Outline
Contract

Binding agreement specifying what two more parties can expect from each other

- A contract structures interactions among autonomous parties
  - People and corporations
  - Governmental agencies
- Unlike a contract in programming
- Key questions: how to create, modify, perform, or monitor a contract
Motivation for Contracts

- Provide a basis for service agreements
- Crucial in open environments
  - Emphasize interactions: observable by others
  - Constrain interactions: limit autonomy
  - Except where needed, generally disregard internal implementations, thus facilitating heterogeneity
What is a Contract?

A description of business-level interactions

A reusable description of an interaction understood to preserve the participants’ autonomy

- Analogous to an abstract class or interface for objects
- Specifies well-defined roles
- Specifies message (types or schemas) among the roles and how they affect interaction state
  - Capturing commitments on a business partner playing a role
  - Setting local policies while complying with a protocol
- Stored in a repository, i.e., as an asset or resource in its own right
- Refined and composed for implementation
Importance of Governance

Stakeholders using resources to best serve their needs

- Share resources in a controlled manner
- Configure and reconfigure
- Enable unanticipated uses for resources
- Administer respecting human organizational needs

In particular, stakeholders administer themselves
Governance versus Management
Alternative approaches to administration

- **Management**: by superiors of subordinates
  - Control over managed resources
  - Necessary but not sufficient

- **Governance**: by autonomous equals of themselves
  - Collaborative decision-making among stakeholders
  - Share resources flexibly, enabling unanticipated uses
  - Administer respecting human organizational needs

- Governance is what we need, yet management is what current approaches support

- Today, governance is hidden: manual via out-of-band communications
- Automation presupposes representing contracts
Difficulty of Governance

Independence of stakeholders motivates high-level normative descriptions

The points that make governance desirable also make it difficult

- **Autonomy**: Stakeholders behave independently, constrained only by their agreements
- **Heterogeneity**: Stakeholders are independently constructed, constrained only by interface descriptions
- **Dynamism**: The set of stakeholders and their mutual relationships may change continually

Normative models can help conquer this complexity
What is a Norm?
A characterization of the normal

- Something accepted by many
- A standard
  - Formal or *de jure*
  - Informal or *de facto*
- For us
  - Some constraint or rule of encounter agreed to be the participants
  - An elementary directed relationship between two parties
Understanding Governance

Philosophy

Governance is about how stakeholders administer their resources

- Focus on stakeholders
- Focus on interactions among stakeholders, framed as *normative relationships*
  - Commitments to each other and such
- Focus on policies (capture autonomy)
- Focus on where the policies apply
  - *Policy points*: where each party takes an action
- Focus on perspicuous specification of policies
Contracts and Governance

Applying Contracts in IT Administration

Governance of service engagements

- Currently, humans achieve governance manually
  - Low productivity
  - Poor scalability to fine-grained, real time governance decisions
  - Hidden, implicit considerations yield low confidence in correctness and poor maintainability

- Can we address governance through contracts?
  - Applied commonly for external services: SLAs generally, cloud services
  - Apply for internal services as well
Approach: Contracts and Policies
Both are centered on interaction, but . . .

- Contracts are public units of abstraction over interactions,
  - Identify meanings of interactions in normative terms
  - If they refer to aspects of the implementation, they place those aspects in the public scope
- Policies are inherently private
- Policies lead each party to adopt a contract and decide whether and how to act given a contract
- Methodologically, we advocate going top down
  - Identify contracts
  - Identify policy points in a contract
  - Thus improving modularity and reusability
Outline

Contracts and Governance
The Governance Hypothesis
Governance is a basis for understanding contracts even outside of IT

- Each contract is governed, not just IT resources
- Reify organization into an Org, where
  - The Org’s members are stakeholders
  - The Org itself is a stakeholder
  - The Org provides the context of the contract
- The Org determines
  - Identity of its members
  - Enrollment: who becomes a member in what role
  - Enforcement of contracts among its members
- Each member handles
  - How to act: policies
  - Where to monitor
  - Whether to escalate
Achieving Governance: Agents and Orgs
Put collaboration center stage

- Agents (including Orgs) are active computational entities, and represent principals
- Agents represent the stakeholders: people and organizations
  - Provide a locus for interaction
- Orgs are like *institutions*: have an identity and life time distinct from their members; also modeled as agents
  - Examples: NCSU, UNC System, …
  - Provide a locus for roles and authorizations
  - Enforce behavioral constraints on members
    - Their main hold over their members is the threat of expulsion
Duality of Contracts and Orgs

- A set of contracts define an Org
  - Roles, with their qualifications, privileges, liabilities
- An Org provides the context for defining contracts
Governance Conceptually

- **<<autonomous>> Policy**
  - **Communicative Act**
    - controls

- **Principal**
  - realizes
    - **Contract Facade**

- **Org**
  - has scope
    - **Individual**
      - is the "top" instance (in the sense of scoping)
    - **OOI**
      - requires

- **Org Role Participation**
  - has actor
    - **Org Specification**
      - involves role
        - **Contract Template**
          - constrains

- **Liability**
  - imposes

- **Privilege**
  - grants

- **Qualification**
  - requires

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Patterns for Delegate (Repeated)

(a) Transfer responsibility

(b) Retain responsibility

(c) Escalate

(d) Withdraw delegation
Contextual Patterns: Penalize and Revert

Introducing an Org explicitly as the context

- **original**: $C(\text{debtor, creditor, context, true, original-condition})$
- **context**: $C(\text{context, creditor, context, cancel(Original), create(Penalty)})$
- **penalty**: $C(\text{debtor, creditor, context, true, penalty-condition})$

(a) Penalize

(b) Revert offer
A Purchase Service Engagement

Demonstrates incremental specification as a form of stepwise refinement

(a) Pair of conditional commitments describing purchase

(b) Introducing bank and shipper via delegations of commitments

(c) Allowing buyer to skip payment or get a refund upon returning goods
Exercise
Identify different types of clauses

- Rental lease
- Business process outsourcing
Contract Life Cycle

Vázquez-Salceda et al. from the European CONTRACTS Project
Additional Norms
Directionality and context are key features

Permission versus prohibition and sanction
Norms and Façades
Read as: The subject is committed to the object . . .

<table>
<thead>
<tr>
<th>Normative Concept</th>
<th>Subject’s Façade</th>
<th>Object’s Façade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment</td>
<td>Liability</td>
<td>Privilege</td>
</tr>
<tr>
<td>Authorization</td>
<td>Privilege</td>
<td>Liability</td>
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<tr>
<td>Power</td>
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<tr>
<td>Prohibition</td>
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</tr>
<tr>
<td>Sanction</td>
<td>Liability</td>
<td>Privilege</td>
</tr>
</tbody>
</table>
Norm Life Cycle: 1

- Norm
- Terminated: null, satisfied, violated
- Create
- Terminate
- Resume
- Active: conditional, in force
- Detach
- Pending
- Suspend
## Norm Life Cycle: 2

Computing the substate of a terminated norm

<table>
<thead>
<tr>
<th>If terminated in</th>
<th>Then</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ant</td>
</tr>
<tr>
<td>false false</td>
<td>null</td>
</tr>
<tr>
<td>false true</td>
<td>sat</td>
</tr>
<tr>
<td>true false</td>
<td>vio</td>
</tr>
<tr>
<td>true true</td>
<td>sat</td>
</tr>
</tbody>
</table>

In the case of a power, a vio occurs upon the failure of an attempt to bring about the consequent.