

Contracts between Software Agents

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Automation of Business Contracts

- Humans in businesses signing contracts
 - Are independent
 - Are distributed
 - Need to manage long-term business relations
 - Keep much information private for various business reasons
- Software agents executing contracts or monitoring contract compliance on businesses' behalf:
 - Can perform actions at high speed (compared to people)
 - Have bounded resources for reasoning
 - Have an electronic presence, relying on user inputs for information on the physical world

Norms and Contracts

- The substance of contracts' content is in normative statements: obligations, prohibitions, permissions
- Some notable characteristics
 - A single obligation can often be violated in different ways
 - Vagueness rather than explicit uncertainty
 - Resolution of violations only to a certain level

Consequences

- **Continuity:** Software needs to know what to do at any one time, even if that is 'nothing' and even if an obligation is violated, this does not cancel the obligation
- **Scalability:** In both executing and monitoring contracts, we aim to reduce the amount of norms under consideration at any one time to allow agents to fulfil norms (if they decide to) in a timely way
- **Mitigation:** Pre-determined penalties are too coarse for long-term relations, but advertising leniency can be detrimental
- **Time:** In a distributed system, time is not treated differently from other observable data: there can be disagreement, time lag in communication, and

Representing Clauses

- In the CONTRACT project, a contractual clause is expressed by five elements

Element	Description
Type	Obligation or permission
Activation Condition	Conditions under which this clause takes force
Normative Condition	Conditions under which the obligation is being met or permission is taken advantage of
Expiration Condition	Conditions under which this clause ceases to take force
Target	The agent obliged or permitted by this clause

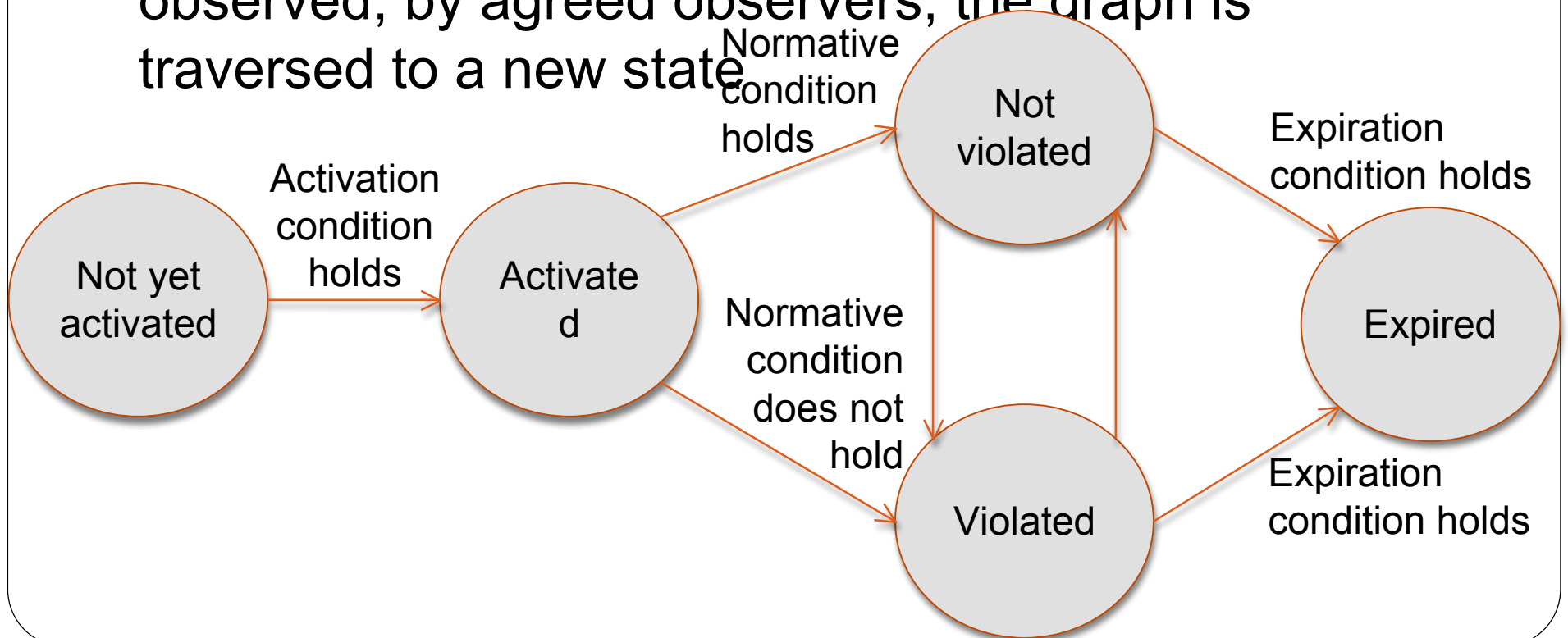
Case Study Clauses

- The clause below obliges a 'service site' to service any engine requiring repair within 7 days (from an

Element	Description
Type	Obligation
Activation Condition	Engine E requires repair at time T
Normative Condition	Engine E is repaired or T + 7 days has not yet been reached
Expiration Condition	Engine E is repaired or T + 7 days has passed
Target	Service site

Monitoring Status Representation

- Each clause monitored is represented as an **independent** graph
- As activating, normative or expiration conditions are observed, by agreed observers, the graph is traversed to a new state



Electronic Contract Requirements

- The CONTRACT project included four business case studies
- While they wanted different things from electronic contracts, some key points can be drawn out
 - Unambiguous norm model (for confidence)
 - Norm model which can be used to reflect human business contracts (absolute fulfilment rather than quantitative)
 - Explanation of violations rather than automatic enforcement

Handling Mitigating Circumstances

- When a violation occurs, a contract may specify a penalty
- For long-term business relationships, this can be an inflexible way to react
- Instead private policies dictate when mitigating circumstances apply and how to react
- Extracting data relevant to determining mitigating circumstances is hard because:
 - There can be a lot of distributed historical data, most irrelevant
 - There can be critical events for which there is no record
- Need provenance and inference (see paper on