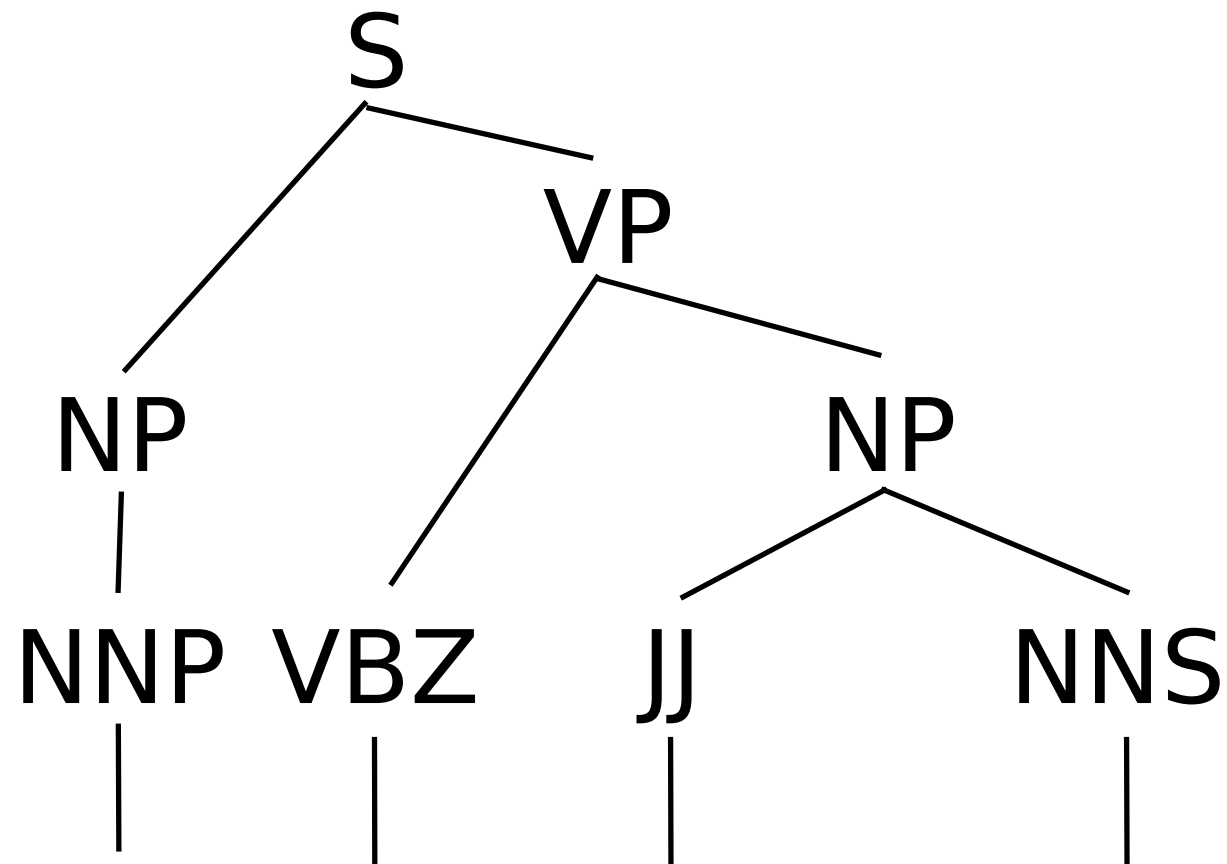


# An Example

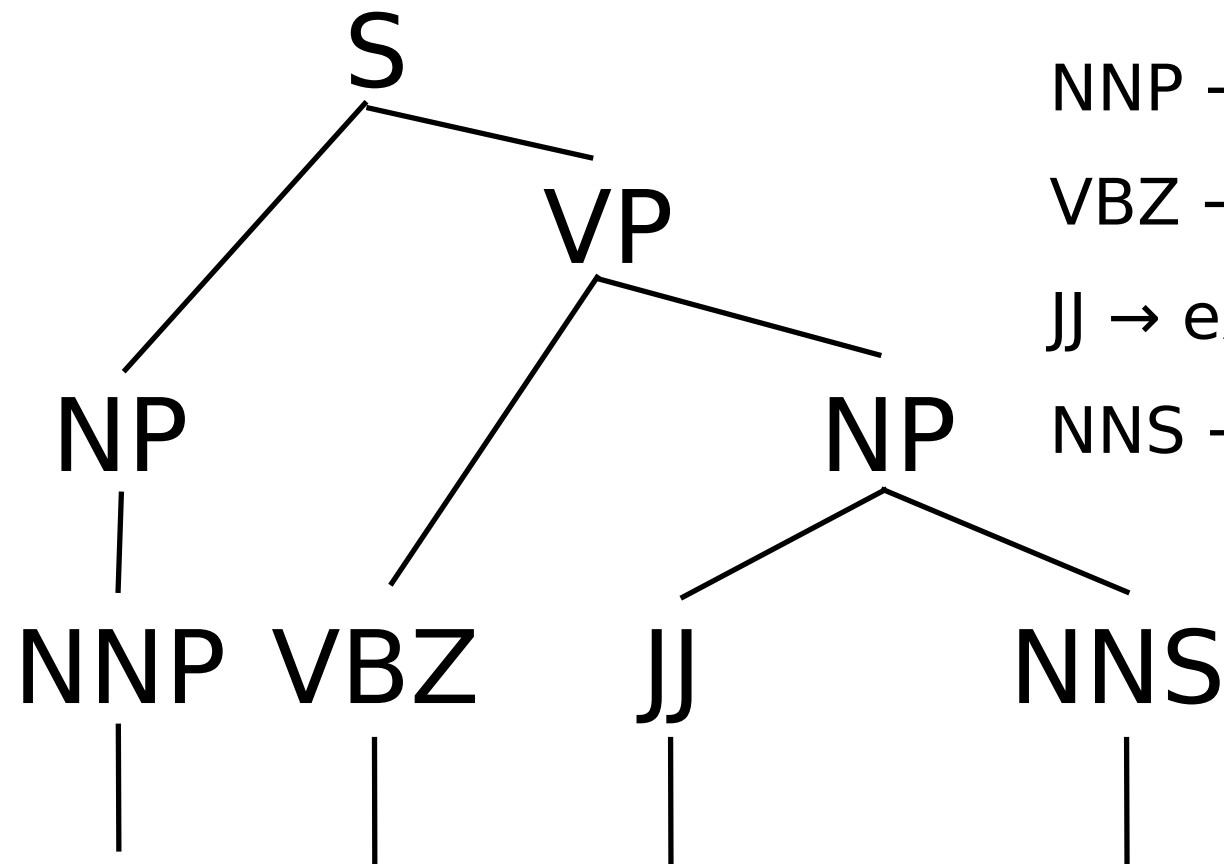
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- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

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NNP  $\rightarrow$  Noah { Noah }

VBZ  $\rightarrow$  likes {  $\lambda f.\lambda y.\forall x f(x) \Rightarrow \text{Likes}(y, x)$  }

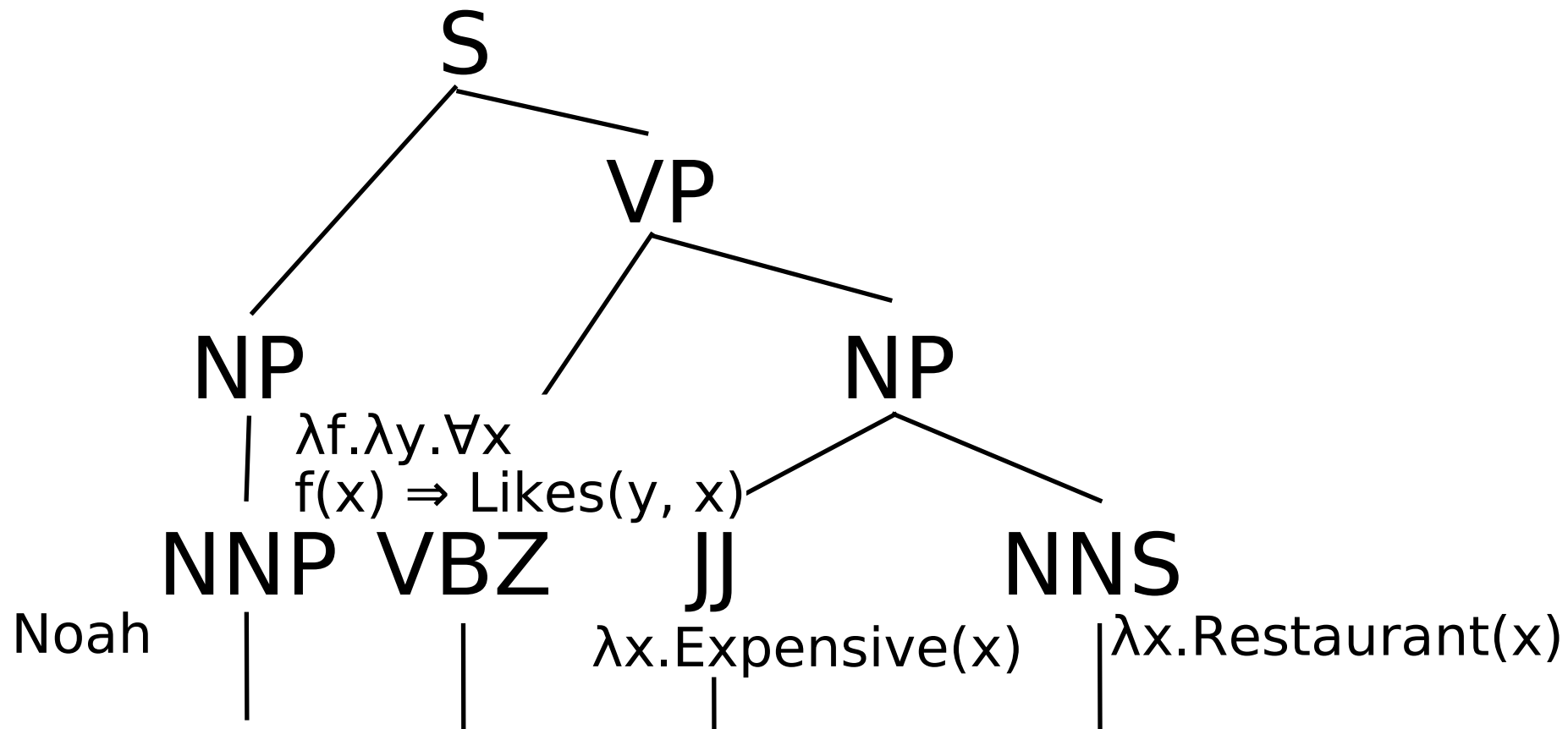
JJ  $\rightarrow$  expensive {  $\lambda x.\text{Expensive}(x)$  }

NNS  $\rightarrow$  restaurants {  $\lambda x.\text{Restaurant}(x)$  }

- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

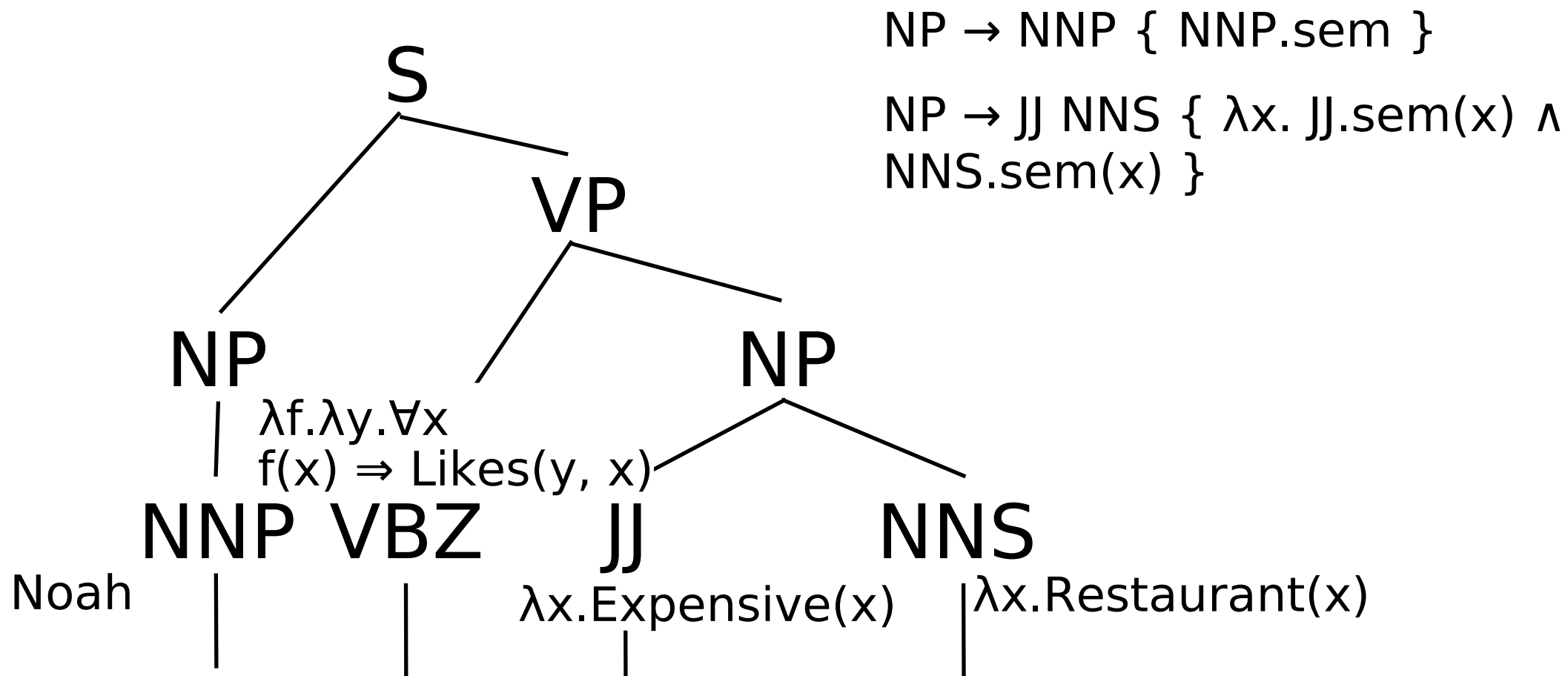
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- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

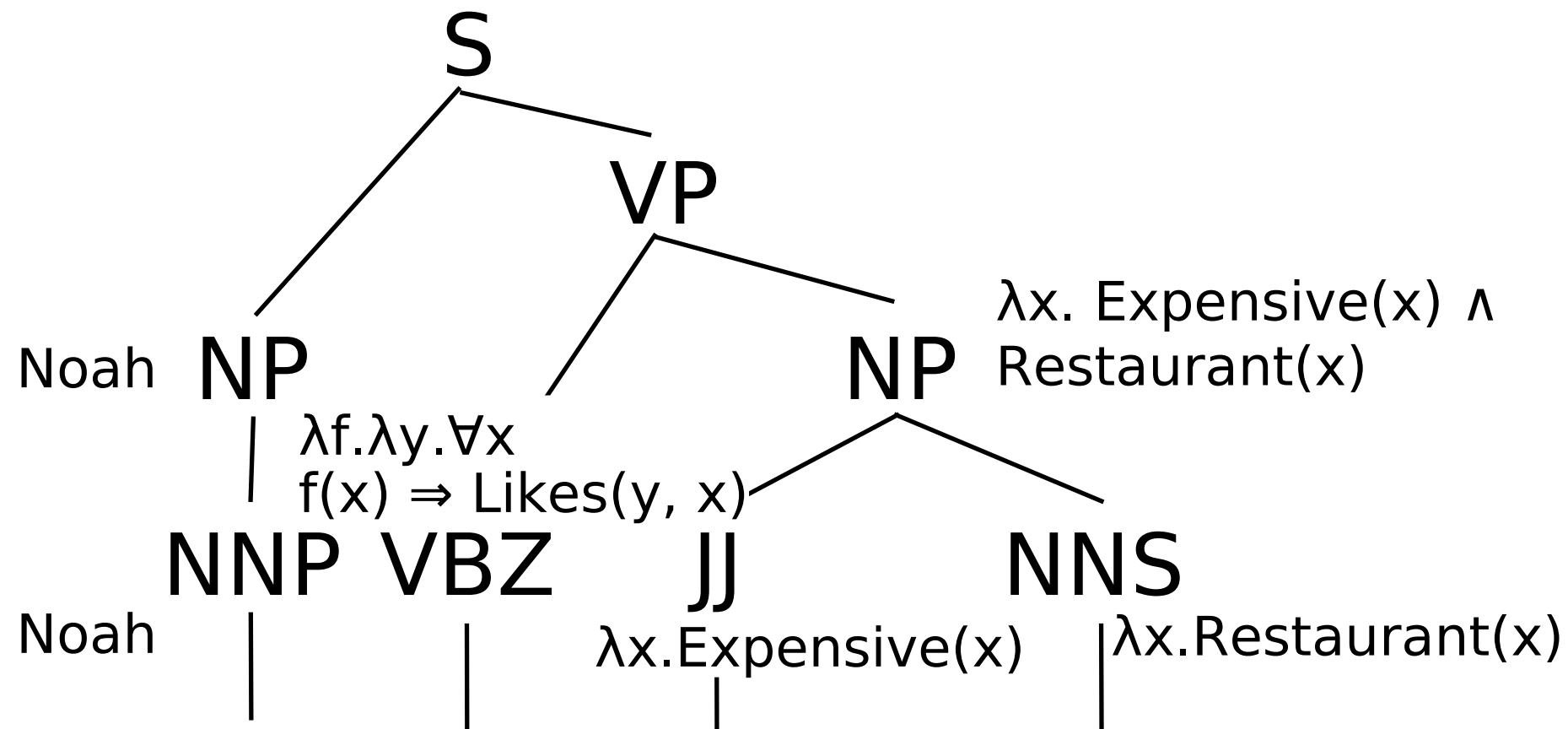
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- Noah likes expensive restaurants.
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# An Example

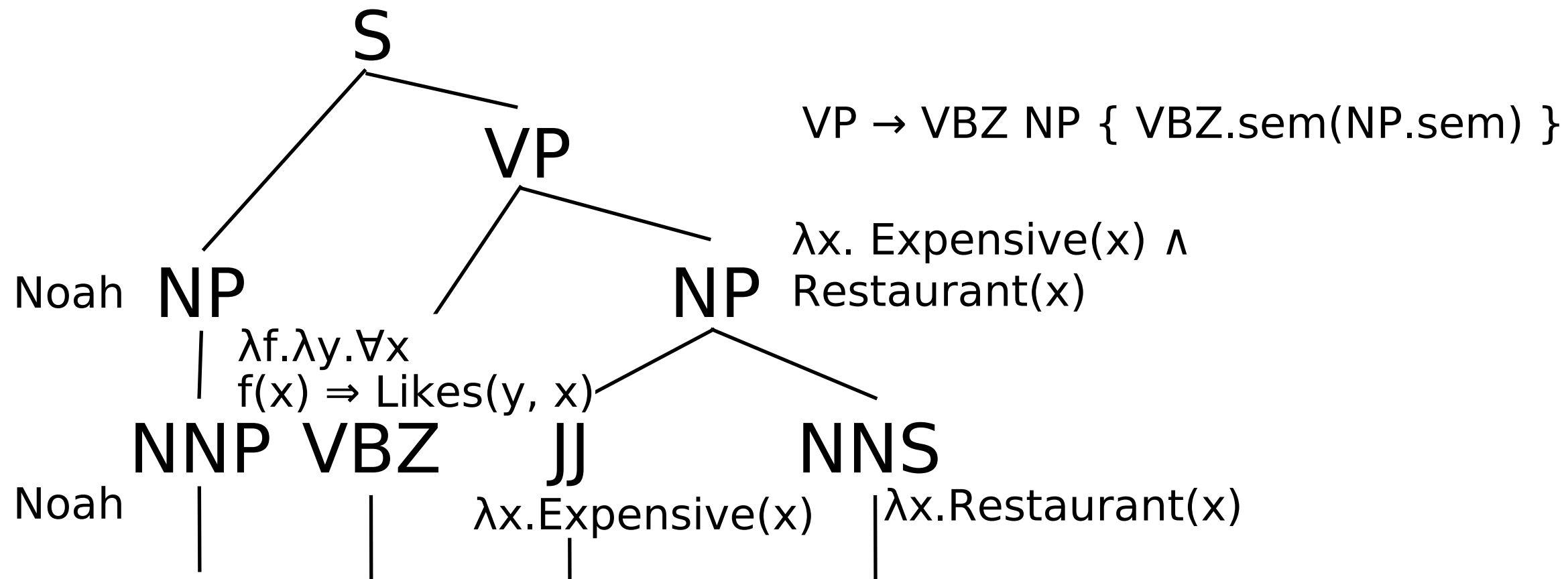
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- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

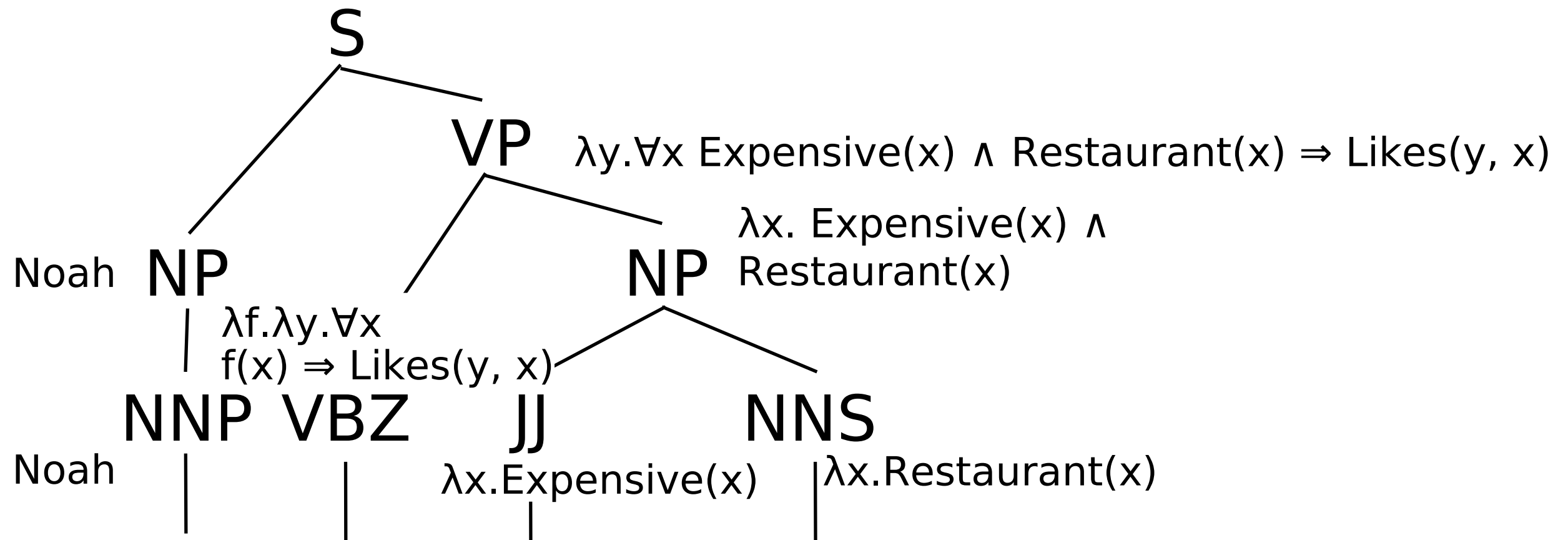
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- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

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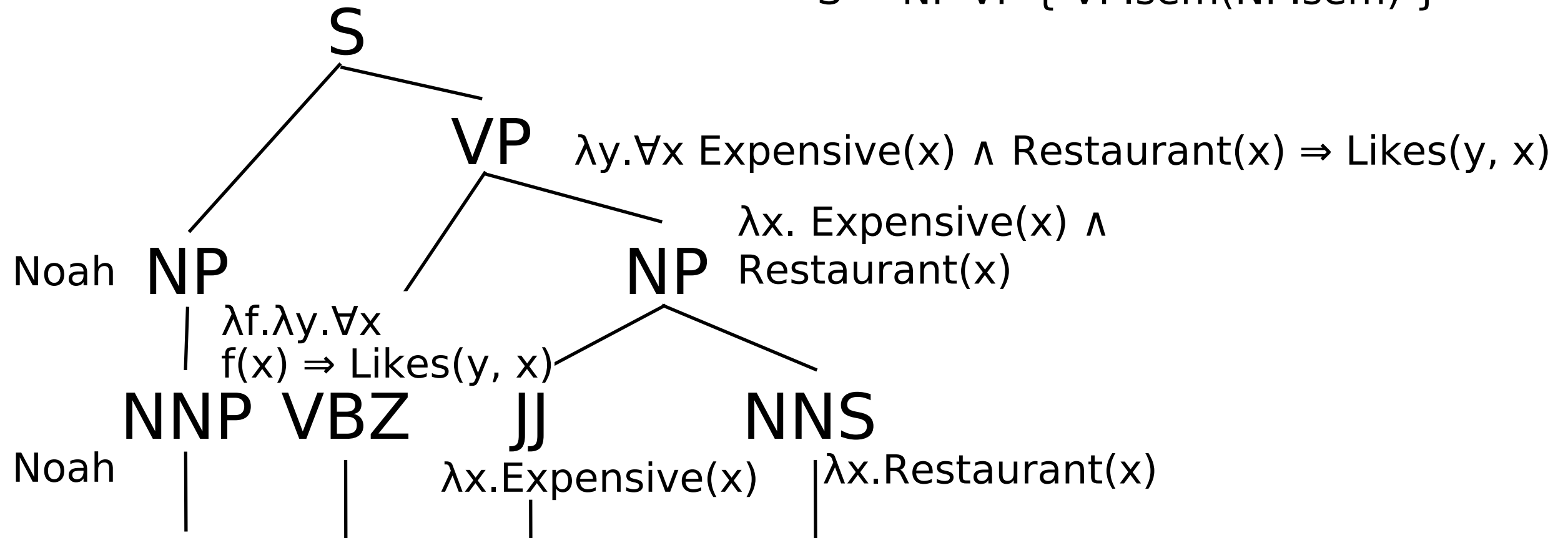


- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

# An Example

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$S \rightarrow NP VP \{ VP.sem(NP.sem) \}$

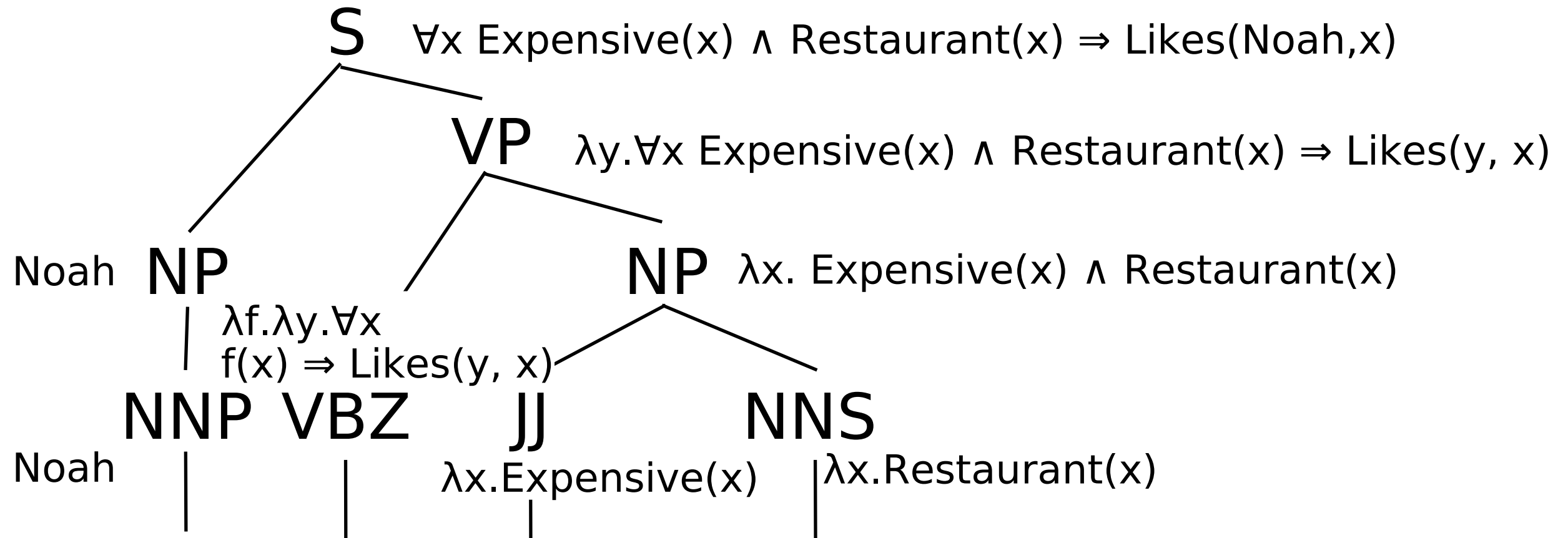


- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$



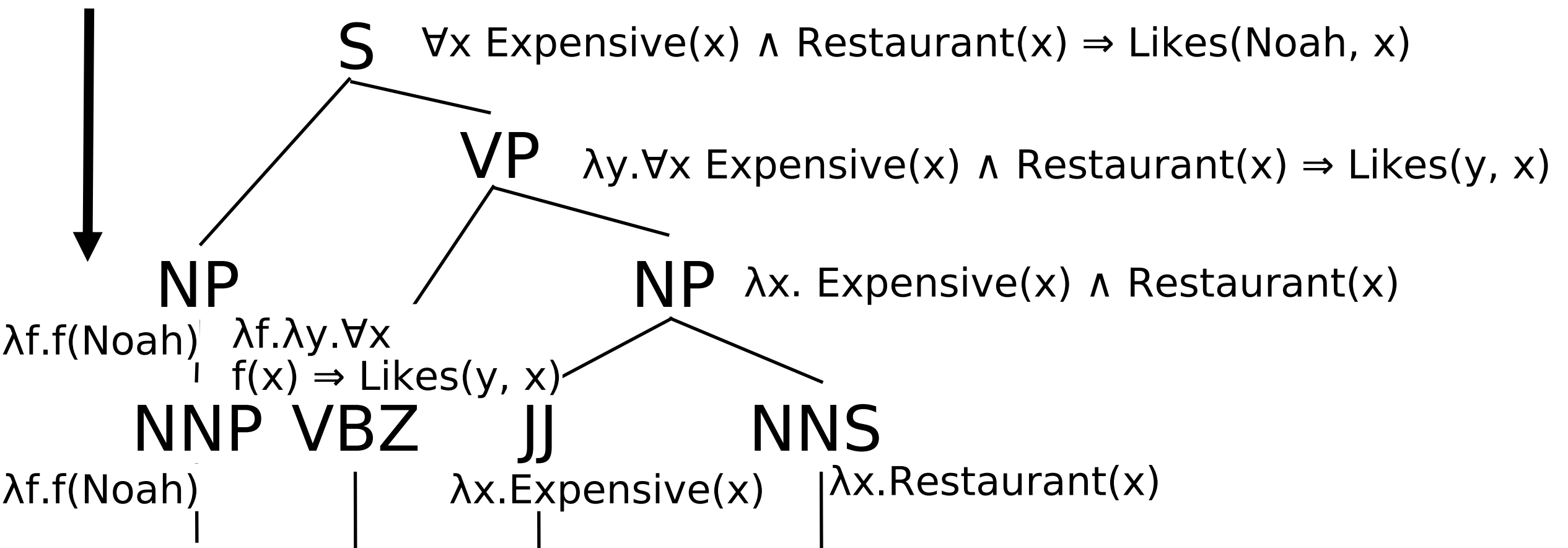
# An Example

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- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

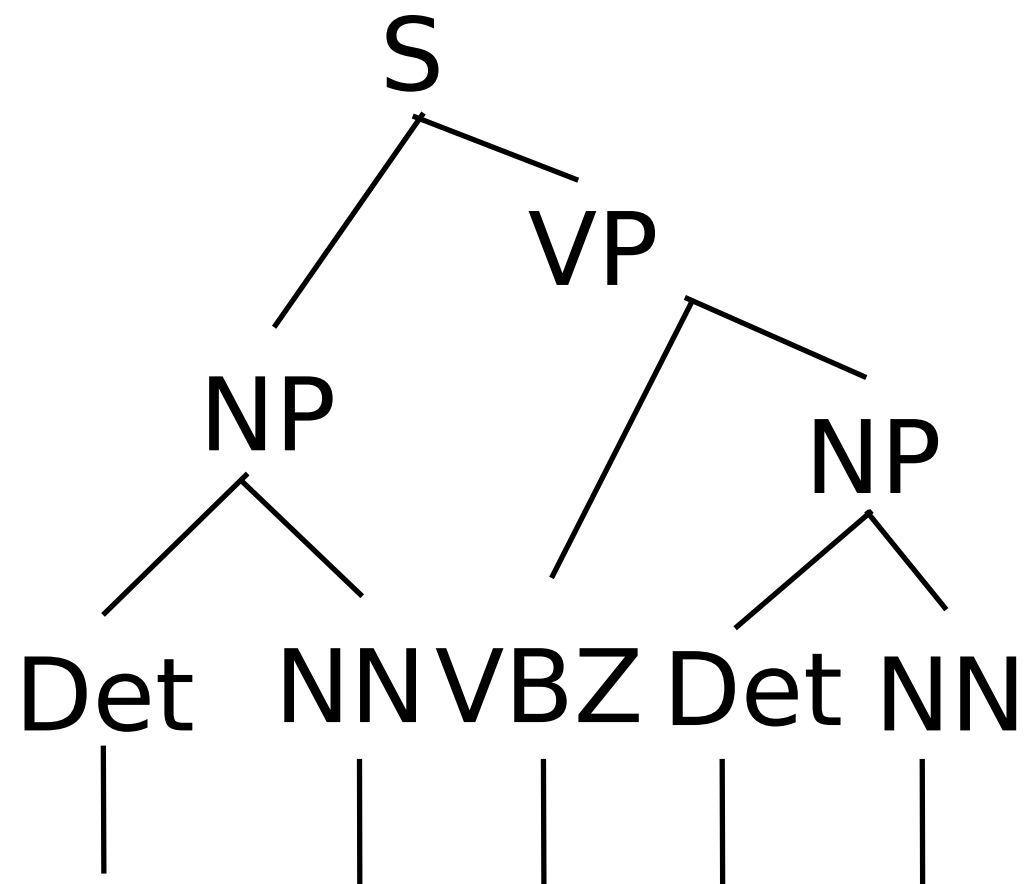
# Alternative (Following *SLP*)



- Noah likes expensive restaurants.
- $\forall x \text{ Restaurant}(x), \text{Expensive}(x) \Rightarrow \text{Likes}(\text{Noah}, x)$

$S \rightarrow NP \ VP \ \{ \ NP.\text{sem}(VP.\text{sem}) \}$

# Quantifier Scope Ambiguity



$S \rightarrow NP \ VP \ \{ \ NP.sem(VP.sem) \}$

$NP \rightarrow Det \ NN \ \{ \ Det.sem(NN.sem) \}$

$VP \rightarrow VBZ \ NP \ \{ \ VBZ.sem(NP.sem) \}$

$Det \rightarrow \text{every} \ \{ \ \lambda f.\lambda g.\forall u \ f(u) \Rightarrow g(u) \}$

$Det \rightarrow \text{a} \ \{ \ \lambda m.\lambda n.\exists x \ m(x) \wedge n(x) \}$

$NN \rightarrow \text{man} \ \{ \ \lambda v.Man(v) \}$

$NN \rightarrow \text{woman} \ \{ \ \lambda y.Woman(y) \}$

$VBZ \rightarrow \text{loves} \ \{ \ \lambda h.\lambda k.h(\lambda w.Loves(k, w)) \}$

- Every man loves a woman.
- $\forall u \ Man(u) \Rightarrow \exists x \ Woman(x) \wedge Loves(u, x)$
- $\exists x \ Woman(x) \wedge \forall u \ Man(u) \Rightarrow Loves(u, x)$

# This Isn't Quite Right!

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- “Every man loves a woman” really is ambiguous.
  - A seat was available for every customer
  - A toll free number was available for every customer
  - A secretary phoned up each director
  - A letter was sent to each customer
- This gives only one of the two meanings.
- One approach is to delay the quantifier processing until the end, then permit any ordering.