Property Conveyances as a Programming Language

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CORNELL
NYCTECH

SPLASH Onward! Oct. 24, 2019

Disclaimer

I am not a lawyer

(and I don't play one on TV*)

and this presentation (& paper) does not constitute legal advice

*though if you have entertainment industry contacts, let me know

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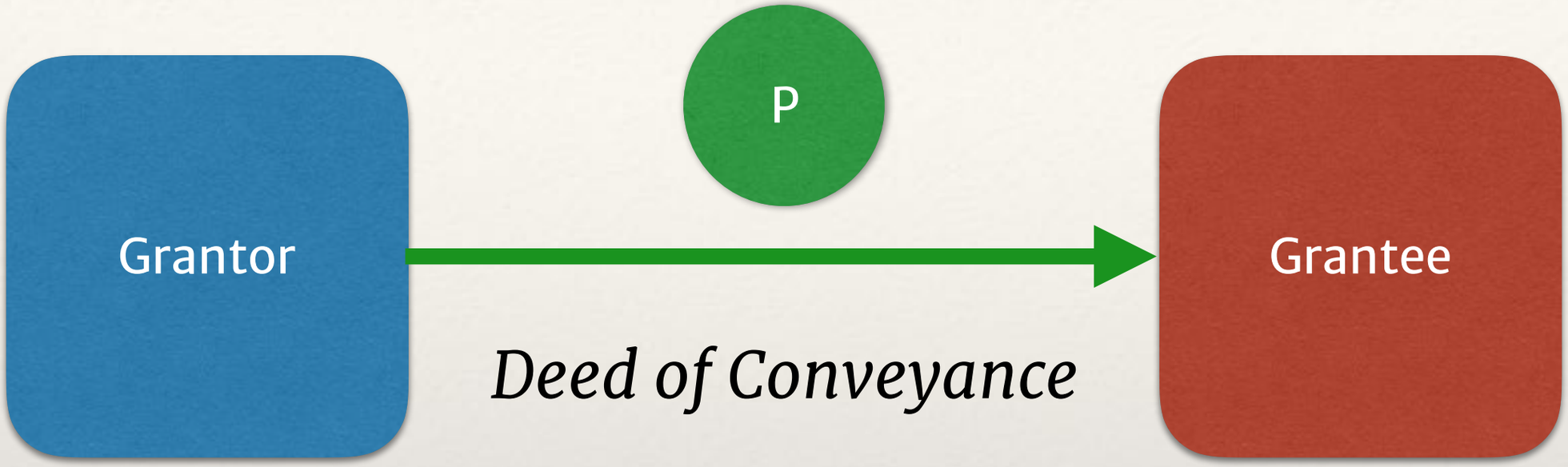


Multiple types of deeds
Differing requirements by jurisdiction
Short documents with standardized language

The right to possess the property is called an *interest.*
Possessory if owner has right to possess *now*, otherwise, *future interest.*

Some Examples

O conveys P to A.

O conveys P to A for life.

O conveys P to A until A graduates.

O conveys P to A for life, then to B.

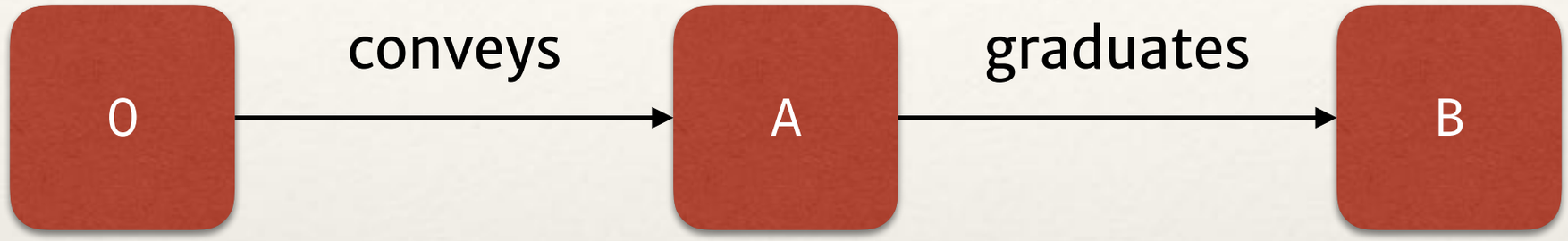
O conveys P to A for life, then to B, but if C marries to C.

Dude,
where's my
λ
?

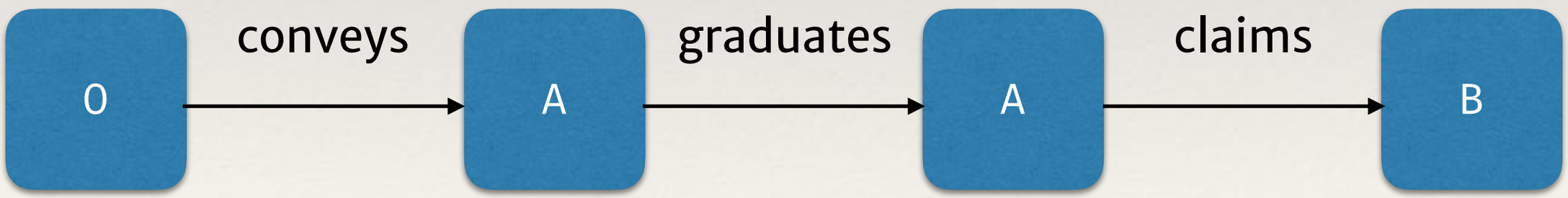
O conveys P to A until A graduates, then to B.

O conveys P to A, but if A graduates to B.

O conveys P to A until A graduates, then to B.



O conveys P to A, but if A graduates to B.



Example: Limitations

- Determinable Estate (immediate transfer)
  - phrased as measure of the duration of the estate *until, so long as, while, during*
  - placed *before* the punctuation mark signaling the end of the description

- Estate Subject to a Condition Subsequent (requires claim)
  - phrased like an afterthought *but if, provided that, however*
  - placed *after* the the punctuation mark signaling the end of the description

Ideal for a DSL

- Well-defined(-ish) syntax
  - People, properties, conditions, keywords, punctuation.
- Rich language of events and conditions
  - dies, graduates, survives, marries vs. is married
- Deterministic, agreed-upon rules

What we did

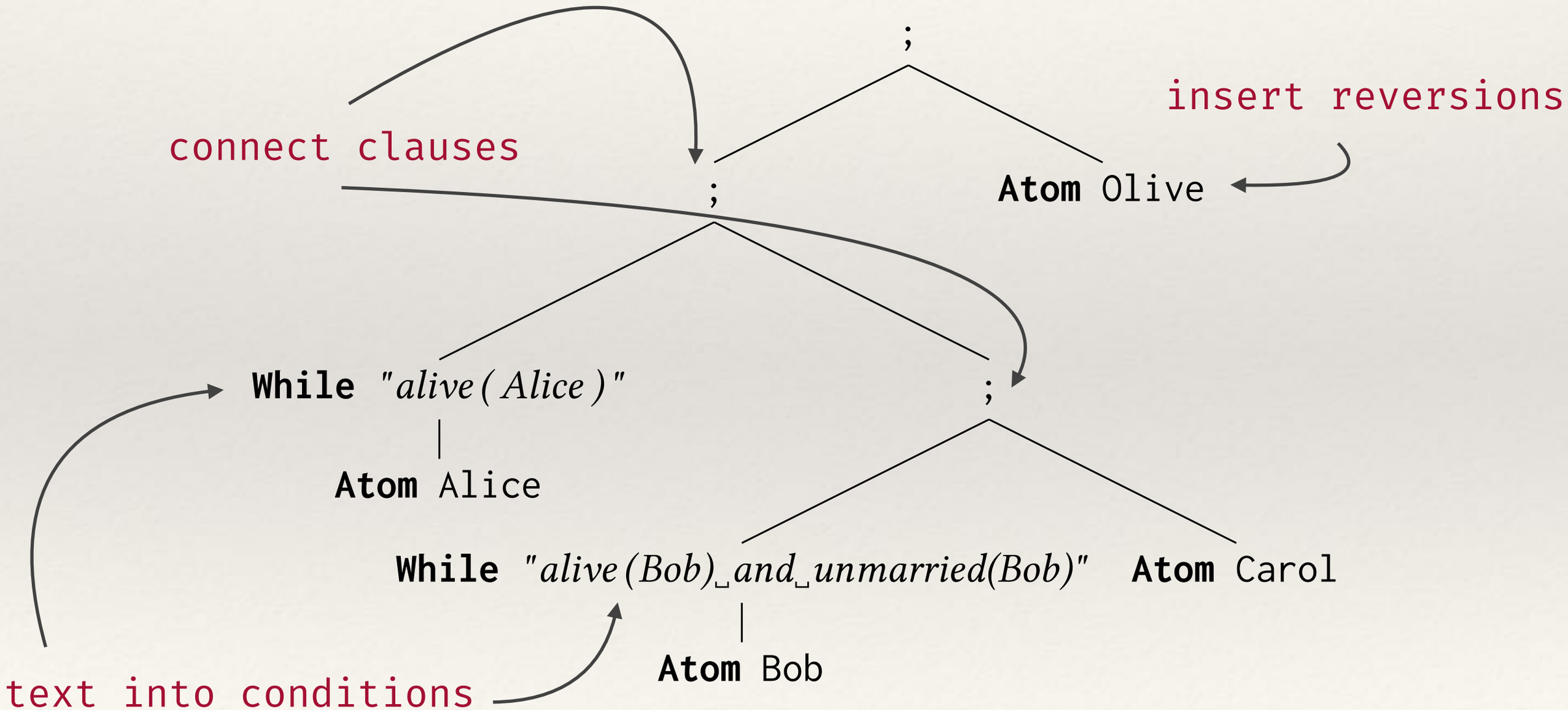
- Develop a core calculus for conveyances
- Translate surface syntax into a core calculus
- Operational and denotational semantics
- Prove equivalence between the semantics
- Prove that semantics obey property law principles
- Implementation and evaluations

```
Olive owns.
Olive conveys to Alice for life, then to Bob
    for life until Bob marries, then to Carol.
Alice dies.
Bob conveys to Dave for life.
Bob marries.
```

1. Olive owns.

Atom Olive

```
Olive owns.
Olive conveys to Alice for life,
 then to Bob for life until Bob marries,
 then to Carol.
```



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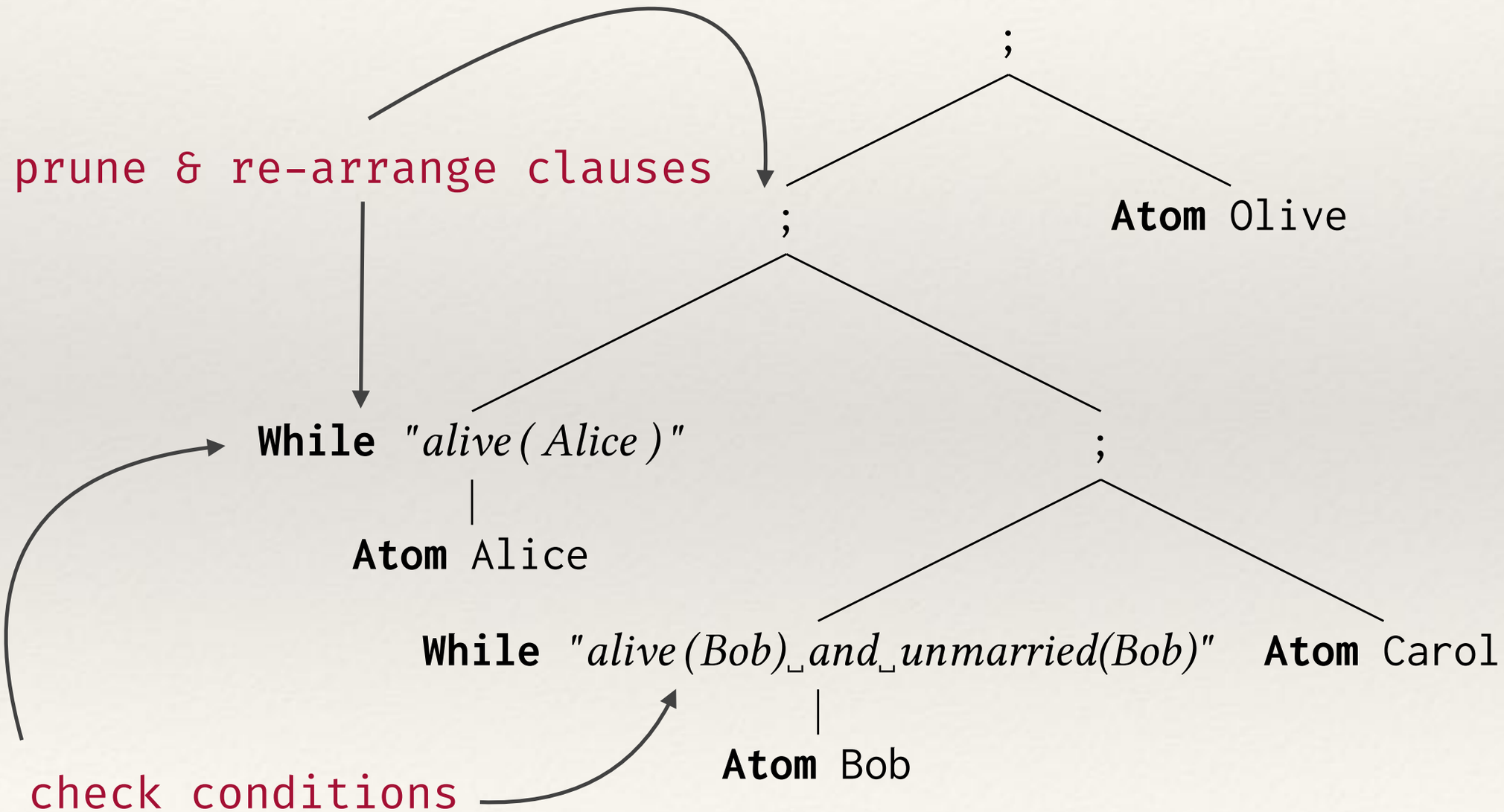

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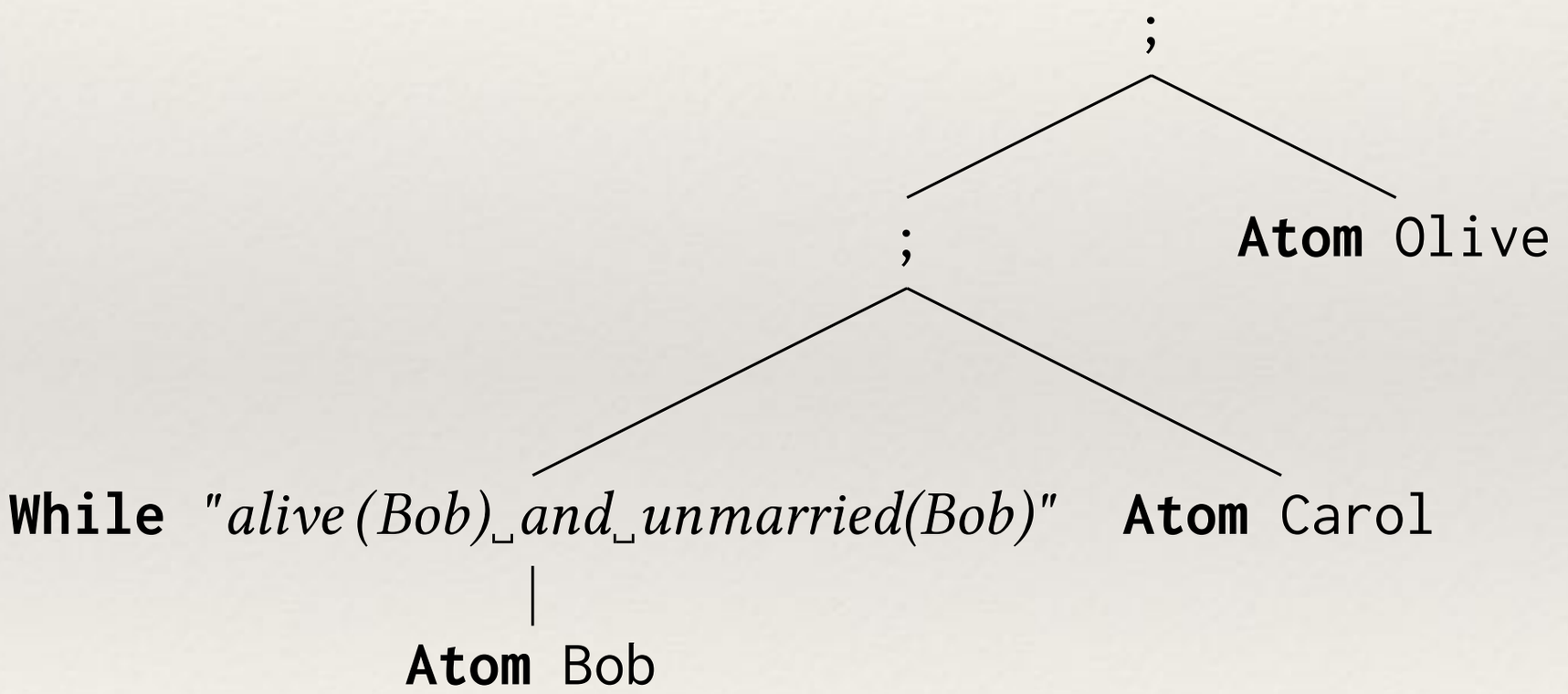
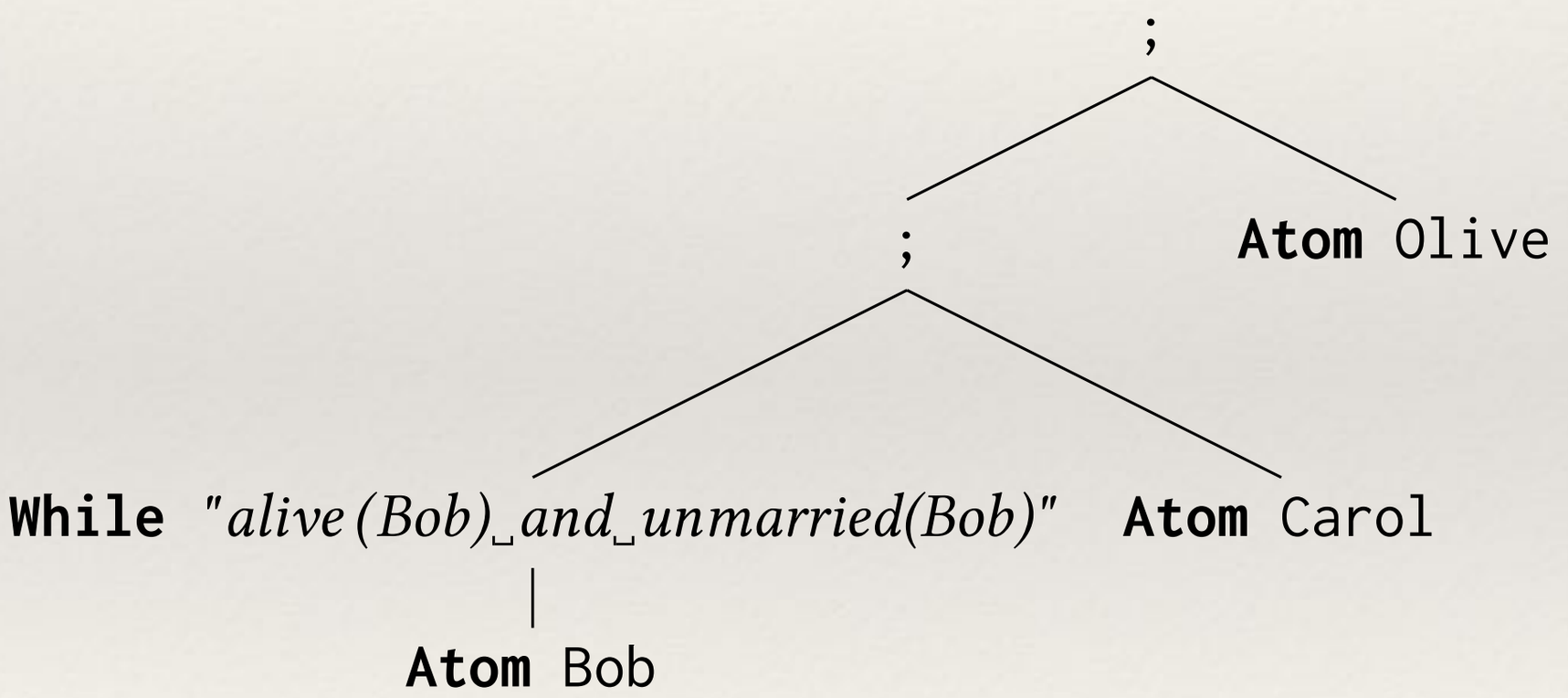


```
Olive owns.
Olive conveys to Alice for life,
 then to Bob for life until Bob marries,
 then to Carol.
Alice dies.
```

Bob conveys to Dave for life.



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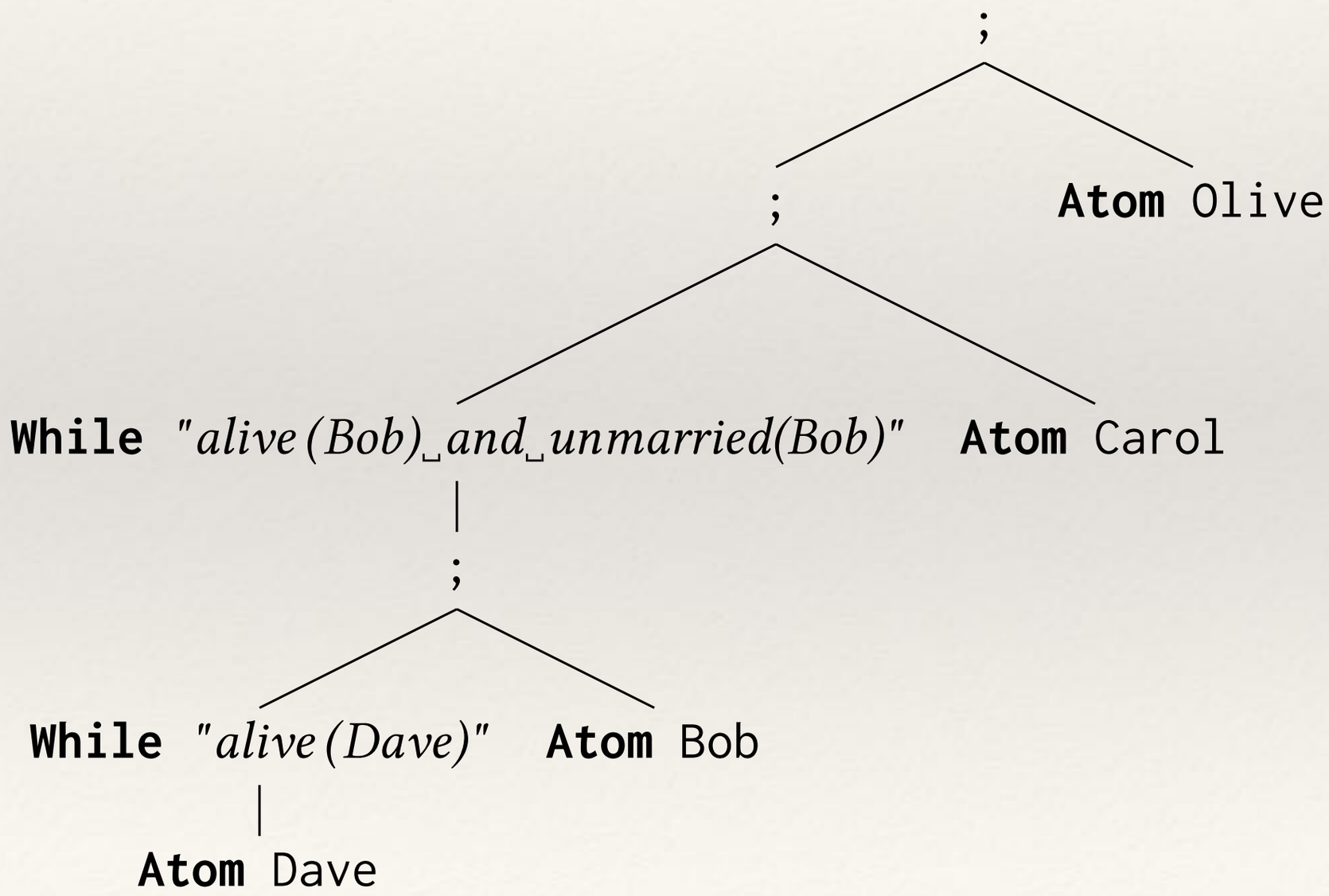
Olive conveys to Alice for life,
 then to Bob for life until Bob marries,
 then to Carol.
Alice dies.
Bob conveys to Dave for life.
```



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Bob conveys to Dave for life.
Bob marries.
```

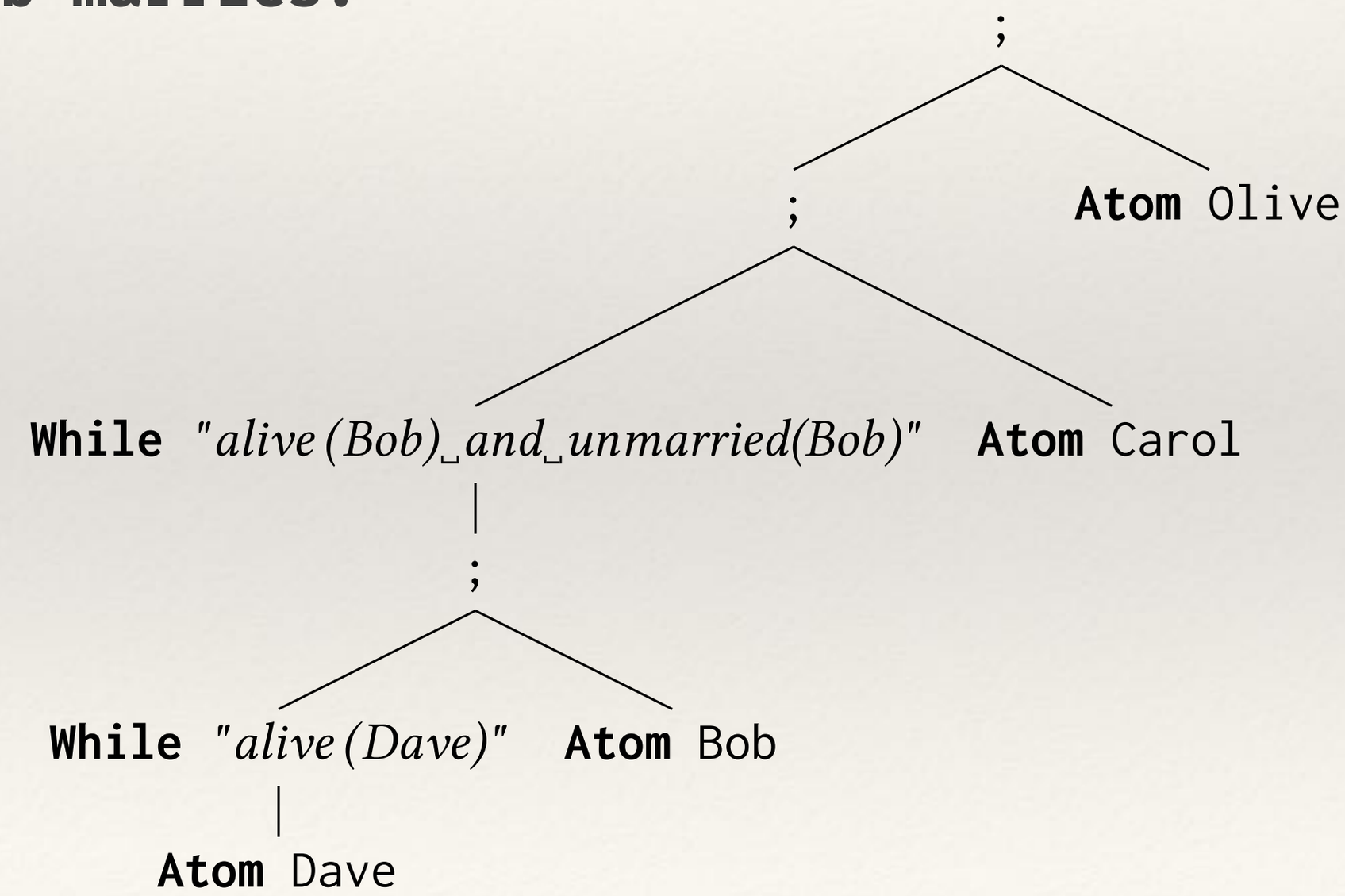

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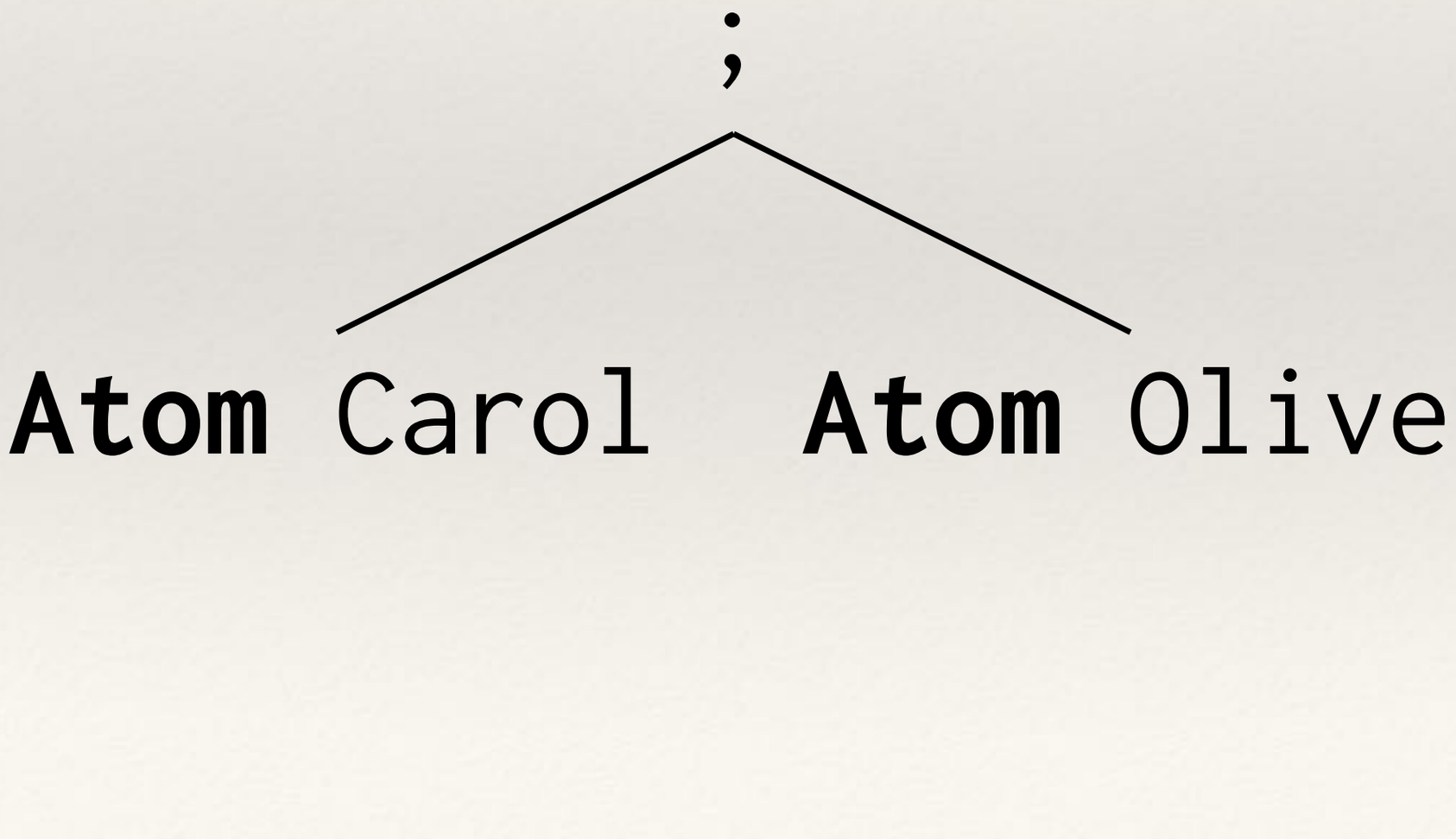


Core Calculus

$$
\begin{array}{rrll}
\text{Interest } \Gamma \ni \gamma & ::= & \text{To } (n \in \mathbb{N}, g, o \in \mathbb{P}) & \text{Transfer} \\
\\
\text{Terms } t \ni T & ::= & \text{Atom } \gamma & \text{One Interest} \\
& | & \text{Seq } (t_1, t_2) & \text{Sequencing} \\
& | & \text{While } (c, t) & \text{Termination} \\
& | & \text{If } (c, t) & \text{Precondition} \\
& | & \text{Bottom} & \text{Reversion} \\
\\
\text{Statement } S \ni s & ::= & \text{Conveys } (\gamma,\ t) \mid e & \\
\text{Program } \pi & ::= & [\ \text{Owns } p;\ s_0 \ldots s_n\ ] &
\end{array}
$$

p, but if c then $q \rightarrow$ `while(not` c, (p ; `Atom` g)); q

Operational Semantics

- Conditions as black boxes
  - $c : E* \rightarrow \{true, false\}$; stepping function
- Interleave *stepping* and *simplification*
  - *Stepping* moves conditions ahead & expands terms
  - *Simplification* removes expired terms
- *Observe* possessory interest from leftmost term
- Based on derivatives of regular expressions

Evaluation

Theorems

Implementation

Theorems

- A fee simple is perpetual and unconditional
- Ownership is always unambiguous
- *Nemo dat quod non habet*
- First in time, first in right
- Conservation of estates
- Proved using the denotational semantics

Implementation

Computational Conveyances

Choose an example or write your own

```
O owns Blackacre.
O conveys Blackacre to B until B dies.
B dies.
```

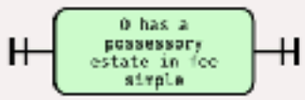
Interpret! Show trace

Examples for Onward! 2019

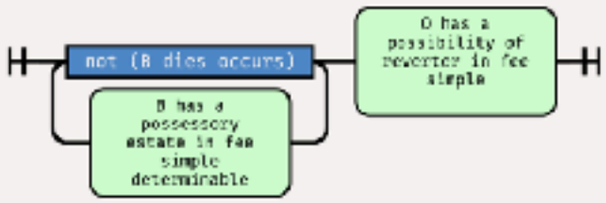
- O conveys Blackacre to A.
- O conveys Blackacre to A for life.
  A dies.
- O conveys Blackacre to A for life, then to B.
  A dies.
- O conveys Blackacre to A for the life of X.
- O conveys Blackacre to A for life, then to B for life, then to C.
- O conveys Blackacre to A until B marries.
- O conveys Blackacre to A until B marries, then to C.
- O conveys Blackacre to A, but if B marries then to C.
- O conveys Blackacre to A for life until B marries.
- O conveys Blackacre to A for life, but if B marries then to C.

See the results

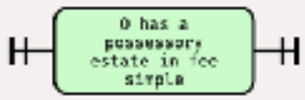
O owns the property



Conveyance by O



B dies



Implementation

- 119 examples from *Estates in Land and Future Interests: A Step-by- Step Guide* by Linda Edwards
- 104 passed without issue (26 required minor edits)
- 13 had complicated conditions; 2 required extra syntax

Why?

- It’s an interesting experiment!
- An exploration of (dis-)similarities between legal & computational reasoning
- Potential pedagogical tool for law students
- Proof assistants & explorers for legal reasoning

https://conveyanc.es