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## Part I

# Business

## Part II

# Technical

A legal matter processed in IDEAL traverses four states:

- *Generation* ( $\mathcal{G}$ ).
- *Representation* ( $\mathcal{R}$ ).
- *Transformation* ( $\mathcal{T}$ ).
- *Presentation* ( $\mathcal{P}$ ).

We can understand IDEAL as a system of *plug-ins* which either generate, or commonly access and transform a unified representation of a legal matter into derivative states. Consequently, the system is a series of machines mapping  $[\alpha_i \in \mathcal{G}] \rightarrow \mathcal{R}$ , or  $\mathcal{R} \rightarrow [\alpha_i \in \mathcal{T} \cup \mathcal{P}]$ . We denote  $\langle \alpha_i \rangle$  as a *generator* state which can generate  $\mathcal{R}$ , and  $\alpha_i$  as a *producible* state which be produced by some action on  $\mathcal{R}$ .

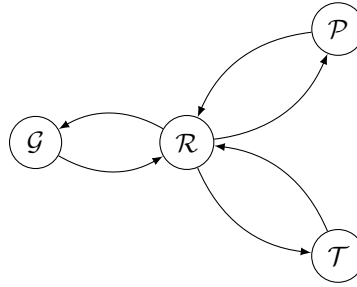


Figure 1: Visualising the interactions between the states.

In this section, we define  $\mathcal{R}$ , and provide an example of  $(\mathcal{G} \rightarrow \mathcal{R})$  and  $(\mathcal{R} \rightarrow \mathcal{P})$ .

## 1 Defining the Representation

Our goal is to define a mathematical structure for  $\mathcal{R}$  which encodes legal information and maximises the number of producible states. Given that the representation is driven by the encoded legal information, we begin by discussing our generalisation of information relevant to a legal case.

### 1.1 Generalising the Information in a Legal Case

Generally, a lawyer functions as a mechanism for identifying the *existence* or *non-existence* of a legal relationship between *objects*, as well as the extrapolation of any implications for a client.

**Facts, Nodes and the NodeState.** We describe a legal object as a **Node**, and define the admissible *factual* actions, attributes or character of the **Node** as the **NodeState**. The **NodeState**<sub>*n*</sub> is an unordered set of *n* **Fact** objects which are generated and edited by an oracle,  $\mathcal{F}$ , in combination with a **SourceOfLaw**:

$$\mathcal{F} : (\text{SourceOfLaw}, \{ \text{Fact}_0, \dots, \text{Fact}_n \}) \rightarrow \text{NodeState}_n \quad (1.1)$$

$$\mathcal{F} : (\text{Fact}, \text{NodeState}_n) \rightarrow \text{NodeState}_{n'} \quad (1.2)$$

$$\mathcal{F} : \text{NodeState}_n \rightarrow \text{NodeState}_{n''} \quad (1.3)$$

**Sources of Law.** A **SourceOfLaw** defines the conditions, attributes or characteristics which are required for the oracle to generate the **Role** (1.1.1) associated with a **NodeState**. Concretely, these are objects such as legislation or common law which have the inherent capacity to generate legal rights or obligations.

### 1.1.1 The Role Object

A **Role** defines the *legal personality* of a **Node** by capturing the attributes, actions, or characteristics attributable under law. A **Node** can be subject to multiple **Role** objects of arbitrary complexity, provided they are distinct under (1.6). The **Role** associated with a **Node** is generated by a pair (**NodeState**, **SourceOfLaw**) under the oracle function,  $\mathcal{F}$ , and is transformable under the **Consequence** of a **Link** (1.1.2):

$$\mathcal{F} : [ (\text{NodeState}, \text{SourceOfLaw}) \rightarrow \text{Role} ] \quad (1.4)$$

$$\text{Consequence} : [ \text{Role} \rightarrow \text{Role}' ] \quad (1.5)$$

**Equivalence of Roles.** We define an equivalence relation on a pair (**Role**<sub>*i*</sub>, **Role**<sub>*j*</sub>) by comparing their generating states, such that they are only pairwise distinct where the generative facts or law diverge:

$$[ \text{Role}_i = \text{Role}_j ] \iff [ (\text{NodeState}_i \iff \text{NodeState}_j) \wedge (\text{SourceOfLaw}_i \iff \text{SourceOfLaw}_j) ] \quad (1.6)$$

**Role Extension.** The **NodeState** of a **Node** can generate multiple **Role** objects *iff* the (**NodeState**, **SourceOfLaw**) pair are distinct under (1.6). A **Role** is *reducible* where a subset of the generative pair (**NodeState**, **SourceOfLaw**) can produce another distinct **Role**:

$$[ N := \{ \text{Fact}_0, \dots, \text{Fact}_n \} ] \wedge [ M := \{ \text{Fact}_0, \dots, \text{Fact}_m \} ] : [ M \subset N ] \quad (1.7)$$

$$[ \text{NodeState}_i = \mathcal{F}(N) ] : [ \text{Role}_i = \mathcal{F}(\text{NodeState}_i, \text{SourceOfLaw}_i) ] \quad (1.8)$$

$$[ \text{NodeState}_j = \mathcal{F}(M) ] : [ \text{Role}_j = \mathcal{F}(\text{NodeState}_j, \text{SourceOfLaw}_j) ] \quad (1.9)$$

$$\implies [ N \text{ is reducible} ] \quad (1.10)$$

A **Role** which is reducible is an *extension* of another **Role**, and the **Role** objects which are extended are called the *components of the extension*. The extended **Role** will automatically import any components

of the extension objects into its own definition. We denote an extension using subset notation, such that the following indicates  $\text{Role}_i$  is an extension of  $\text{Role}_j$ :

$$\text{Role}_j \subset \text{Role}_i \quad (1.11)$$

Given that an extension implies any components, a **Node** with multiple **Role** objects *may* replace any **Role** with an extension:

$$(\text{Role}_j \subset \text{Role}_i) \implies (\text{Role}_i \implies \text{Role}_j) \quad (1.12)$$

We distinguish a **Role** extension from a **Role composition**, by defining a composition as a set of distinct **Role** objects without an extension.

### 1.1.2 Links and Consequences

A **Link** is a directed, pairwise relationship between a source,  $\text{Role}_i$ , and a destination,  $\text{Role}_j$ , which has been generated by a **SourceOfLaw**. Given a pair  $(\text{Role}_i, \text{Role}_j)$  and an associated  $\text{Link}_{i \rightarrow j}$  drawn by the oracle,  $\text{Role}_j$  is mapped into  $\text{Role}_{j'}$  under some **Consequence**:

$$\mathcal{F} : (\text{SourceOfLaw}, \text{Role}_i, \text{Role}_j) \rightarrow \text{Link}_{i \rightarrow j} \quad (1.13)$$

**Hooking a Link.** The **Hook** and **Anchor** objects are a specialisation of the **Role** object which represent the symbiotic requirements of a **Link**, and are generated under a  $(\text{SourceOfLaw}, \text{Role})$  pairing. The oracle defines a **Link** by consuming a **Hook**, a **SourceOfLaw** and an **Anchor**:

$$\begin{aligned} & [\mathcal{F}(\text{SourceOfLaw}, \text{Role}_i) = \text{Hook}] \wedge [\mathcal{F}(\text{SourceOfLaw}, \text{Role}_j) = \text{Anchor}] \\ & \implies \mathcal{F} : (\text{SourceOfLaw}, \text{Role}_i, \text{Role}_j) \rightarrow (\text{Hook}, \text{Anchor}) \rightarrow \text{Link}_{i \rightarrow j} \end{aligned} \quad (1.14)$$

**Consequence.** Given a **Link** to a relationship, the oracle,  $\mathcal{F}$ , implies a **Consequence** from a **SourceOfLaw**:

$$\text{Link}_{i \rightarrow j} \implies [\mathcal{F} : \text{SourceOfLaw} \rightarrow \text{Consequence}] \quad (1.15)$$

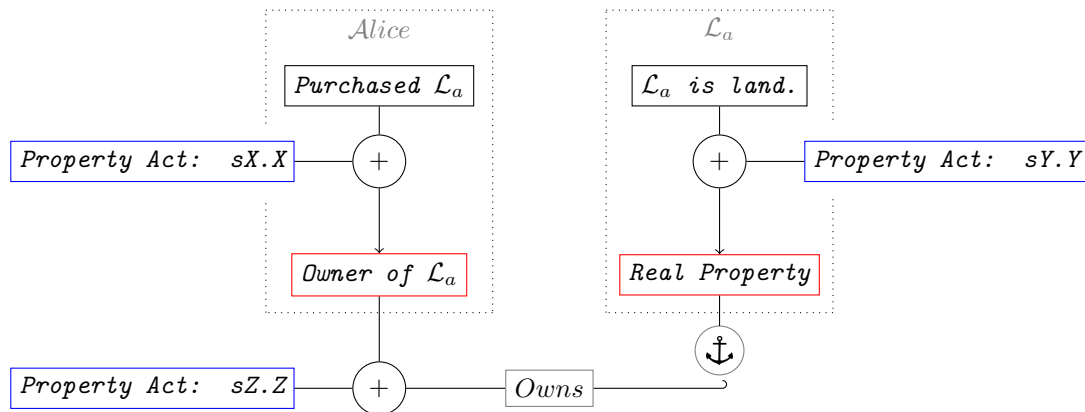
A **Node** may be modified under the **Consequence** of a **Link**, changing either the **NodeState** or associated **Role**:

$$\{\mathcal{F}(\text{Consequence}, \text{Node}) = \text{Node}'\} \implies \{[\text{NodeState} \rightarrow \text{NodeState}'] \vee [\text{Role}_i \rightarrow \text{Role}'_i]\} \quad (1.16)$$

The oracle subsequently *walks the consequence forward* to generate or decouple any **Hook** or **Anchor** objects which have been invalidated by the **Consequence**.

**Example.**

Consider a boundary dispute between *Alice* and *Bob* on two adjacent plots of land:  $\mathcal{L}_a$  and  $\mathcal{L}_b$ . In this case, *Alice* is the owner of  $\mathcal{L}_a$ , and *Bob* is the owner of  $\mathcal{L}_b$ . We are attempting to define whether it is permissible for *Alice* to build a structure by defining a boundary line delineating the properties, called *Bound*. The graphs below snapshot a portion of the legal relationship.

**Diagram 1.1** *Alice owns a parcel of land.*

**Compliance and Deviation.** A lawyer constructs a **Link(Consequence)** by analysing the **Role** of an object relative to a set of legal conditions. We define both compliance and deviation as:

$$[ \exists \text{Link(Existence, Consequence)} ] \wedge \begin{cases} [ \text{Role} \implies \text{Link}(\dots) ], & \text{Compliance} \\ [ \text{Role} \not\implies \text{Link}(\dots) ], & \text{Deviation} \end{cases} \quad (1.17)$$

**Example.** Continuing the previous example, we define compliance as Bob enforcing the terms of C against Alice, because Alice fulfils the relevant **Role**. Bob could not, however, enforce C against a third party, unless they also fulfilled a role which generated a **Link** to C.