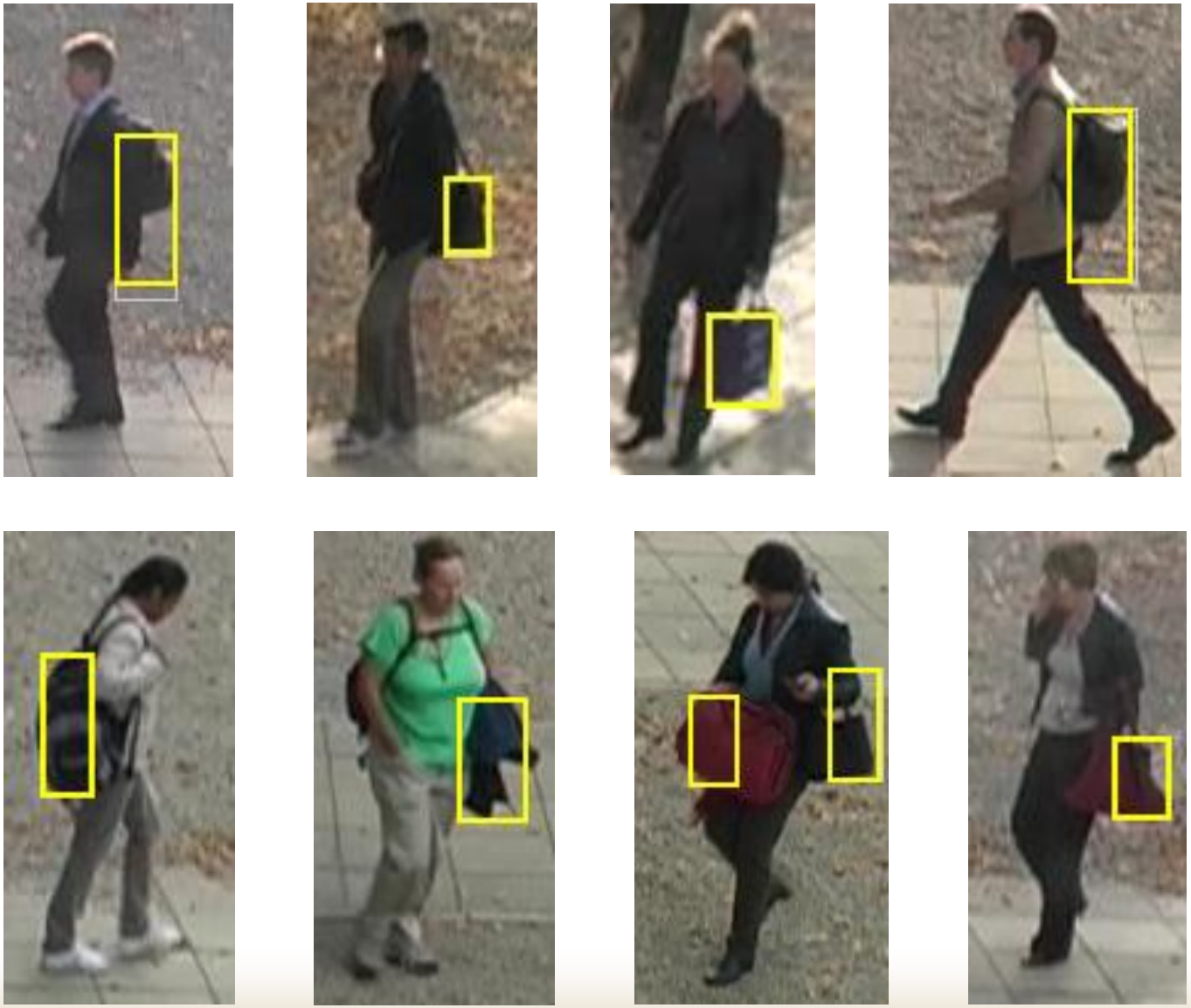
Global Explanation

- Global explanation

Global Explanation

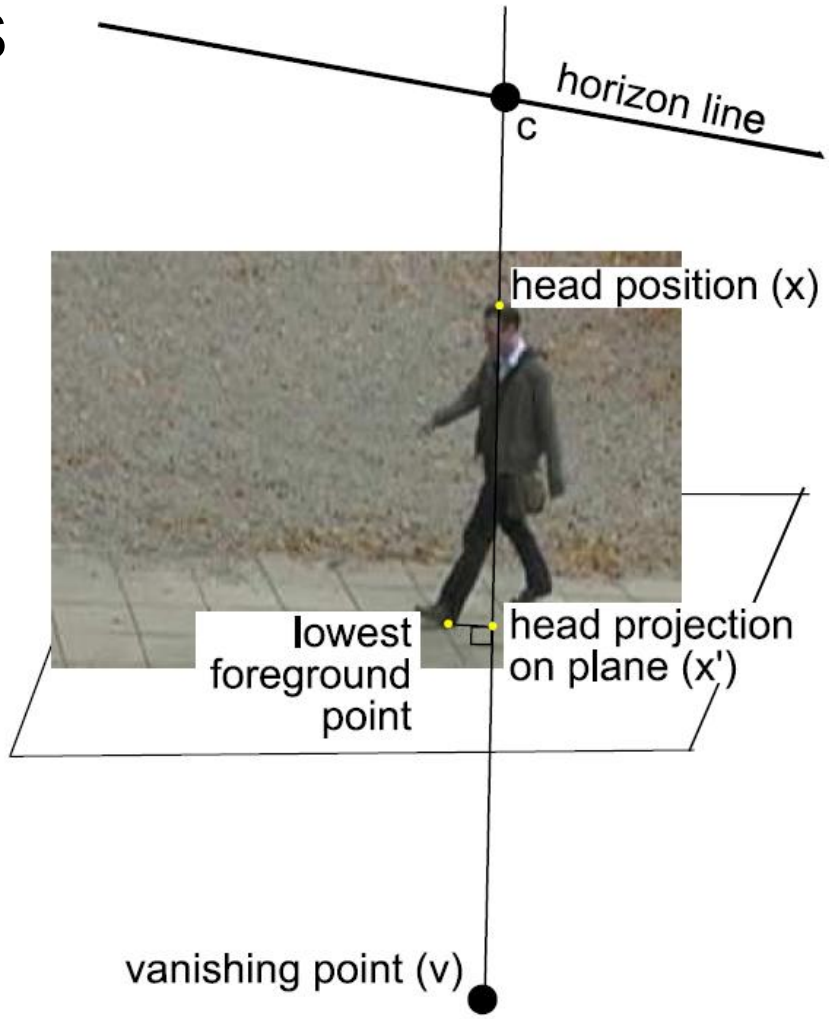


Using Baggage Detector [ECCV 08]



Selected Features

1. Matching Heights



Selected Features

2. Clothing Colour

Selected Features

3. Baggage Colour

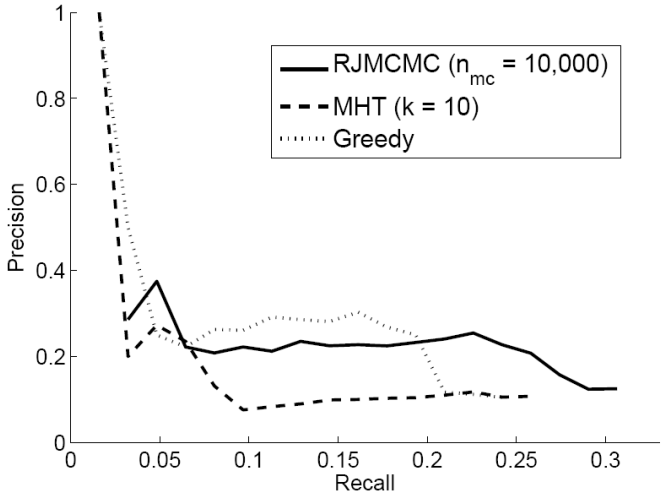
Selected Features

4. Baggage Relative Height

Experiment

- 12 hours
- 326 people
- 429 candidate bags
- 62 ground truth pairs

Results



	Local	Global		
		Greedy	MHT	RJMCMC
Paired	13	14	16	19
Unpaired	49	48	46	43
Incorrect Pairs	173	133	135	142

Conclusion

- Defining activity using AMG
  - Hierarchies of events
  - Multisets
  - Intra-activity constraints → synthetic attributes
  - Inter-activity constraints → inherited attributes
- Finding the best parse tree → Recognition
  - Building BN
  - Searching for MAP
- Two case studies
- Future work

Thank you ☺

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