HD-automata with distinctions

Emilio Tuosto
University of Leicester

joint work with
Kidane Yemane & Marino Miculan

Menu

- A glimpse of HD-automata
- Why distinctions?
- HD-automata with distinctions
- Conclusions

Ingredients bought from...

- Ghani, Yemane, Victor [CMCS04]
- Cattani, Sewell [lics00]
- Fiore, Turi, Plotkin [lics99]
- Gabbay, Pitts [lics99]
- Fiore, Moggi, Sangiorgi [lics96]
- Stark [lics96]
- ...

time

for a comparison, see
Fiore-Staton [CMCS04]
and
Gadducci-Miculan-Montanari [HO Sym. Comp. 06]

names and binders in semantic models

An Operational Model for HD Formalisms

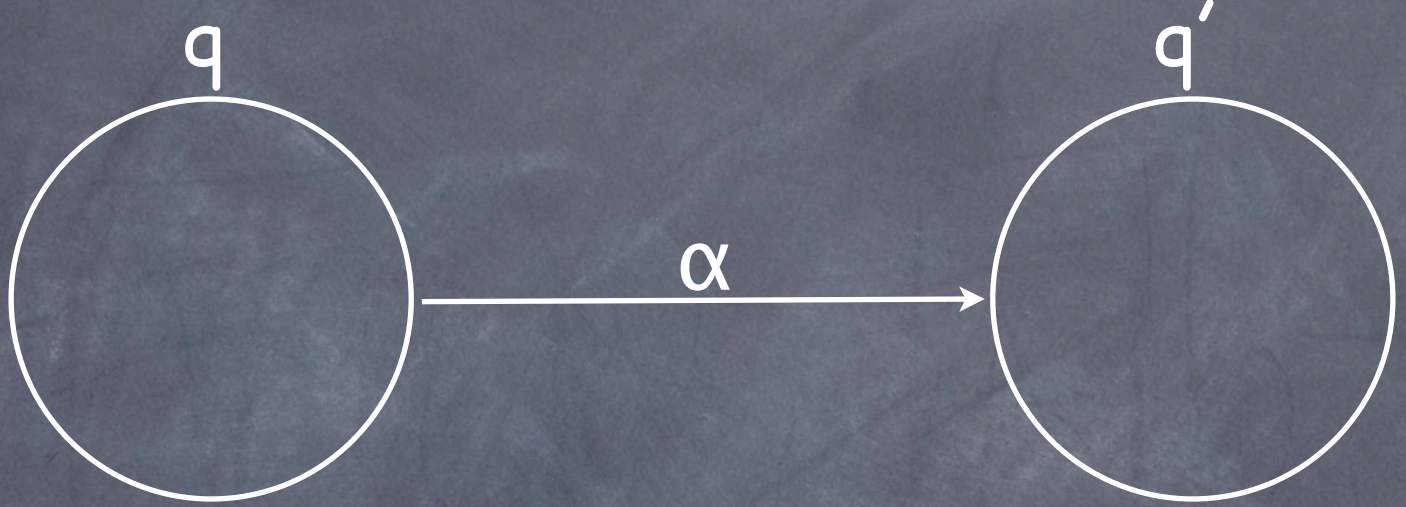
HD formalisms can express computations where

- new "events" can be generated
- behaviour depends on events generated in the past

Examples:

- Petri nets
- VP-CCS
- nominal calculi
- ...

(Basic) HDA: an Intuition



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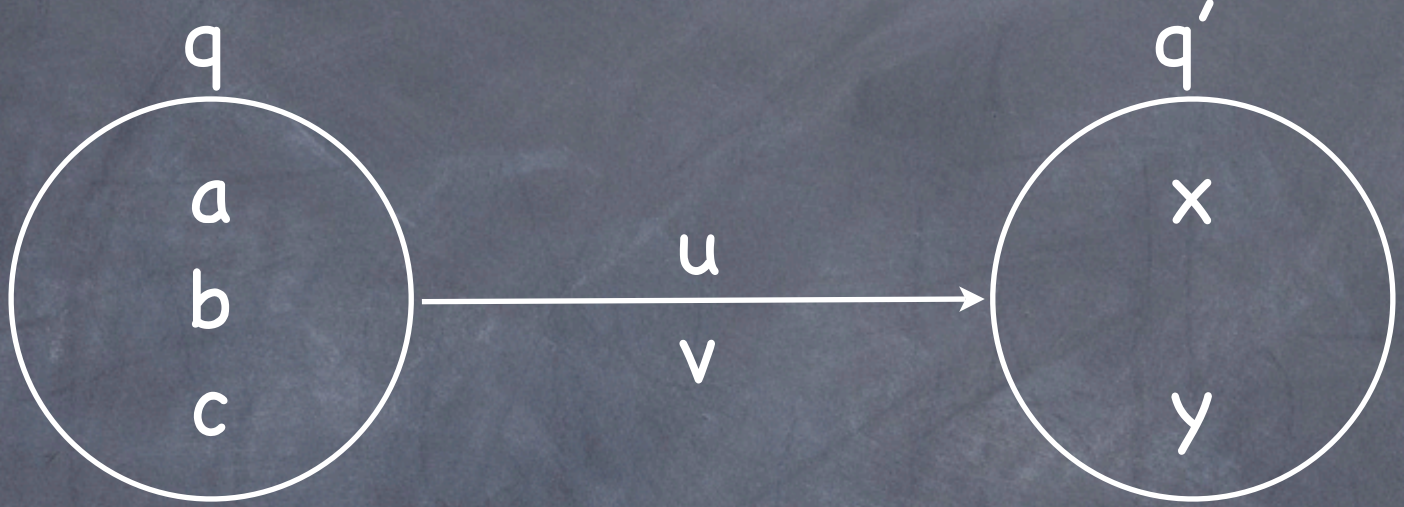
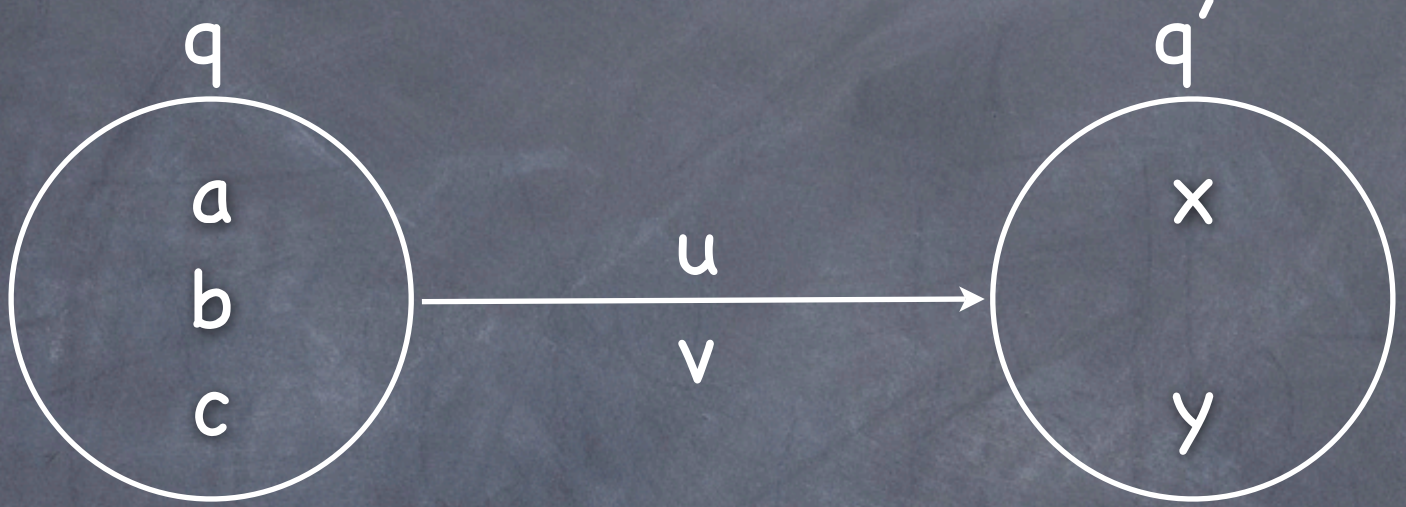


- Names explicitly used in the model
- Names are local to states and transitions
  - "[...] identity of names does not affect the behaviour of a process[...]" [fms96]
- Operations on names can be modelled (creation/deallocation)

HDA Transitions



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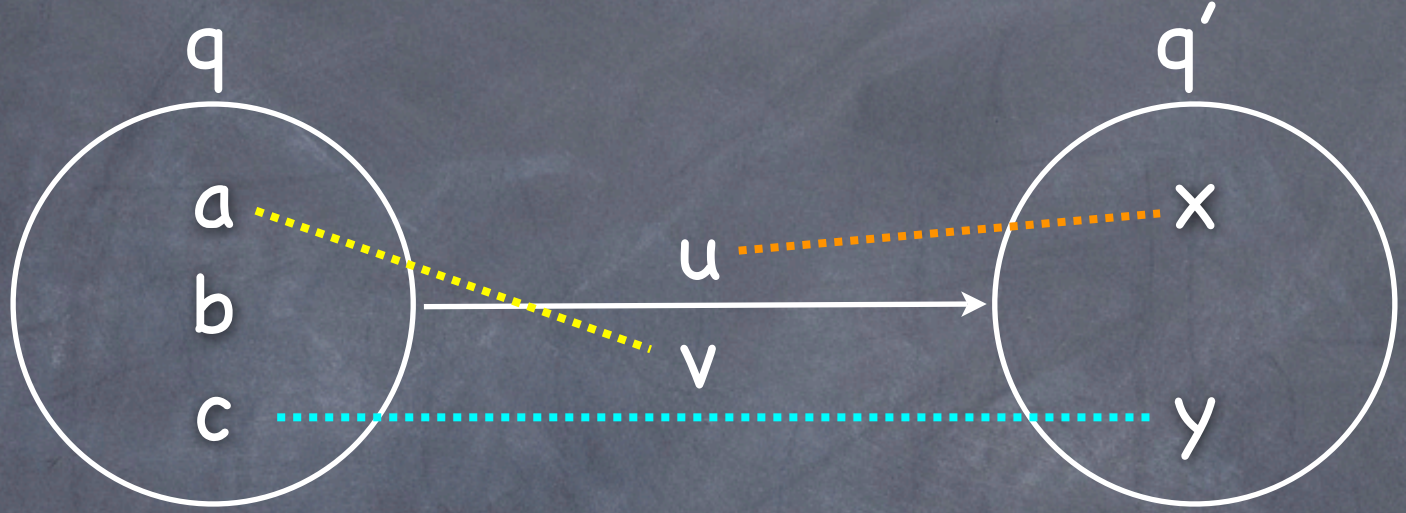

- 'a' is exposed as 'v' during the transition
- 'c' is called 'y', afterward
- 'u' is freshly generated and identified as 'x'
- 'b' is discharged along the transition

Behavioural Minimisation

- HDA aim to yield minimal representation of process behaviour
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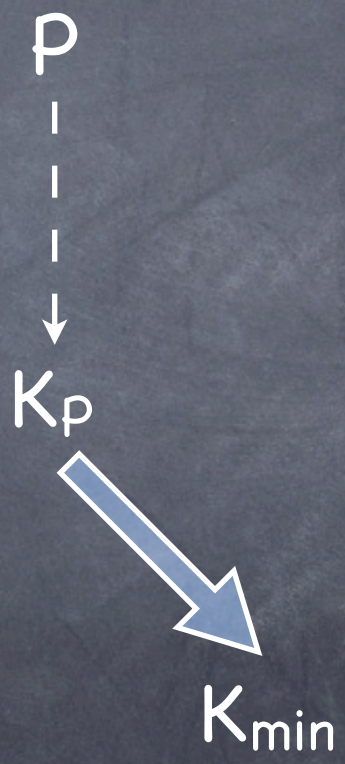

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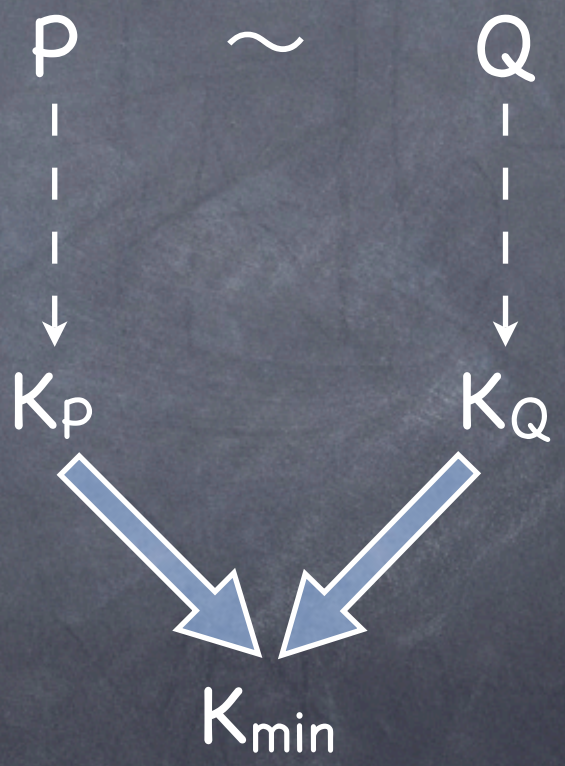
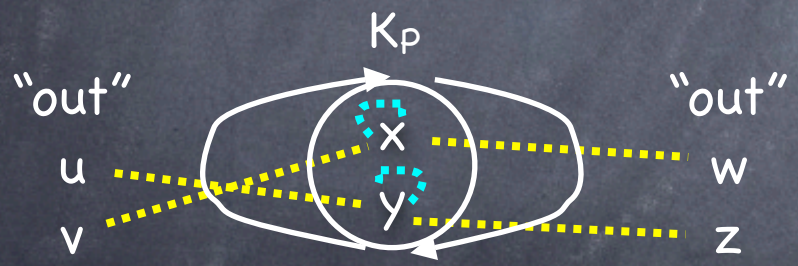


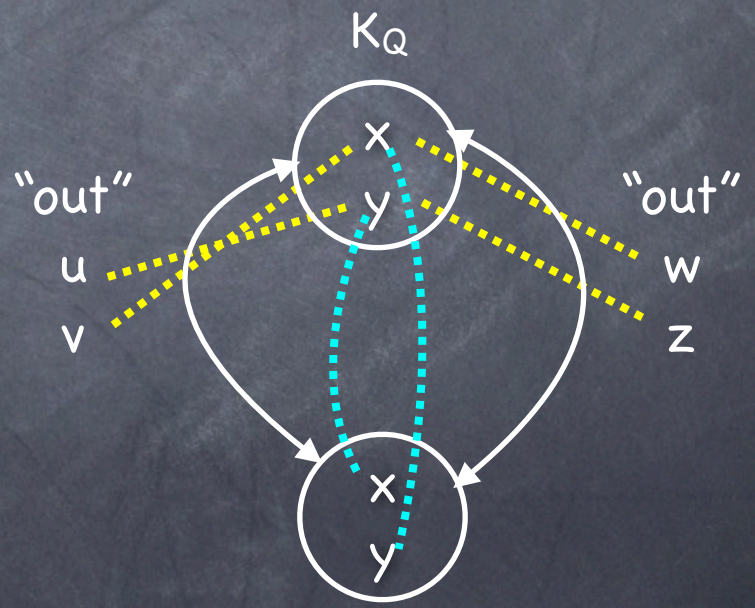
Need of Symmetries

- Basic HDA do not have canonical minimal representatives

P(x,y) = out x y.P(x,y) + out y x.P(x,y)

Q(x,y) = out x y.Q(y,x) + out y x.Q(y,x)





- Both minimal but not isomorphic (Pistore's thesis)

Use of Symmetries

- Symmetries are enough for obtaining a minimal realisation [MP00]
- Symmetries can model early/late pi-calculus [FMP02,FMT05] or fusion (hyperbisimulation) [FMTYV05]
- but...

Other ingredients

- "[...] and that equality and inequality conditions on names may affect process bisimilarity."

[fms96]

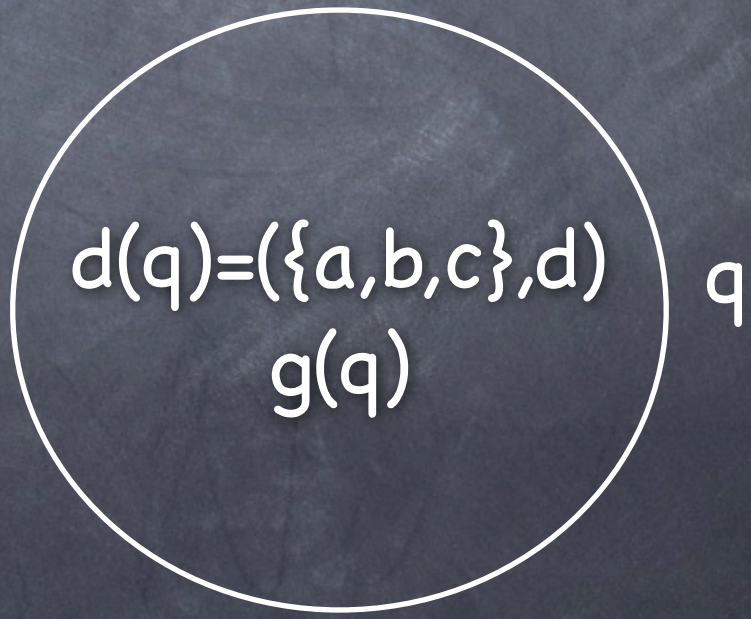
- "[...] finding a mathematical formalism to ensure that extruded names are renamed injectively while other names may be renamed non-injectively is the key to understanding open bisimulation."

[gyv04]

HDA with Distinctions

Def. A *distinction relation on* $\mathcal{N}$ is a pair (n, d), denoted by $n^{(d)}$, where $n \in \wp_{\text{fin}}(\mathcal{N})$ and $d \subseteq n \times n$ is a symmetric relation such that $(x, x) \notin d$, for all $x \in n$.

- We equip HDA with distinctions
- symmetries must "respect" distinctions



Nfs in Pictures

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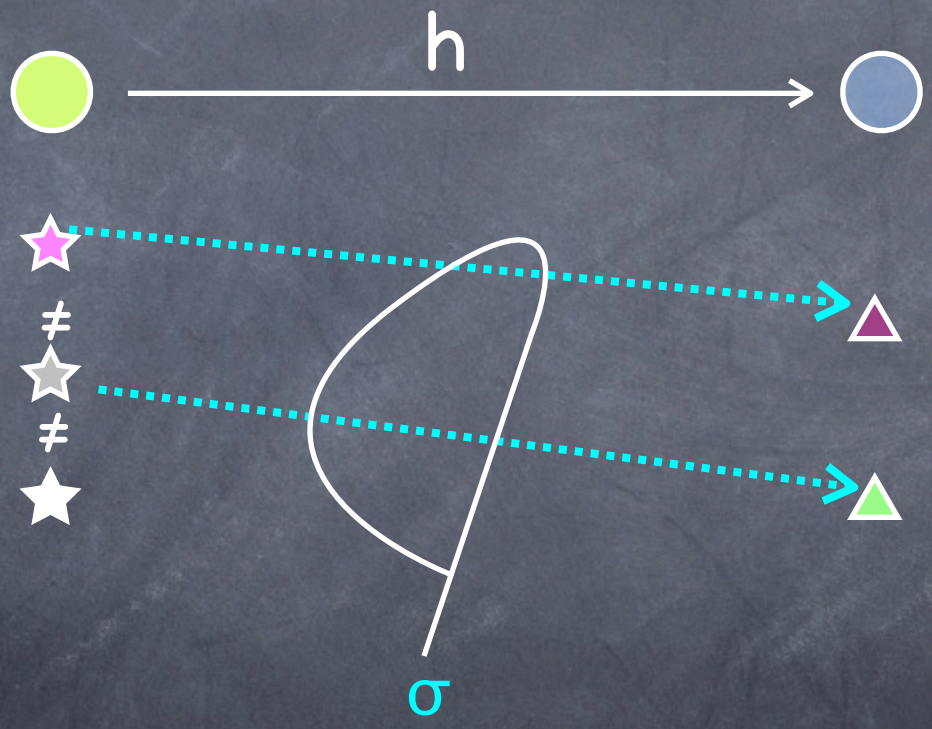

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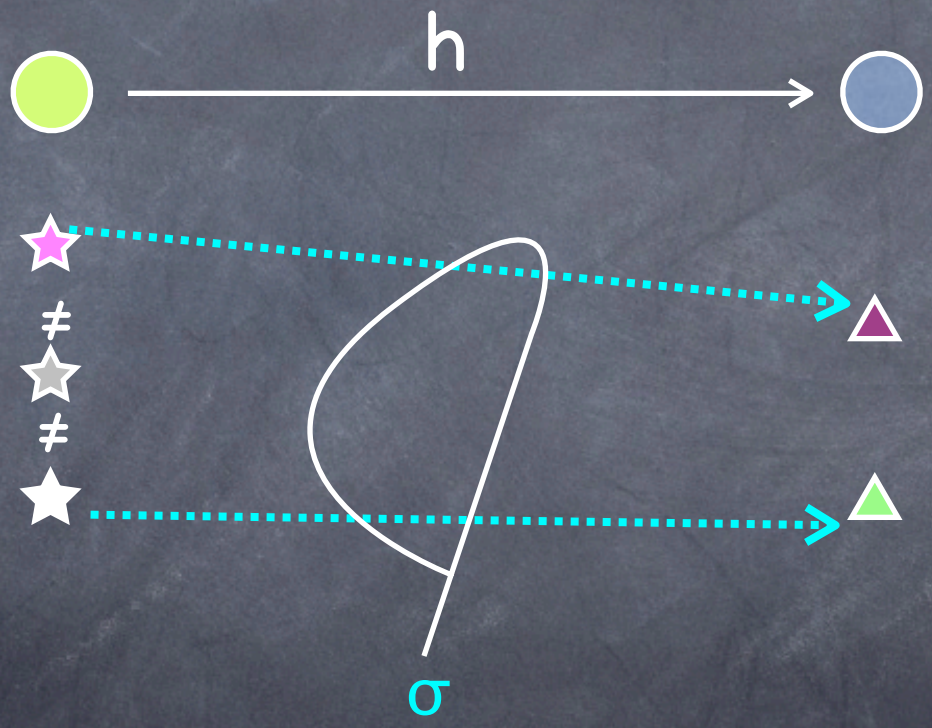

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HDA on DNSet

Def. An *HD-automaton with distinctions* over $L \in \mathrm{obj}(\mathtt{DNSet})$ is a coalgebra $K : E \to \wp_{\mathrm{fin}}(L \otimes E)$ for the functor $T_L(\_) = \wp_{\mathrm{fin}}(L \otimes \_)$.

- The minimisation alg. on hda is a variant of Ferrari, Montanari and Pistore's one
- it constructs (an approx. of) the final coalgebra
- using an explicit normalisation step

$$\mathrm{h}_{H_{(0)}}(q) \quad \stackrel{\mathrm{def}}{=} \quad \emptyset, \;\; \forall q \in Q_E$$

$$H_{(i+1)} \quad \stackrel{\mathrm{def}}{=} \quad N_{i+1}(K; T(H_{(i)}))$$

Concluding remarks

- Classical HDA extended (?) with distinctions
- Minimisation algorithm re-shaped in a more modular form
- HDA with distinctions can model open pi

- To be done: work out the relationships between
  - NSet and DNSet
  - DNSet and pullback-preserving functors over index category of distinctions

Thank You