Biography

- PhD (1993) Grenoble "Des Bisimulations pour la Sémantique des Systmes Réactifs"
- Postdoctorate Sussex Unievrsity
- Lecturer U. Rennes1 and Researcher in S4* project (INRIA) (*) System Synhtesis and Supervosion, Scenarios)
- Habilitaiton á Diriger les Recherches (2003)
- Marie Curie Fellowship CSL RSISE ANU (2006)

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- Scientific coordinator of the Marie Curie Scientific Project MASLOG 021669 (FP6-2004-Mobility-6)
- Advisory Board of the MCFA
- Commissions of Experts at U. Rennes 1 & U. Bret.Occid.
- Board of Directors of IFSIC (U. Rennes 1)

Research Interests

- Logics: temporal logics, second order temporal logics, mu-calculus, satisfiability, model-checking
- Automata and Games: tree automata, parity automata, games (two players, multi players)
- Synthesis: models synthesis from logical specifications
- Open and Component-based Systems
- Planning and Games
- Theory of Control: discrete-event systems, controller synthesis, architectures of control, partial observation, decentralized and modular control
- Observability Issues
- Diagnosis: diagnosis patterns, diagnosis of open systems

Current Research on Logics for Multi-player Arenas

Relevance of the topic: open systems, component-based systems, multi-agents paradigm, etc.

Current Research on Logics for Multi-player Arenas

- Interpretation of (temporal and modal) logics in multi-player arenas
- Monadic Second Order Extensions
- Commitments
- Decidability Issues for the Model-Cheking Problem
  e.g. Automata Constructions
- Subsumes Alternating Time Logics [Alur et al. 2002]

Multi-player Arenas

- A subclass of Kripke Structures
- A set of players P who individually select in eacg state some subsets of successors; when all the players have chosen, a single successor is designated
- Similar to Concurrent Game Structures

Definition

$\mathcal{S} = \langle S, R, \bar{\Lambda}, \bar{\lambda}, P \rangle$

- States S, successor binary relation $R \subseteq S \times S$, labeling of state $\lambda : \Lambda \to 2^S$

Multi-player Arenas

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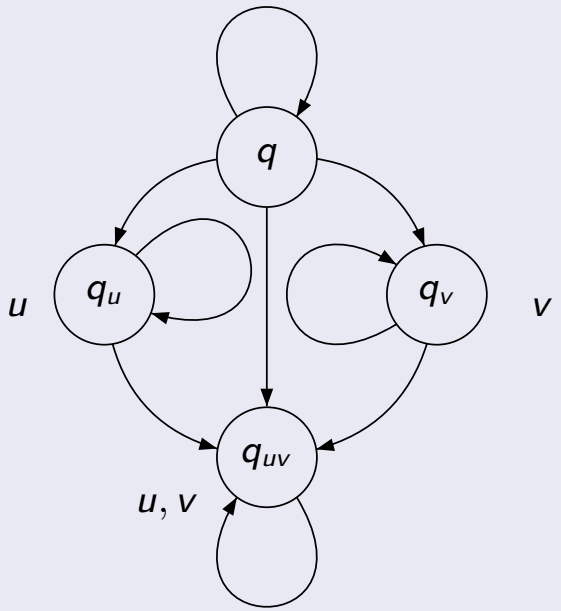
- $P = \{U, V\}$ where U (resp. V) controls variable u (resp. v)



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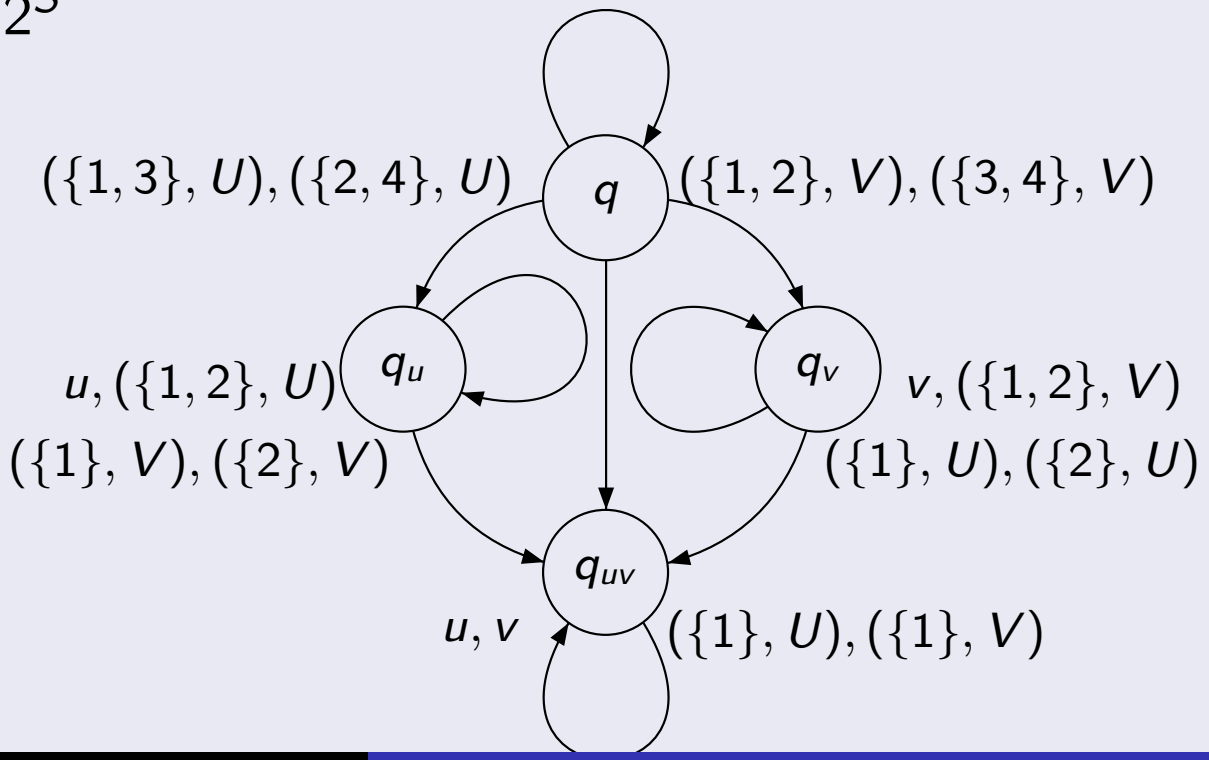

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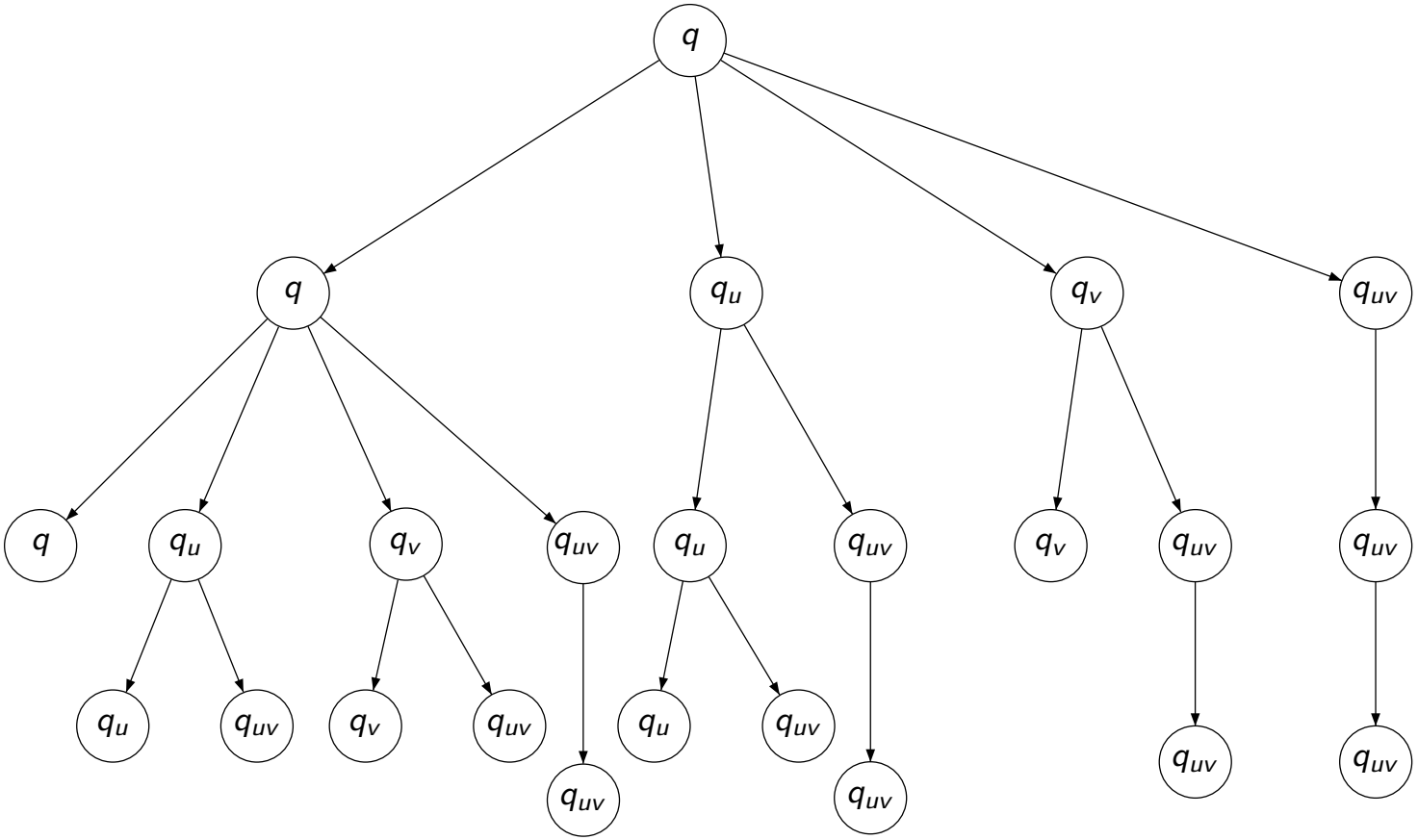
- States S, successor binary relation $R \subseteq S \times S$, labeling of state $\lambda : \Lambda \to 2^S$
- R has a finite maximal *degree* m
- Directions are elements of $[m]$ $(= \{1, \ldots, m\})$
- $\bar{\Lambda} = \Lambda \cup (\mathcal{P}([m]) \times P)$ and $\bar{\lambda} : \bar{\Lambda} \to 2^S$

$\bar{\lambda}(q_u)$ contains u, but also $(\{1,3\}, U)$, $(\{2,4\}, U)$

Kripke Structures as Trees



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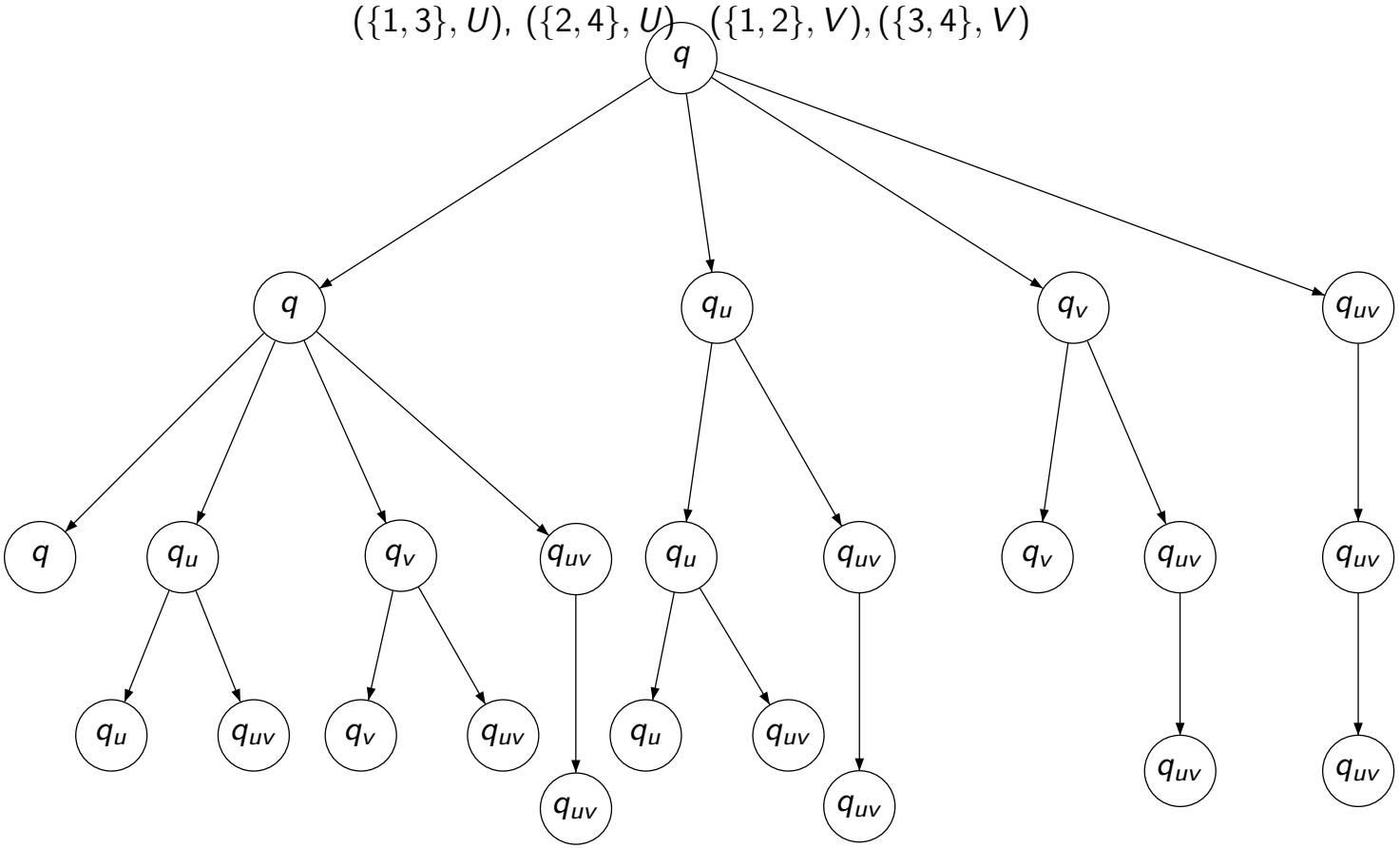

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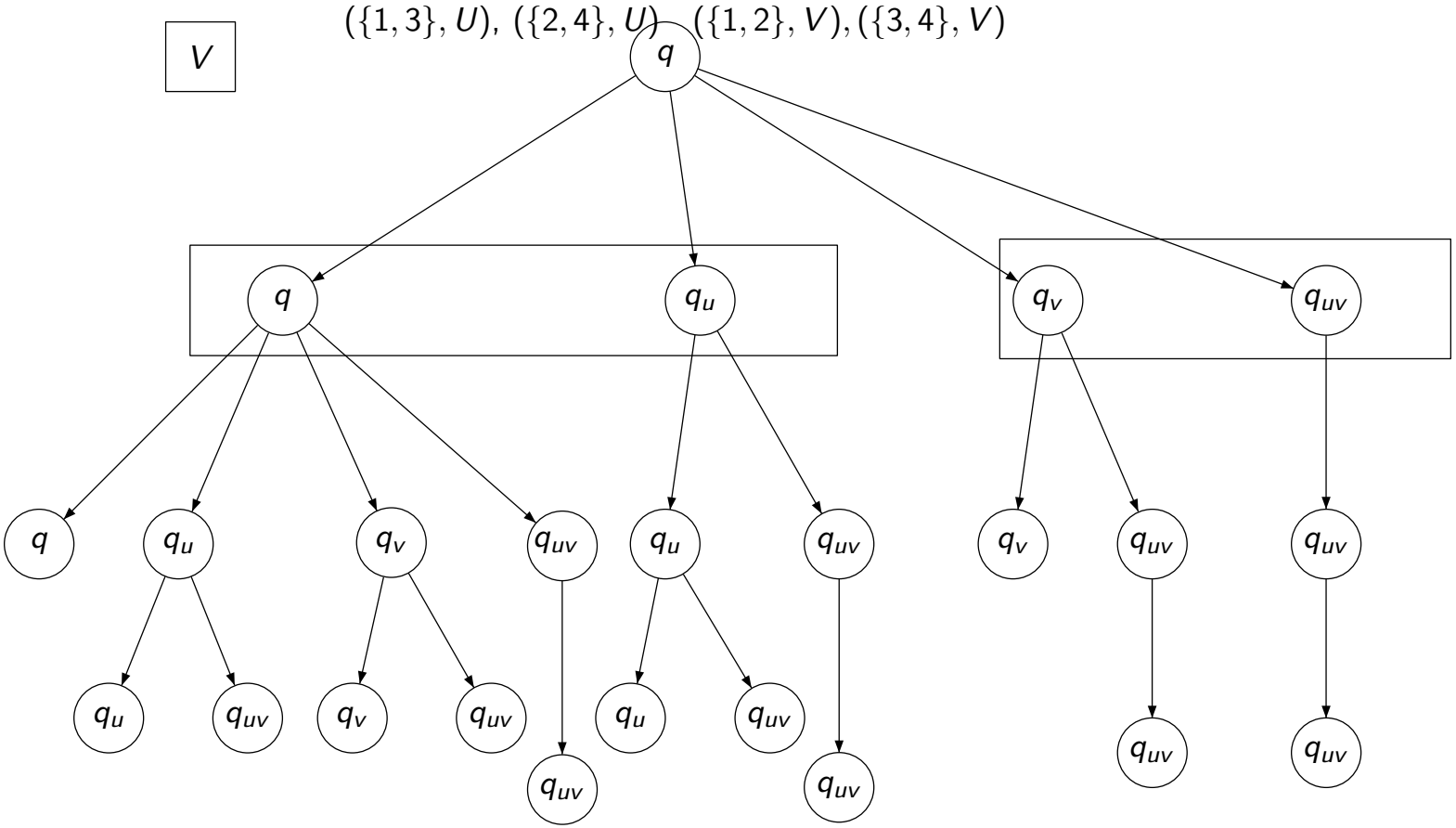

Temporal Logics with Decision Modalities

- Branching time propositional mu-calculus [Kozen83]

$$g \mid \top \mid \neg\beta \mid \beta_1 \vee \beta_2 \mid \mathbf{E}\,\mathbf{X}\,\beta \mid Z \mid \mu Z.\beta(Z)$$

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Definition

A *decision modality* is written $(p)f$

- where f is a proposition, and $p \in Players$
- "All propositions in f matches a decision of p"

Temporal Logics with Decision Modalities

- $g \mid \top \mid (p)f \mid \neg\beta \mid \beta_1 \vee \beta_2 \mid \mathbf{E}\,\mathbf{X}\,\beta \mid \ldots$

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$$[[\, (p)\Gamma \,]]_{\mathcal{S}} = \{s \in S \mid sR \cap [\bigcap_{f \in \Gamma} \lambda(f)] \in dec(s,p)\}$$

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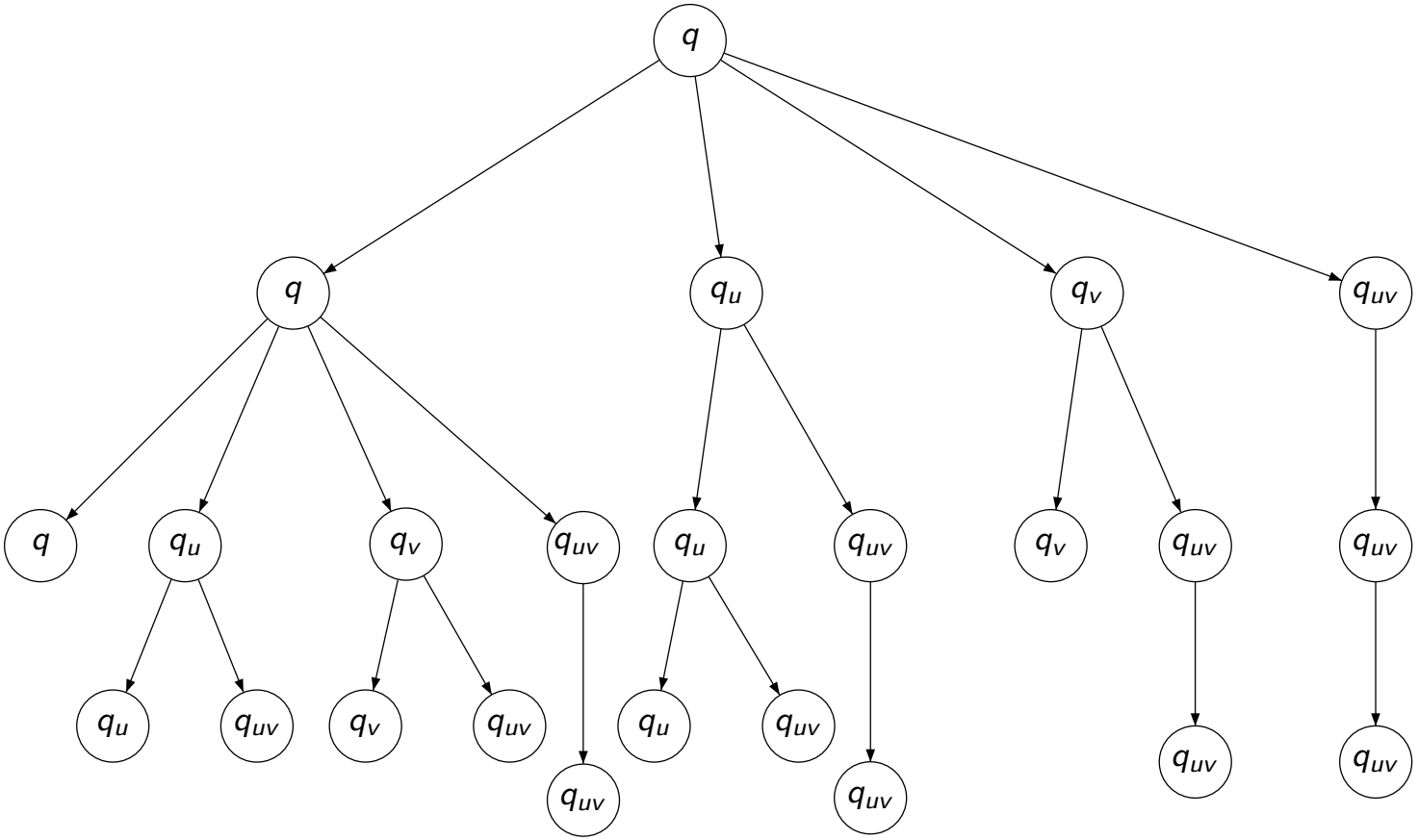
- $[[\, (p)f \,]]_{\mathcal{S}} = \{s \in S \mid sR \cap \lambda(f) \in dec(s, p)\}$

- Write $\mathcal{S}, s \models \beta$ for $s \in [[\, \beta \,]]_{\mathcal{S}}$

Example of Decision Modalities



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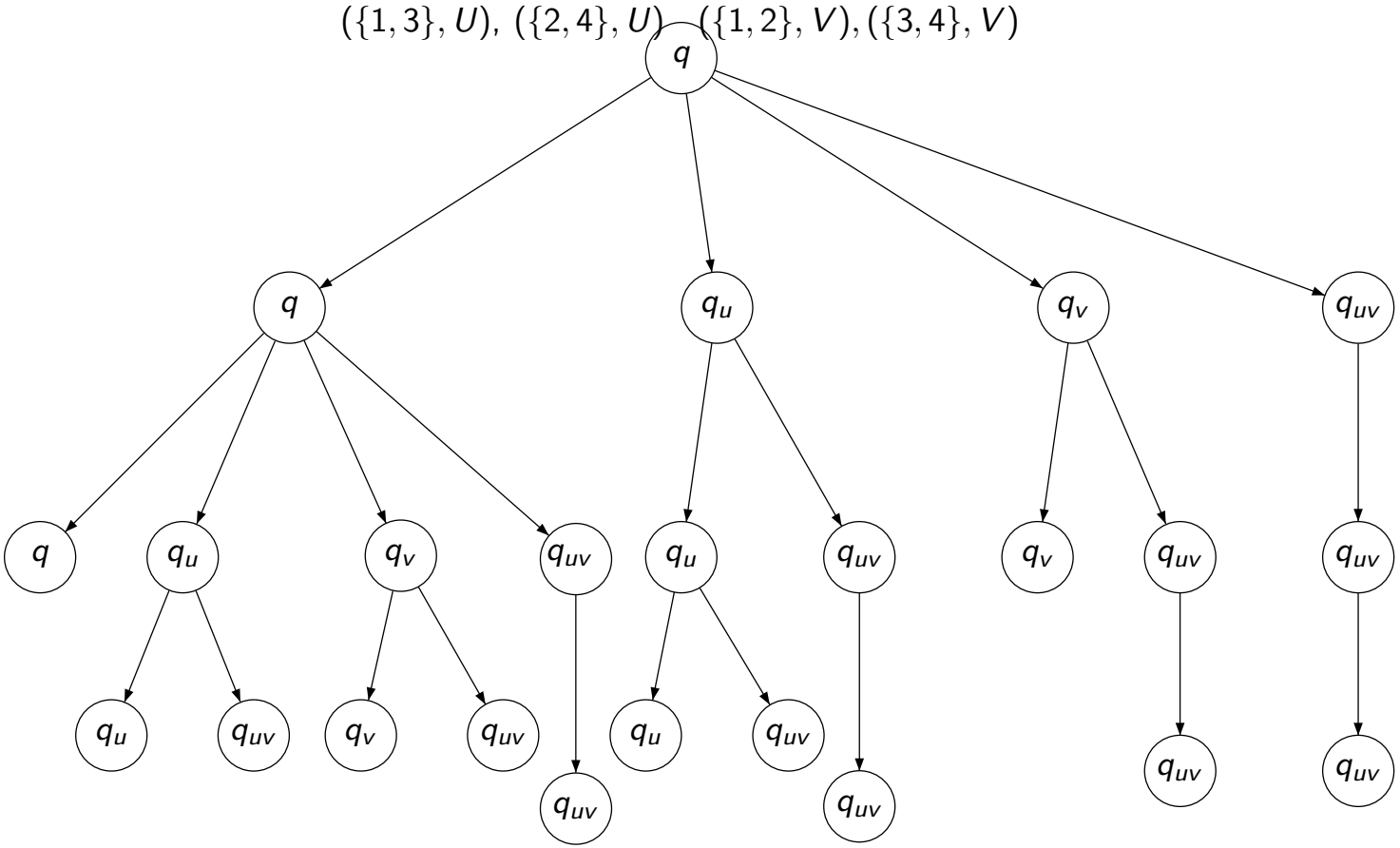

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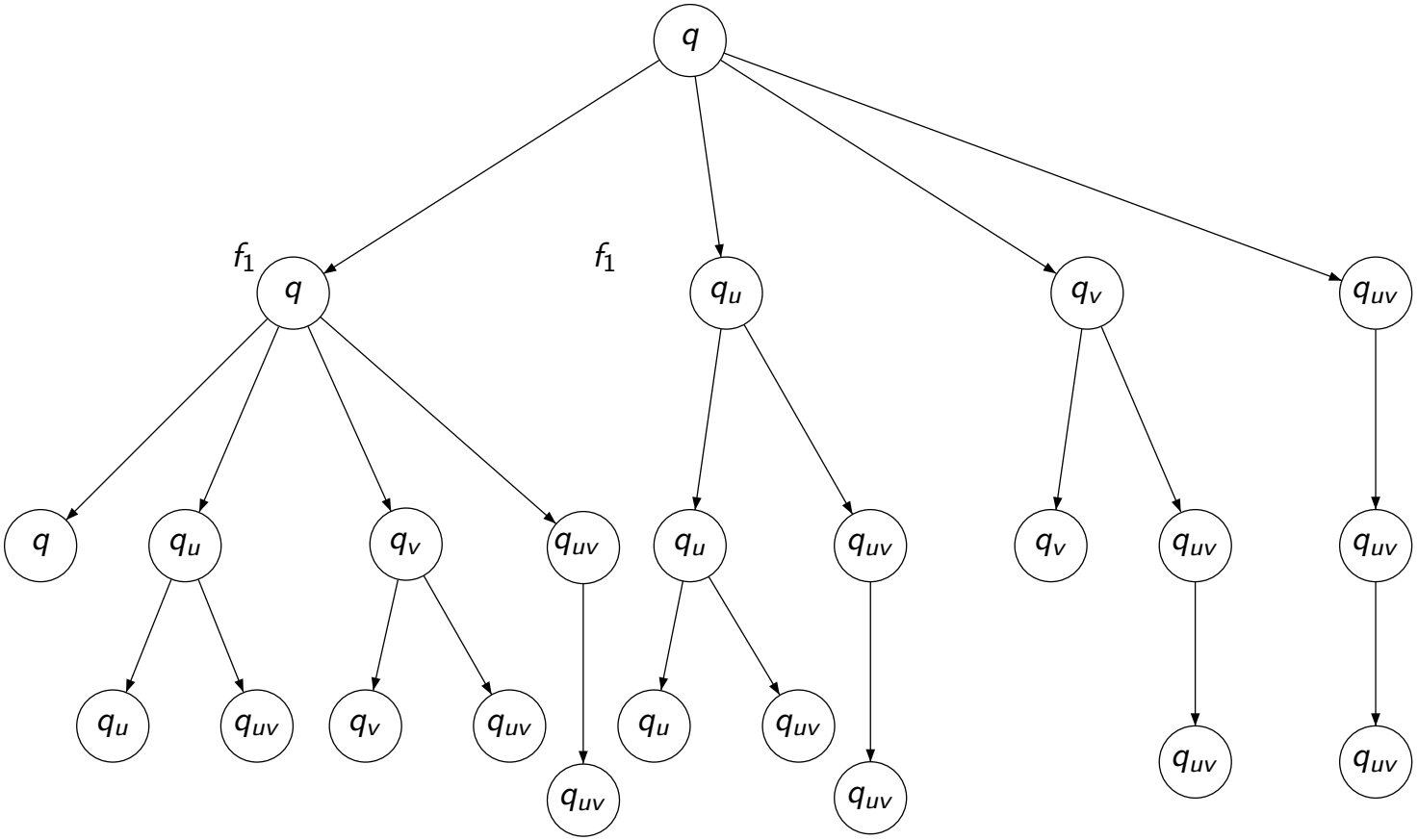

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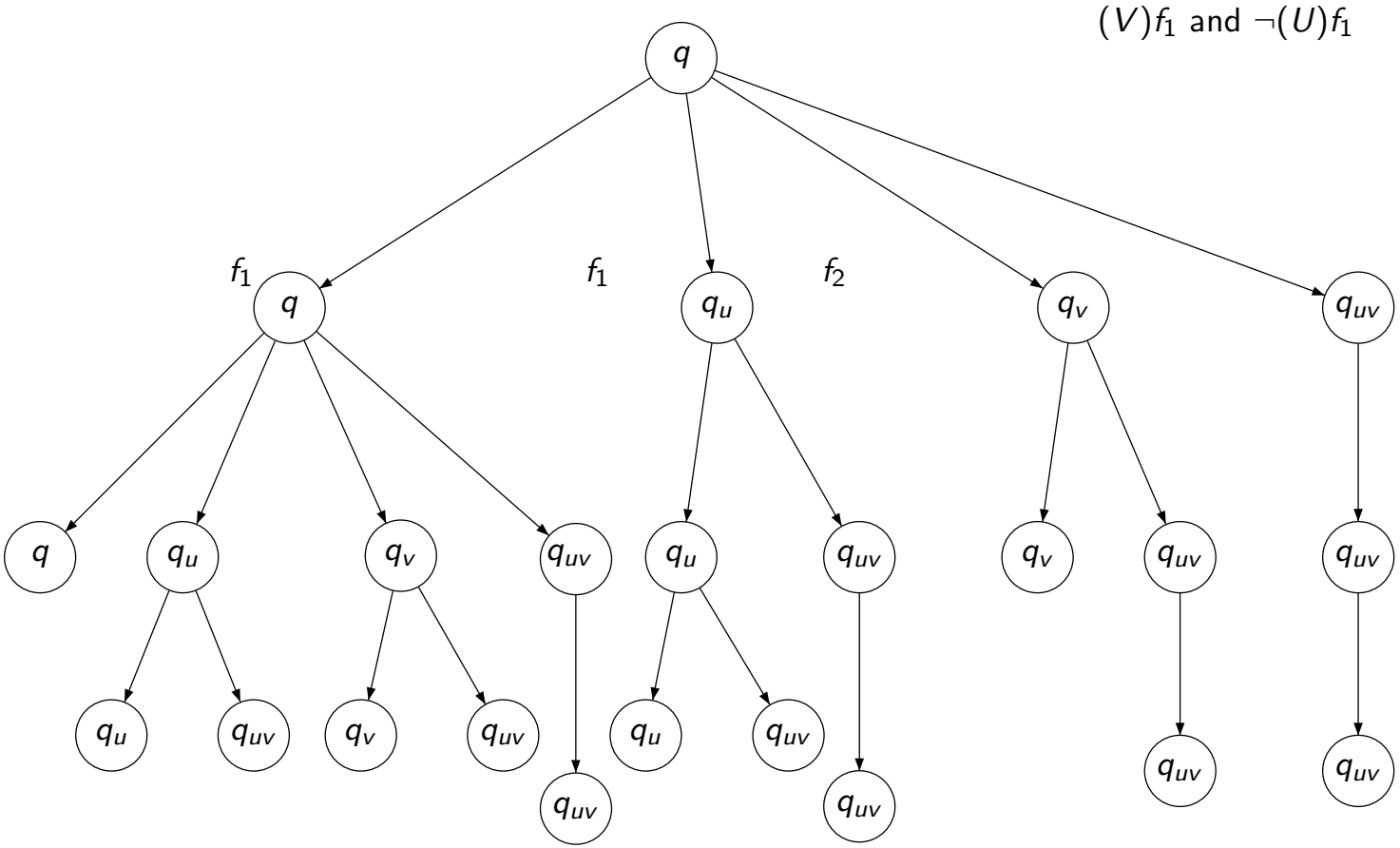

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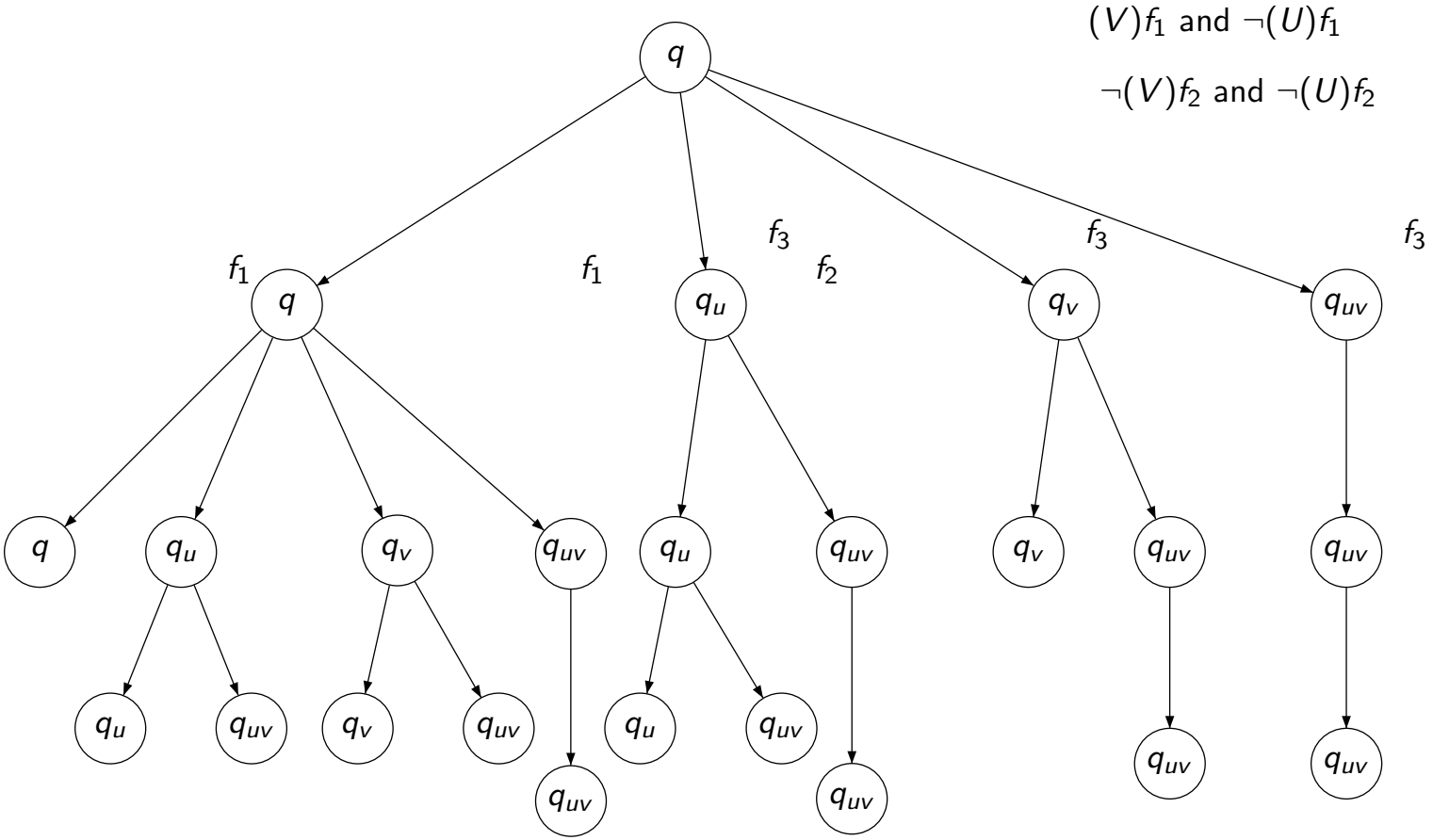

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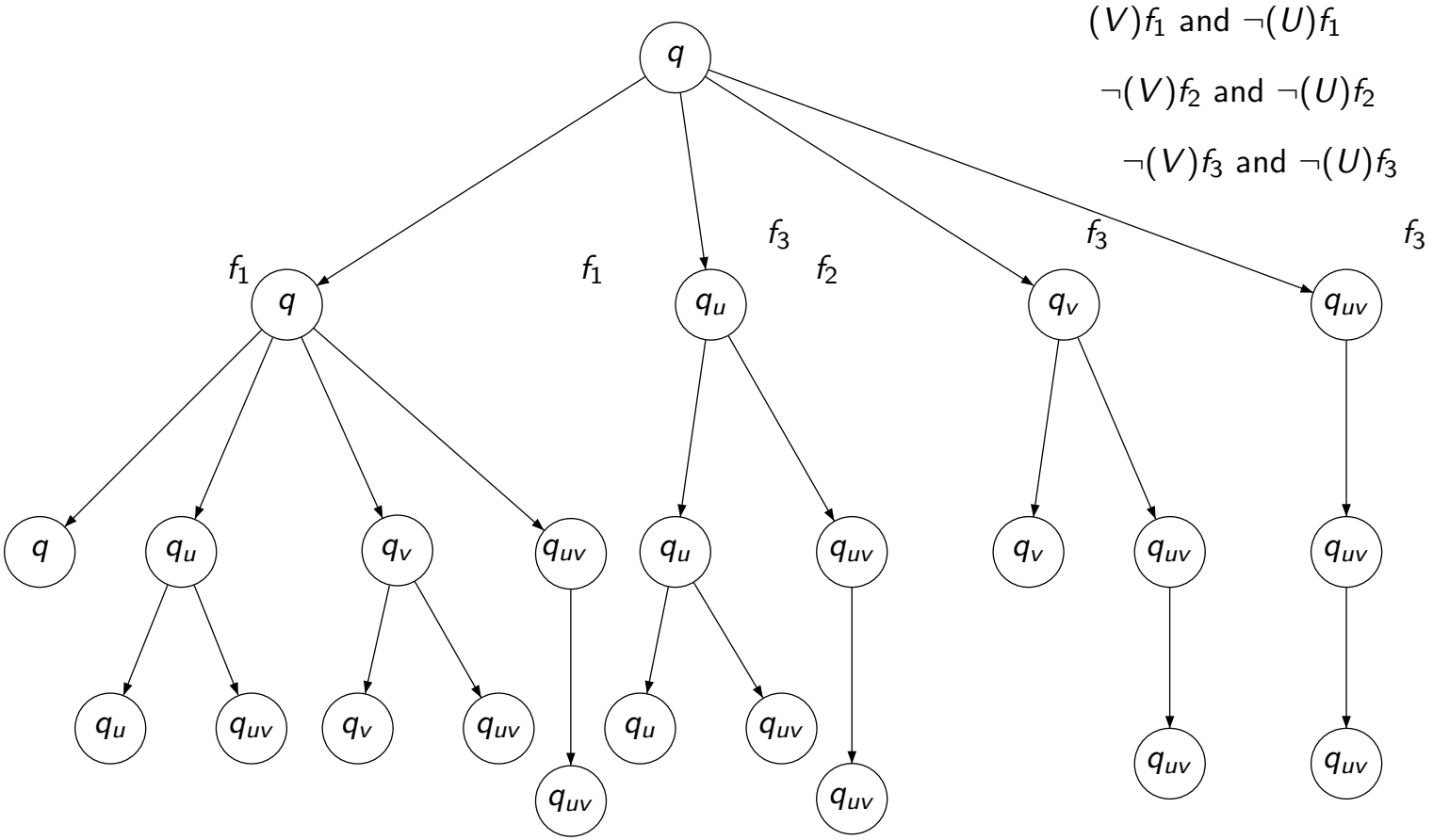


Labelings and Strategies

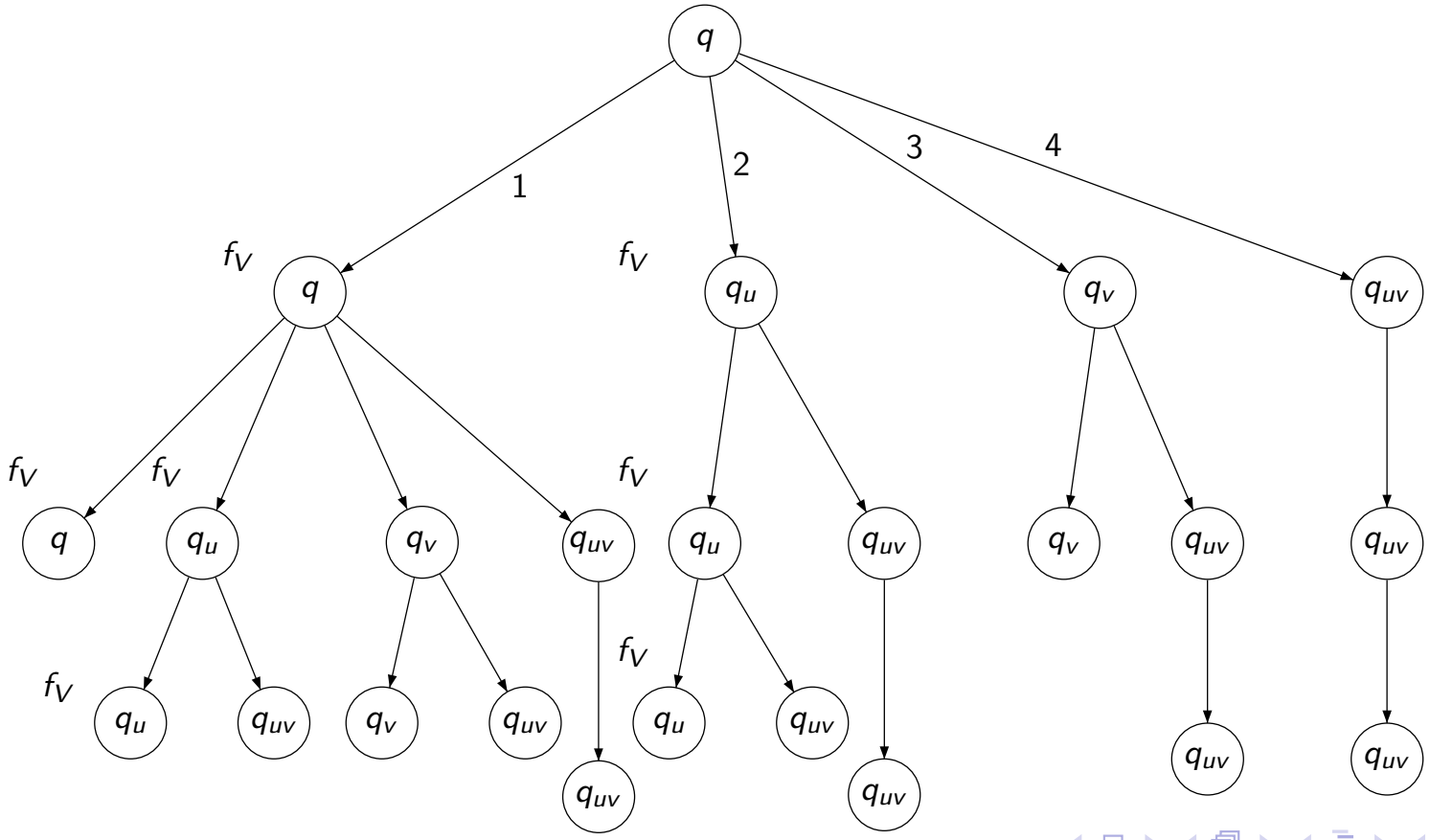
Definition

A *f-labeling* of $\mathcal{S}$ from s_0 is a (complete) Kripke Structure $\mathcal{E}$ with the only proposition f.

To label $\mathcal{S}$, take $\mathcal{S} \times \mathcal{E}$ which starts from (s_0, r).

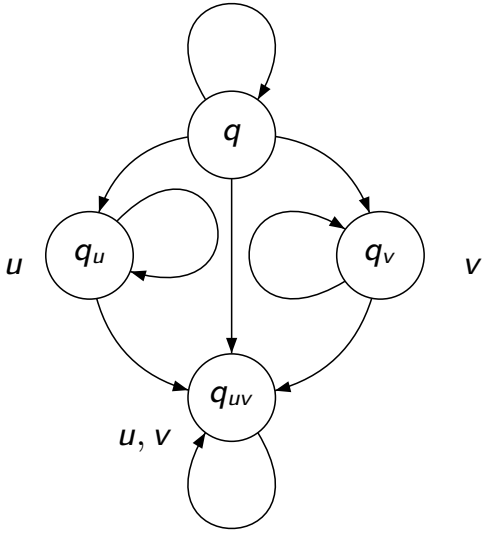
Labelings and Strategies

Consider a labeling of $\mathcal{S}$

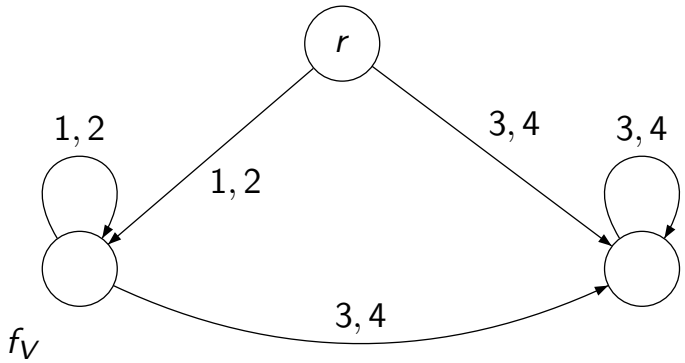


Labelings and Strategies

$\mathcal{S}$



$\mathcal{E}$



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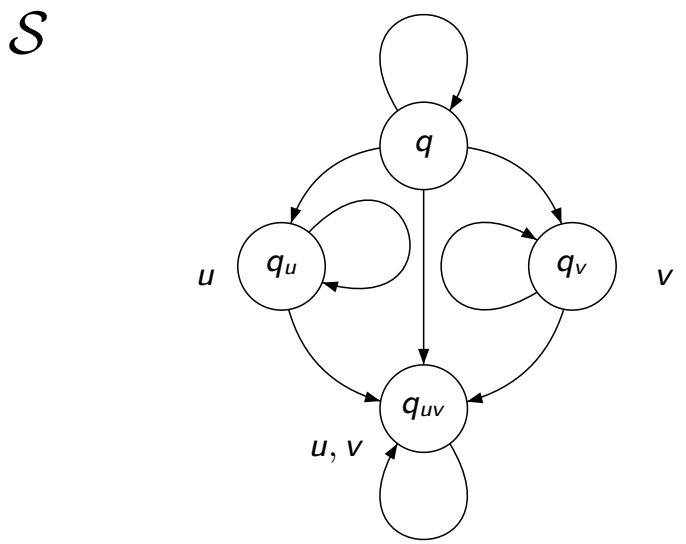
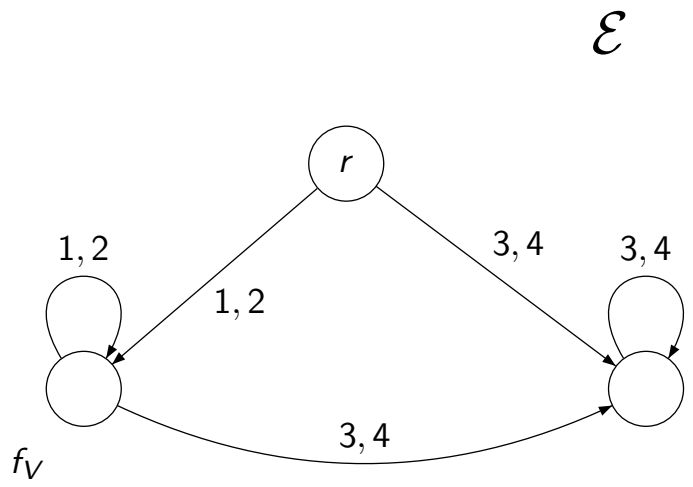




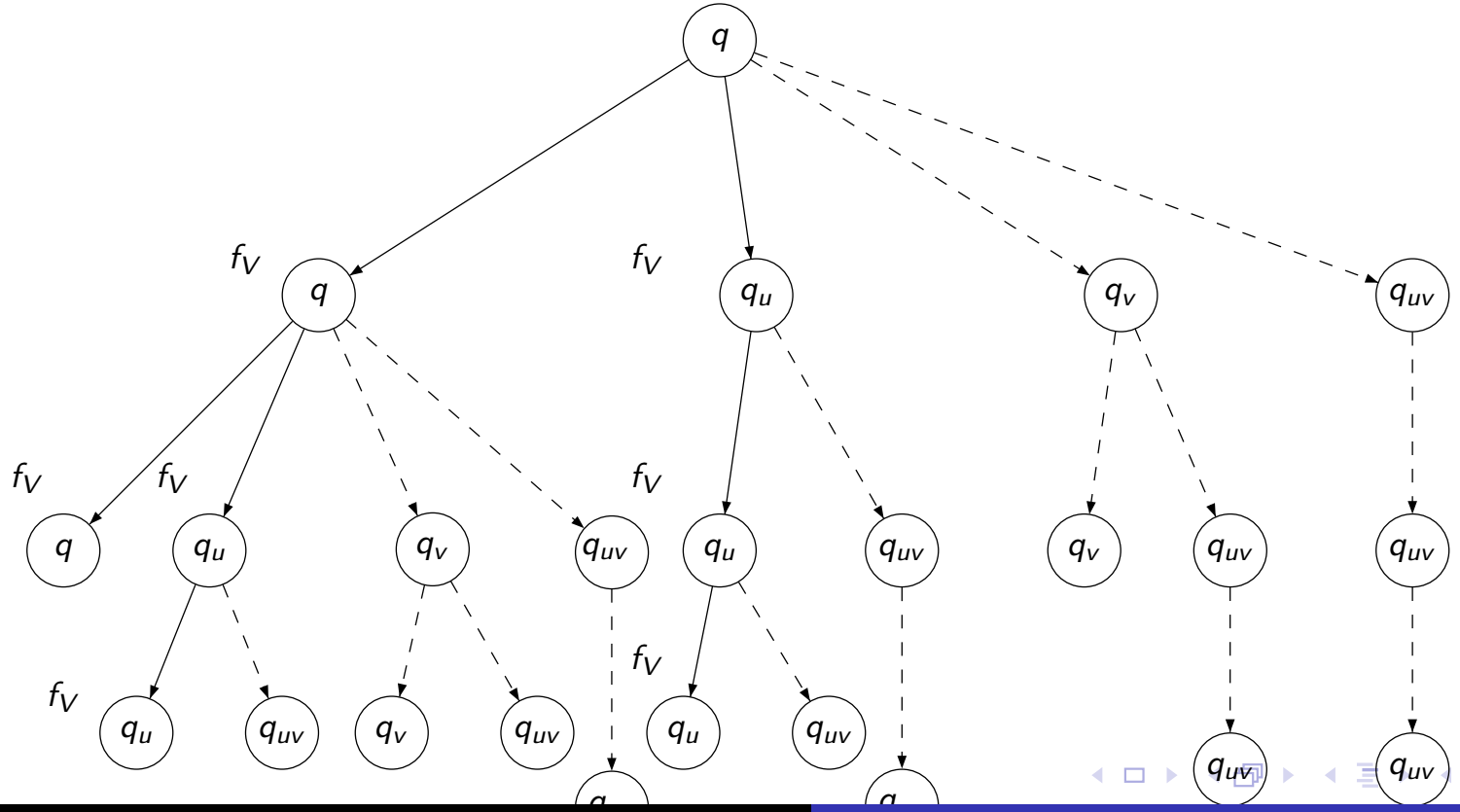
Definition

A f-labeling $\mathcal{E}$ of $\mathcal{S}$ from s_0 is a *p-strategy* whenever

$$\mathcal{S} \times \mathcal{E}, (s_0, r) \models \mathbf{AG}\,(p)f$$

Outcomes

Given a p-strategy, say using proposition f_p, cut everything which leaves f_p. Obtain $\textsc{out}(f_p, \mathcal{S}, s_0)$



Summary

1. The tree of $\mathcal{S}$ from s_0 can be decorated with a proposition f, via a f-labeling, $\mathcal{E}$.
2. We can express that the decoration by f respects (everywhere) a possible choice of some player p, with $\mathbf{AG}\,[(p)f]$.
3. We can prune $(\mathcal{S}, s_0)$ according to f to get $\textsc{out}(f, \mathcal{S}, s_0)$ the outcome of this policy of the player p

   $+$ By considering several propositions $f_{p_1}, f_{p_2}, \ldots, f_{p_k}$, we can handle coalitions.

Back to the logic - Relativization

Given $(\mathcal{S}, s_0)$ and a p-strategy $\mathcal{E}$ (using proposition f), we have

Theorem

For any formula β,

$$\textsc{out}(f, \mathcal{S}, s_0), s_0 \models \beta \textit{ iff } \mathcal{S}, s_0 \models (\beta * f)$$

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$(\beta * f)$, the *f-relativization* of β, is defined by

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$$(\beta_1 \vee \beta_2 * f) = (\beta_1 * f) \vee (\beta_2 * f) \qquad ((p)f' * f) = (p)(f \wedge f')$$

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$$(\mathbf{E}\, \beta_1\, \mathbf{U}\, \beta_2 * f) = \mathbf{E}\, [f \wedge (\beta_1 * f)]\, \mathbf{U}\, [f \wedge (\beta_2 * f)]$$

Expressing properties of strategies

$$\mathcal{S}, s_0 \models \mathbf{AG}\,[(p)f] \wedge (\beta * f)$$

means

"player p has a strategy to guarantee β"

- Generalizes to a set of players
- Existence of strategies is captured by the monadic second order extension of the logic

Monadic second order extension of the logic

- $\mathcal{S}, s \models \exists f.\alpha(f)$ means there exists a f-labeling $\mathcal{E}$ s.t.

$$\mathcal{S} \times \mathcal{E}, (s_0, r) \models \alpha(f)$$

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  - $\Rightarrow$ Can compute $\mathcal{E}$, hence strategies
  - $\Rightarrow$ Always regular solutions!

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    Inside the "f-subtree" there is a position from which a f'-subtree exists where α holds.
  - However, we can express alternating time logics properties

$$\langle\!\langle U \rangle\!\rangle \mathbf{G}[\neg u \wedge \langle\!\langle U, V \rangle\!\rangle \mathbf{F}(u \wedge v)]$$

by using the *bounded relativization*

Conclusion

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- Commitments easily specified
- Commitment not considered in Alternating Time Logics