# 1. Junctions (Infinitary Operators)

| | | |
|---|---|---|
| $\wedge$ | conjunction | every |
| $\vee$ | disjunction | some |
| Л | subjunction | any |
| ⊠ | exclusive-disjunction | exactly-one |
| $\Sigma$ | sum | "a" (basic)[1] |
| $\Pi$ | product | "a" (promoted) |

# 2. General Formation Rules

First, for each junction Ж, we posit a new type-forming operator Ж, defined so that

if $\mathfrak{I}$ is a type, then so is Ж$\mathfrak{I}$.

We further propose the following formation rule.

If $\nu$ is a variable, $\varepsilon$ is an expression of type $\mathfrak{I}$, and $\Phi$ is a formula, then

$$\text{Ж}_\nu\{\varepsilon \mid \Phi\}$$

is an expression of type Ж$\mathfrak{I}$, which we read as:

the Ж (over $\nu$) of all $\varepsilon$ such that $\Phi$

where 'Ж' is replaced by the appropriate term (e.g., 'conjunction' or 'product').

# 3. Interpretation of Quantifiers (so far)

$$[\![\text{every}]\!] = \lambda P_0 \wedge\{x \mid Px\}$$

$$[\![\text{some}]\!] = \lambda P_0 \vee\{x \mid Px\}$$

$$[\![\text{no}]\!] = \lambda P_0 \wedge\{\neg \times x \mid Px\} \qquad [\neg =_{df} \lambda P{\sim}P]$$

$$[\![\text{any}]\!] = \lambda P_0 \text{Л}\{x \mid Px\}$$

# 4. Composition

| **Junction-Composition (Ж-Com)** | |
|---|---|
| $\alpha$ | $\alpha$ is any expression (**or null**) |
| $\text{Ж}_\nu\{\beta \mid \Phi\}$ | Ж **admits** $\alpha$ |
| $\{\alpha,\beta\} \vdash \gamma$ | a sub-derivation of $\gamma$ from $\{\alpha,\beta\}$ |
| $\text{Ж}^*{}_\nu\{\gamma \mid \Phi\}$ | Ж* is a *transform* of Ж |

Here, $\alpha$, $\beta$, $\gamma$ are expressions, and Ж is any junction. The nature of Ж*, and the admissibility restrictions are gradually spelled out over these pages.

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[1] The word 'a' is scare-quoted because it is often not pronounced. In English, singular common-noun-phrases *require* 'a', but plural-phrases and mass-phrases *prohibit* 'a'. By comparison, Spanish has plural forms of 'a' ['unas' and 'unos'].

## 5. Admissibility Restrictions (so far)

$(\wedge_1)$ $\wedge$ does not admit $\lambda P_1 \lambda x_1 {\sim} Px$ [‘does-not’].

$(\wedge_2)$ $\wedge$ does not admit any relative-pronoun-phrase.[2]

$(\wedge_3)$ $\wedge$ does not admit $\wedge\{\ \lambda Q{\sim}Qx \mid Px\ \}$ [‘no P’].

$(\wedge_4)$ $\wedge$ does not admit $\lambda P \lambda Q\{P \rightarrow Q\}$ [‘if’].

## 6. Simplification Principles (so far)

$\wedge_\nu\{\Psi \mid \Phi\}$ / $\forall\nu\{\Phi \rightarrow \Psi\}$ [$\wedge$-simplification]

$\vee_\nu\{\Psi \mid \Phi\}$ / $\exists\nu\{\Phi \& \Psi\}$ [$\vee$-simplification]

## 7. Transform Principles (so far)

$(\text{Л}_1)$ anti-tonic functions transform (promote) Л to $\wedge$.

## 8. Anti-Tonic (Monotonic-Decreasing) Functions

$\phi$ is anti-tonic $=_{\text{df}}$ $\forall xy\{\ x \leqslant y \rightarrow \phi(y) \leqslant \phi(x)\ \}$

where $\leqslant$ is an *order-relation*; in semantics, $\leqslant$ corresponds to (generic) *entailment*.

**Examples:**

1. not
2. does-not
3. if
4. if $x$ is A
5. no
6. no A
7. every

## 9. Pronoun-Binding

We propose two anaphoric morphemes

(α) creates an anaphoric-role (where α is a negative integer)
[α] produces an item to fill (bind) the anaphoric role created by (α)

which are type-logically rendered as follows.

(α) $\curvearrowright$ $\lambda x_\alpha\{x\}$
[α] $\curvearrowright$ $\lambda x\{x_\alpha\}$

e $\curvearrowright$ $\varnothing$ [essentially-anaphoric pronoun-root]

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[2] In other words, an NP headed by a relative pronoun, such as ‘who’ and ‘whose mother’.

## 10. Simple Examples

1. Jay respects his mother

<table>
<tr><td>Jay</td><td>[+1]</td><td>[–1]</td><td>respects</td><td>(–1)</td><td colspan="2">his</td><td>mother</td><td>[+2]</td></tr>
<tr><td></td><td>$\lambda x\{x_1\}$</td><td>$\lambda x\{x_{-1}\}$</td><td></td><td></td><td>e+M</td><td>[+6]</td><td></td><td></td></tr>
<tr><td>J</td><td colspan="2">$\lambda x\{x_1 \times x_{-1}\}$</td><td></td><td>$\lambda x_{-1}\{x\}$</td><td>$\varnothing$</td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td></td><td colspan="2">$\lambda x_{-1}\{x\}$</td><td>$\lambda x\{x_6\}$</td><td></td><td></td></tr>
<tr><td colspan="3"></td><td></td><td colspan="3">$\lambda x_{-1}\{x_6\}$</td><td>$\lambda x_6\{\mathbf{m}(x)\}$</td><td></td></tr>
<tr><td colspan="3"></td><td></td><td colspan="4">$\lambda x_{-1}\{\mathbf{m}(x)\}$</td><td>$\lambda x\{x_2\}$</td></tr>
<tr><td colspan="3"></td><td>$\lambda y_2 \lambda x_1 \mathbf{R} xy$</td><td colspan="5">$\lambda x_{-1}\{\mathbf{m}(x_2)\}$</td></tr>
<tr><td colspan="3">$\text{J}_1 \times \text{J}_{-1}$</td><td colspan="6">$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x,\mathbf{m}(y)]$</td></tr>
<tr><td colspan="9">$\mathbf{R}[\text{J},\mathbf{m}(\text{J})]$</td></tr>
</table>

2. Kay's father respects her mother

<table>
<tr><td>Kay</td><td>'s</td><td>[–1]</td><td>father</td><td>[+1]</td><td>respects</td><td>(–1)</td><td colspan="2">her</td><td>mother</td><td>[+2]</td></tr>
<tr><td></td><td>$\lambda x\{x_6\}$</td><td>$\lambda x\{x_{-1}\}$</td><td></td><td></td><td></td><td></td><td>e+F</td><td>[+6]</td><td></td><td></td></tr>
<tr><td>K</td><td colspan="2">$\lambda x\{x_6 \times x_{-1}\}$</td><td></td><td></td><td></td><td>$\lambda x_{-1}\{x\}$</td><td>$\varnothing$</td><td>$\lambda x\{x_6\}$</td><td></td><td></td></tr>
<tr><td colspan="3"></td><td></td><td></td><td></td><td colspan="3">$\lambda x_{-1}\{x_6\}$</td><td>$\lambda x_6\{\mathbf{m}(x)\}$</td><td></td></tr>
<tr><td colspan="3">$\text{K}_6 \times \text{K}_{-1}$</td><td>$\lambda x_6\{\mathbf{f}(x)$</td><td></td><td></td><td colspan="4">$\lambda x_{-1}\{\mathbf{m}(x)\}$</td><td>$\lambda x\{x_2\}$</td></tr>
<tr><td colspan="4">$\mathbf{f}(\text{K}) \times \text{K}_{-1}$</td><td>$\lambda x\{x_1\}$</td><td>$\lambda y_2 \lambda x_1 \mathbf{R} xy$</td><td colspan="5">$\lambda x_{-1}\{\mathbf{m}(x)_2\}$</td></tr>
<tr><td colspan="5">$\mathbf{f}(\text{K})_1 \times \text{K}_{-1}$</td><td colspan="6">$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x,\ \mathbf{m}(y)]$</td></tr>
<tr><td colspan="11">$\mathbf{f}(\text{K})_1 \times \lambda x_1\ \mathbf{R}[x,\ \mathbf{m}(\text{K})]$</td></tr>
<tr><td colspan="11">$\mathbf{R}[\ \mathbf{f}(\text{K}),\ \mathbf{m}(\text{K})\ ]$</td></tr>
</table>

## 11. Pronoun-Binding with Junctions

There are numerous problems with our theory of pronoun-binding when it applies to quantifier phrases, as they are originally formulated in terms of second-order predicates. Let us now see how binding works when applied to junctions.

1. every man respects his mother

<table>
<tr><td>every</td><td>man</td><td>[+1]</td><td>[–1]</td><td>respects (–1) his mother [+2]</td></tr>
<tr><td>$\lambda P_0 \wedge \{x \mid Px\}$</td><td>$\mathbf{M}_0$</td><td>$\lambda x\{x_1\}$</td><td>$\lambda x\{x_{-1}\}$</td><td rowspan="3">$\lambda y_{-1}\ \lambda z_1\ \mathbf{R}[z,\mathbf{m}(y)]$</td></tr>
<tr><td colspan="2">$\wedge\{\ x \mid \mathbf{M}x\ \}$</td><td colspan="2">$\lambda x\{x_1 \times x_{-1}\}$</td></tr>
<tr><td colspan="4">$\wedge\{\ x_1 \times x_{-1} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="5">$\wedge\{x_1 \times x_{-1} \times \lambda y_{-1}\ \lambda z_1\ \mathbf{R}[z,\mathbf{m}(y)] \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="5">$\wedge\{x_1 \times \lambda z_1\ \mathbf{R}[z,\mathbf{m}(x)] \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="5">$\wedge\{\ \mathbf{R}[x,\mathbf{m}(x)] \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="5">$\forall x\ \{\ \mathbf{M}x \rightarrow \mathbf{R}[x,\mathbf{m}(x)]\ \}$</td></tr>
</table>

2. every man is happy if he is virtuous

<table>
<tr><td>every man</td><td>[+1]</td><td>[–1]</td><td>is happy</td><td>if</td><td>(–1)</td><td>he</td><td>[+1]</td><td>is virtuous</td></tr>
<tr><td rowspan="2">$\wedge\{\ x \mid \mathbf{M}x\ \}$</td><td>$\lambda x\{x_1\}$</td><td>$\lambda x\{x_{-1}\}$</td><td rowspan="3">$\lambda x_1\mathbf{H}x$</td><td rowspan="3">$\lambda P\lambda Q\{P\rightarrow Q\}$</td><td>$\lambda x_{-1}\{x\}$</td><td>$\varnothing$</td><td>$\lambda x\{x_1\}$</td><td rowspan="2">$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\lambda x\{x_1 \times x_{-1}\}$</td><td colspan="3">$\lambda x_{-1}\{x_1\}$</td></tr>
<tr><td colspan="3">$\wedge\{\ x \times x_{-1} \mid \mathbf{M}x\ \}$</td><td colspan="4">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="4">$\wedge\{\ \mathbf{H}x \times x_{-1} \mid \mathbf{M}x\ \}$</td><td colspan="5">$\lambda x_{-1}\ \lambda Q\ \{\mathbf{V}x \rightarrow Q\}$</td></tr>
<tr><td colspan="9">$\wedge\{\ \mathbf{H}x \times x_{-1} \times \lambda x_{-1}\ \lambda Q\{\mathbf{V}x \rightarrow Q\} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="9">$\wedge\{\ \mathbf{H}x \times \lambda Q\{\mathbf{V}x \rightarrow Q\} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="9">$\wedge\{\ \ \{\mathbf{V}x \rightarrow \mathbf{H}x\} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="9">$\forall x\ \{\ \mathbf{M}x \rightarrow \{\mathbf{V}x \rightarrow \mathbf{H}x\}\ \}$</td></tr>
</table>

Note carefully that this is the second example of an anti-tonic function – namely ⟦if (-1)he is virtuous⟧ – that is admitted by ∧; the first one is ⟦every⟧. It remains a puzzle to figure out what underlying principle can account for these, and perhaps other, exceptions to the overall principle that ∧ admits no anti-tonic functions.

## 12. More Difficult Examples

Not only does the new theory of quantifiers make computations involving anaphora much easier, it handles examples that are intractable using the old theory . For example, the earlier theory predicts the wrong semantic-value for ‘no-if’ sentences.

By contrast, the new theory proposes the following analysis, which is **much better**.

1. no man is happy if he is virtuous

| | no man | [+1] | [–1] | is happy | if | (–1) | he | [+1] | is virtuous |
|---|---|---|---|---|---|---|---|---|---|
| | $\bigwedge\{ \neg \times x \mid \mathbf{M}x \}$ | $\lambda x\{x_1\}$ | $\lambda x\{x_{-1}\}$ | $\lambda x_1 \mathbf{H}x$ | $\lambda P \lambda Q\{P \rightarrow Q\}$ | $\lambda x_{-1}\{x\}$ | $\varnothing$ | $\lambda x\{x_1\}$ | $\lambda x_1 \mathbf{V}x$ |
| | | $\lambda x\{x_1 \times x_{-1}\}$ | | | | $\lambda x_{-1}\{x_1\}$ | | | |
| | $\bigwedge\{ \neg \times x_1 \times x_{-1} \mid \mathbf{M}x \}$ | | | | | $\lambda x_{-1} \mathbf{V}x$ | | | |
| ① | $\bigwedge\{ \neg \times \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$ | | | | $\lambda x_{-1}\, \lambda Q\, \{\mathbf{V}x \rightarrow Q\}$ | | | | |
| ② | $\bigwedge\{ \sim\mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$ | | | | | | | | |
| | $\bigwedge\{ \sim\mathbf{H}x \times \lambda Q\, \{\mathbf{V}x \rightarrow Q\} \mid \mathbf{M}x \}$ | | | | | | | | |
| | $\bigwedge\{ \mathbf{V}x \rightarrow \sim\mathbf{H}x \mid \mathbf{M}x \}$ | | | | | | | | |
| | $\forall x\, \{ \mathbf{M}x \rightarrow \{\mathbf{V}x \rightarrow \sim\mathbf{H}x\} \}$ | | | | | | | | |

Notice that ② derives from ① by applying ¬ to $\mathbf{H}x$ using simple function-application. This is moreover not optional, in light of the following **forced-locality principle**, which we now make official.

a product $\alpha \times \beta$ must be (immediately) simplified
by function-application
if either factor is an argument for the other

If we don't institute this principle, we run into numerous problems with functors gaining too-wide scope.[3] In this particular example, without forced locality, we have the following derivation, which is precisely what we are trying to avoid.

| no man [–1] is happy | if (–1) he is virtuous |
|---|---|
| $\bigwedge\{ \neg \times \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$ | $\lambda x_{-1}\, \lambda Q\, \{\mathbf{V}x \rightarrow Q\}$ |
| $\bigwedge\{ \neg \times \mathbf{H}x \times \lambda Q\, \{\mathbf{V}x \rightarrow Q\} \mid \mathbf{M}x \}$ | |
| $\bigwedge\{ \neg \times \{\mathbf{V}x \rightarrow \mathbf{H}x\} \mid \mathbf{M}x \}$ | |
| $\bigwedge\{ \sim\{\mathbf{V}x \rightarrow \mathbf{H}x\} \mid \mathbf{M}x \}$ | |
| ※ $\forall x\, \{ \mathbf{M}x \rightarrow \sim\{\mathbf{V}x \rightarrow \mathbf{H}x\}$ ※ | |

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[3] For example, without forced locality, the reflexive morpheme ‘self’ can attach to *any* earlier verb, when in fact it *should* only attach to the nearest verb. This problem was first discovered by Peter Marchetto.

## 13. Examples involving 'any'

Our original theory of quantifiers/binding also cannot account for 'any', as in the following examples.

2. no man respects any enemy of his

<table>
<tr><th>no man</th><th>[+1] [–1]</th><th>respects</th><th>any</th><th>enemy</th><th>of</th><th>(–1)</th><th>his</th><th>[+2]</th></tr>
<tr><td>$\wedge\{\neg \times x \mid \mathbf{M}x\}$</td><td>$\lambda x\{x_1 \times x_{-1}\}$</td><td rowspan="5">$\lambda y_2 \lambda x_1 \mathbf{R}xy$</td><td rowspan="3">$\lambda \mathrm{P}_0 \text{Л}\{y \mid \mathrm{P}y\}$</td><td rowspan="2">$\lambda z_6 \lambda y_0 \mathbf{E}yz$</td><td>$\lambda x\{x_6\}$</td><td>$\lambda x_{-1}\{x\}$</td><td>$\varnothing$</td><td rowspan="4">$\lambda x\{x_2\}$</td></tr>
<tr><td colspan="2" rowspan="5">$\wedge\{\neg \times x_1 \times x_{-1} \mid \mathbf{M}x\}$</td><td colspan="3">$\lambda z_{-1}\{z_6\}$</td></tr>
<tr><td colspan="4">$\lambda z_{-1}\ \lambda y_0\ \mathbf{E}yz$</td></tr>
<tr><td colspan="5">$\lambda z_{-1}\ \text{Л}\{\ y \mid \mathbf{E}yz\ \}$</td></tr>
<tr><td colspan="6">$\lambda z_{-1}\ \text{Л}\{\ y_2 \mid \mathbf{E}yz\ \}$</td></tr>
<tr><td colspan="7">$\lambda z_{-1}\ \text{Л}\{\ \lambda w_1 \mathbf{R}wy \mid \mathbf{E}yz\ \}$</td></tr>
<tr><td colspan="9">$\wedge\{\neg \times x_1 \times \text{Л}\{\ \lambda w_1 \mathbf{R}wy \mid \mathbf{E}yx\ \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\wedge\{\neg \times \text{Л}_y\{\ \mathbf{R}xy \mid \mathbf{E}yx\ \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\wedge\{\ \wedge_y\{\ {\sim}\mathbf{R}xy \mid \mathbf{E}yx\ \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\forall x\ \{\ \mathbf{M}x \rightarrow \forall y\{\mathbf{E}yx \rightarrow {\sim}\mathbf{R}xy\}\ \}$</td></tr>
</table>

3. no man respects any woman who does not respect him

<table>
<tr><th rowspan="2">no man [+1, –1]</th><th rowspan="2">respects</th><th rowspan="2">any [+2]</th><th rowspan="2">woman</th><th rowspan="2">who [+1]</th><th rowspan="2">does-not</th><th rowspan="2">respect</th><th rowspan="2">(–1)</th><th colspan="2">him</th></tr>
<tr></tr>
<tr><td rowspan="9">$\wedge\{\neg \times x_1 \times x_{-1} \mid \mathbf{M}x\}$</td><td rowspan="8">$\lambda y_2 \lambda x_1$<br>$\mathbf{R}xy$</td><td rowspan="7">$\lambda \mathrm{P}_0 \text{Л}$<br>$\{z_2 \mid \mathrm{P}z\}$</td><td rowspan="6">$\mathbf{W}_0$</td><td rowspan="5">$\lambda \mathrm{Q}_1 \lambda \mathrm{P}_0 \lambda x_0$<br>$\{\mathrm{P}x \& \mathrm{Q}x\}$</td><td rowspan="4">$\lambda \mathrm{P}_1 \lambda x_1 {\sim}\mathrm{P}x$</td><td rowspan="3">$\lambda y_2 \lambda x_1$<br>$\mathbf{R}xy$</td><td rowspan="2">$\lambda x_{-1}\{x\}$</td><td>e+M</td><td>[+2]</td></tr>
<tr><td>$\varnothing$</td><td>$\lambda x\{x_2\}$</td></tr>
<tr><td colspan="3">$\lambda x_{-1}\{x_2\}$</td></tr>
<tr><td colspan="4">$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}xy$</td></tr>
<tr><td colspan="5">$\lambda y_{-1}\ \lambda x_1\ {\sim}\mathbf{R}xy$</td></tr>
<tr><td colspan="6">$\lambda y_{-1}\ \lambda \mathrm{P}_0\ \lambda x_0\ \{\ \mathrm{P}x \ \&\ {\sim}\mathbf{R}xy\ \}$</td></tr>
<tr><td colspan="7">$\lambda y_{-1}\ \lambda x_0\ \{\ \mathbf{W}x \ \&\ {\sim}\mathbf{R}xy\ \}$</td></tr>
<tr><td colspan="8">$\lambda y_{-1}\ \text{Л}\{\ z_2 \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zy\ \}$</td></tr>
<tr><td colspan="9">$\lambda y_{-1}\ \text{Л}\{\ \lambda w_1 \mathbf{R}wz \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zy\ \}$</td></tr>
<tr><td colspan="10">$\wedge\{\ \neg \times x_1 \times x_{-1} \times \lambda y_{-1}\ \text{Л}\{\ \lambda w_1 \mathbf{R}wz \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zy\ \} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="10">$\wedge\{\ \neg \times x_1 \times \text{Л}\{\ \lambda w_1 \mathbf{R}wz \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zx\ \} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="10">$\wedge\{\ \neg \times \text{Л}_z\{\ \mathbf{R}xz \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zx\ \} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="10">$\wedge\{\ \wedge_z\{\ {\sim}\mathbf{R}xz \mid \mathbf{W}z \ \&\ {\sim}\mathbf{R}zx\ \} \mid \mathbf{M}x\ \}$</td></tr>
<tr><td colspan="10">$\forall x\ \{\ \mathbf{M}x \rightarrow \forall z\ \{\ (\mathbf{W}z \ \&\ {\sim}\mathbf{R}zx) \rightarrow {\sim}\mathbf{R}xz\ \}\ \}$</td></tr>
</table>

These examples demonstrate that 'any' cannot simply be *given* wide scope, for then the 'any' phrase is not governed by 'no man', but the 'any' phrase contains a pronoun that is anaphoric to ‘no man’. The same issue arises in the following more complicated example, in which there are two occurrences of ‘any’.

4. no man recommends any friend of his to any woman

<table>
<tr><th>no man [+1, –1]</th><th>recommends</th><th>any [+2]</th><th>friend</th><th>of</th><th>(–1)</th><th>his</th><th>to</th><th>any woman</th></tr>
<tr><td rowspan="8">$\wedge\{\neg \times x_1 \times x_{-1} \mid \mathbf{M}x\}$</td><td rowspan="6">$\lambda y_2\lambda z_3\lambda x_1$<br>$\mathbf{R}xyz$</td><td rowspan="5">$\lambda \mathrm{P}_0\text{Л}\{y_2 \mid \mathrm{P}y\}$</td><td rowspan="4">$\lambda z_6\lambda y_0$<br>$\mathbf{F}yz$</td><td rowspan="3">$\lambda x\{x_6\}$</td><td rowspan="2">$\lambda w_{-1}\{w\}$</td><td>eM</td><td rowspan="2">$\lambda x\{x_3\}$</td><td rowspan="2">$\text{Л}\{ z \mid \mathbf{W}z \}$</td></tr>
<tr><td>$\varnothing$</td></tr>
<tr><td colspan="2">$\lambda w_{-1}\{w\}$</td><td colspan="2" rowspan="5">$\text{Л}\{ z_3 \mid \mathbf{W}z \}$</td></tr>
<tr><td colspan="3">$\lambda w_{-1}\{w_6\}$</td></tr>
<tr><td colspan="4">$\lambda w_{-1}\lambda y_0\mathbf{F}yw$</td></tr>
<tr><td colspan="5">$\lambda w_{-1}\ \text{Л}\{ y_2 \mid \mathbf{F}yw \}$</td></tr>
<tr><td colspan="6">$\lambda w_{-1}\ \text{Л}\{ \lambda z_3\lambda x_1\mathbf{R}xyz \mid \mathbf{F}yw \}$</td></tr>
<tr><td colspan="8">$\lambda w_{-1}\ \text{Л}\{ \text{Л}\{ \lambda x_1\mathbf{R}xyz \mid \mathbf{W}z \} \mid \mathbf{F}yw \}$</td></tr>
<tr><td colspan="9">$\wedge\{ \neg \times x_1 \times x_{-1} \times \lambda w_{-1}\ \text{Л}\{ \text{Л}\{ \lambda x_1\mathbf{R}xyz \mid \mathbf{W}z \} \mid \mathbf{F}yw \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\wedge\{ \neg \times x_1 \times \text{Л}\{ \text{Л}\{ \lambda x_1\mathbf{R}xyz \mid \mathbf{W}z \} \mid \mathbf{F}yx \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\wedge\{ \neg \times \text{Л}\{ \text{Л}\{ \mathbf{R}xyz \mid \mathbf{W}z \} \mid \mathbf{F}yx \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\wedge\{ \wedge\{ \wedge\{ \sim\mathbf{R}xyz \mid \mathbf{W}z \} \mid \mathbf{F}yx \} \mid \mathbf{M}x\}$</td></tr>
<tr><td colspan="9">$\forall x \{ \mathbf{M}x \rightarrow \forall y \{ \mathbf{F}yx \rightarrow \forall z\{\mathbf{W}z \rightarrow \sim\mathbf{R}xyz\} \} \}$</td></tr>
</table>

Notice that ¬ crosses two Л-operators, promoting each to ∧.

## 14. Failed Binding

A theory of binding should explain both positive and negative cases of binding. In this connection, contrast the two previous examples with the following four examples.

1. if every man is virtuous, then he is happy

<table>
<tr><th>if</th><th>every man [+1, –1]</th><th>is virtuous</th><th>then</th><th>(–1) he [+1]</th><th>is happy</th></tr>
<tr><td rowspan="2">$\lambda \mathrm{P}\lambda \mathrm{Q}\{\mathrm{P}\rightarrow \mathrm{Q}\}$</td><td>$\wedge\{x_1 \times x_{-1} \mid \mathbf{M}x\}$</td><td>$\lambda x_1\mathbf{V}x$</td><td>$\varnothing$</td><td>$\lambda x_{-1}\{x_1\}$</td><td>$\lambda x_1\mathbf{H}x$</td></tr>
<tr><td colspan="2">$\wedge\{ \mathbf{V}x \times x_{-1} \mid \mathbf{M}x \}$</td><td colspan="3" rowspan="2">$\lambda x_{-1}\mathbf{H}x$</td></tr>
<tr><td colspan="3">※</td></tr>
<tr><td colspan="6">※</td></tr>
</table>

There is no sensible way of combine ⟦if⟧ with $\wedge\{\mathbf{V}x \times x_{-1} \mid \mathbf{M}x\}$; the latter is not a sentence, and ∧ does not admit ⟦if⟧.

The following examples are similar in that ⟦if⟧ cannot be combined with the given antecedent phrase, because it contains an anaphoric-binder [–1] and does not admit ⟦if⟧.

2. if no man is virtuous, then he is happy

| if | no man [+1, –1] | is virtuous | then | (–1) he [+1] | is happy |
|---|---|---|---|---|---|
| $\lambda P \lambda Q\{P \rightarrow Q\}$ | $\wedge\{\neg \times x_1 \times x_{-1} \mid \mathbf{M}x\}$ | $\lambda x_1 \mathbf{V}x$ | $\varnothing$ | $\lambda x_{-1}\{x_1\}$ | $\lambda x_1 \mathbf{H}x$ |
| | $\wedge\{ \sim \mathbf{V}x \times x_{-1} \mid \mathbf{M}x \}$ | | | | |
| ※ | | | $\lambda x_{-1}\mathbf{H}x$ | | |
| ※ | | | | | |

3. if Jay respects every woman, then she respects him

| if | Jay [+1, –1] | respects | every woman [+2, –2] | then | (–2) she [+1] | respects | (–1) him [+2] |
|---|---|---|---|---|---|---|---|
| $\lambda P \lambda Q$ $\{P \rightarrow Q\}$ | $\mathrm{J}_1 \times \mathrm{J}_{-1}$ | $\lambda y_2 \lambda x_1$ $\mathbf{R}xy$ | $\wedge\{ y_2 \times y_{-2} \mid \mathbf{W}y \}$ | $\varnothing$ | $\lambda w_{-2}\{w_1\}$ | $\lambda y_2 \lambda x_1$ $\mathbf{R}xy$ | $\lambda z_{-1}\{z_2\}$ |
| | | $\wedge\{ \lambda x_1 \mathbf{R}xy \times y_{-2} \mid \mathbf{W}y \}$ | | | | $\lambda z_{-1} \lambda x_1 \mathbf{R}xz$ | |
| | $\wedge\{ \mathbf{R}\mathrm{J}y \times \mathrm{J}_{-1} \times y_{-2} \mid \mathbf{W}y \}$ | | | $\lambda z_{-1} \lambda w_{-2} \mathbf{R}wz$ | | | |
| ※ | | | | | | | |
| ※ | | | | | | | |

4. if Jay doesn't respect any woman, then she doesn't respect him

| if | Jay [+1, –1] | doesn't | respect | any woman [+2, –2] | then she doesn't respect him |
|---|---|---|---|---|---|
| $\lambda P \lambda Q\{P \rightarrow Q\}$ | $\mathrm{J}_1 \times \mathrm{J}_{-1}$ | $\lambda P_1 \lambda x_1 {\sim} Px$ | $\lambda y_2 \lambda x_1 \mathbf{R}xy$ | $\text{Л}\{ y_2 \times y_{-2} \mid \mathbf{W}y \}$ | (output of table below)<br>$\lambda z_{-1}\ \lambda w_{-2}\ {\sim}\mathbf{R}wz$ |
| | | | $\text{Л}\{ \lambda x_1 \mathbf{R}xy \times y_{-2} \mid \mathbf{W}y \}$ | | |
| | | $\wedge\{ \lambda x_1 {\sim}\mathbf{R}xy \times y_{-2} \mid \mathbf{W}y \}$ | | | |
| | $\wedge\{ {\sim}\mathbf{R}\mathrm{J}y \times \mathrm{J}_{-1} \times y_{-2} \mid \mathbf{W}y \}$ | | | | |
| ※ | | | | | |
| ※ | | | | | |

| then | (–2) she [+1] | doesn't | respect | (–1) him [+2] |
|---|---|---|---|---|
| $\varnothing$ | $\lambda w_{-2}\{w_1\}$ | $\lambda P_1 \lambda x_1 {\sim} Px$ | $\lambda y_2 \lambda x_1 \mathbf{R}xy$ | $\lambda z_{-1}\{z_2\}$ |
| | | | $\lambda z_{-1}\ \lambda x_1\ \mathbf{R}xz$ | |
| | | $\lambda z_{-1}\ \lambda x_1\ {\sim}\mathbf{R}xz$ | | |
| $\lambda z_{-1}\ \lambda w_{-2}\ {\sim}\mathbf{R}wz$ | | | | |