September 16, 1997

Errata to Kees Doets: *From Logic to Logic Programming*, the MIT Press 1994

page 13, lines +1/2 **For:** Propositional logic ... and $\leftrightarrow$.

Read: Propositional logic is the part of full first-order logic that deals with (some of) the connectives $\neg$, $\wedge$, $\vee$, $\rightarrow$ and $\leftrightarrow$.

p.16, l.9 **For:** ...if the γ assigns...

Read: ...if γ assigns...

p.25, l.-9 **For:** (iv) Describe ...

Read: (iv) Show that $\mathcal{R}^m(S)$ contains every clause that is derivable from S, iff $\mathcal{R}^{m+1}(S) = \mathcal{R}^m(S)$. Describe ...

p.26, l.+12 (Exercise 2.31.)

For: Show that a collection $U \subset \mathbb{N}$ ...

Read: Show that a collection $U \subset \mathcal{P}(\mathbb{N})$ ...

p.31, l.-1 **For:** $\mathbf{A} = (A, \ldots, r, \ldots, f, \ldots, c, \ldots)_{\mathbf{r}\in\mathcal{R},\mathbf{f}\in\mathcal{F},\mathbf{c}\in\mathcal{C}}$

Read: $\mathbf{A} = (A, r, \ldots, f, \ldots, c, \ldots)_{\mathbf{r}\in\mathcal{R},\mathbf{f}\in\mathcal{F},\mathbf{c}\in\mathcal{C}}$

p.42, l.-14 **For:** $(t_1\theta)^{\mathbf{A}} = (t_1\alpha)^{\mathbf{A}}$

Read: $(t_i\theta)^{\mathbf{A}} = (t_i\alpha)^{\mathbf{A}}$

p.43, l.-6 **For:** *Skolem expansion*

Read: *Herbrand expansion*

p.44, l.+17 To Lemma 3.30, add:

Similarly, $\mathbf{A} \models \exists\varphi$ *holds iff* $\mathbf{A}$ *is a model of at least one sentence in ground*(φ).

p.45, l.+10 **For:** $\mathbf{r}(w.y)$

Read: $\mathbf{r}(w, y)$

p.45, l.-9 **For:** $\mathbf{c}$ en $\mathbf{fc}$

Read: $\mathbf{c}$ and $\mathbf{fc}$

p.46vv For complexity reasons, the treatment in Section 3.6 is far from optimal. It is better to forget about prenex forms, and to use the following lemma to eliminate existential quantifiers:

Lemma. Suppose that

- the formula $\exists y\psi(x_1, \ldots, x_n, y)$ has no subformula occurrences in the formula φ in the scope of $\neg$, $\rightarrow$, $\leftrightarrow$,
- $\mathbf{f}$ is a fresh n-ary function symbol,
- $\mathbf{f}(x_1, \ldots, x_n)$ is substitutable for y in ψ,
- φ' is obtained from φ by replacing occurrences of $\exists y\psi(x_1, \ldots, x_n, y)$ by $\psi(x_1, \ldots, x_n, \mathbf{f}(x_1, \ldots, x_n))$.

Then φ is satisfiable iff φ' is.

Proof.

($\Leftarrow$) For models $\mathbf{A}$, functions f (interpreting $\mathbf{f}$) and assignments α, the implication $(\mathbf{A}, f) \models \varphi'\alpha \Rightarrow \mathbf{A} \models \varphi\alpha$ can be proved using induction w.r.t. φ.

($\Rightarrow$) Let $\mathbf{A}$ be a model. Choose a function f (interpreting $\mathbf{f}$) such that, for $a_1, \ldots, a_n \in A$: if $\mathbf{A} \models \exists y \psi\{x_1/a_1, \ldots, x_n/a_n\}$, then $\mathbf{A} \models \psi\{x_1/a_1, \ldots, x_n/a_n, y/f(a_1, \ldots, a_n)\}$.
The implication $\mathbf{A} \models \varphi\alpha \Rightarrow (\mathbf{A}, f) \models \varphi'\alpha$ now follows, again using induction w.r.t. φ.

It is now clear how to transform any first-order sentence into a universally quantified conjunctive normal form with the same satisfiability problem:

(a) Remove connectives $\rightarrow$ and $\leftrightarrow$ in favour of the others,

(b) move negations inside until no quantifier is in the scope of a negation symbol,

(c) remove existential quantifiers one by one using the lemma (starting with the outmost ones), introducing fresh constant and/or function symbols,

(d) pull out all universal quantifiers,

(e) put the rest in conjunctive normal form.

p.49, l.-16 The recipe given does not ensure that the variables in the prefix of the prenex form are pairwise different (as is required by Definition 3.32 p.47). If a variable occurs more than once in the prefix obtained, simply erase all quantifiers in the prefix binding it — except the *last* one. (Those erased are "vacuous".)

p.49, l.-2 **For:** not occurring in φ

Read: not occurring in the language of φ

p.50, l.+10 **For:** a model appropriate to the language of φ

Read: a model for the language of φ

p.52, l.+1 **For:** (iii) $\forall x($

Read: (iii) $\forall y($

p.52, l.+11 **For:** $Var(\chi) = \{u, v\}$

Read: $Var(\chi) = \{u, v\}$.

p.56, l.-10 **For:** Corollary 3.27.

Read: Corollary 3.38(i).
(The problem with 3.27 is that θ is required to be ground here. This restriction can easily be lifted.)

p.58, l.+5 **For:** $\{x/\theta \mid x \in V \cap Dom(\theta)\}$

Read: $\{x/x\theta \mid x \in V \cap Dom(\theta)\}$

p.61, l.-11 **For:** the number of function symbols

Read: the number of constant and function symbols

p.64, l.+12 **For:** Exercise 3.26(i)

Read: Exercise 3.26(ii)

p.66, l.+15 **For:** unifies P an $N\xi$,

Read: unifies P and $N\xi$,

p.67, l.+10 **For:** By 3.76,

Read: By Lemma 3.76,

p.68, l.+9/10 (Exercise 3.39 (i) and (ii), 3rd clause)

For: $\{\mathbf{r}(x, \mathbf{f}x), \neg\mathbf{r}(\mathbf{f}x, y)\}$

Read: $\{\mathbf{r}(x, \mathbf{f}x), \neg\mathbf{r}(\mathbf{f}x, x)\}$

p.72, l.+7, etc. Replace (mistaken) rules by those of Exercise 4.59 p.91.

p.77, l.−6 **For:** (iii) Post-fixed points: $\mathbb{N}$, and ...

Read: (iii) Post-fixed points: $\{2n \mid n \in \mathbb{N}\}$, and ...

p.78, l.+3 **For:** $T_P(M)$;

Read: $T_P(\mathbf{M})$;

p.84, l.−7 **For:** $T(I, J) \subset$;

Read: $T(I, J) \subset I$;

p.88, l.−14 **For:** ...replacement of Λ by 1.

Read: ...replacement of Λ by 1Λ.

p.88, l.−12 **For:** $\mathbf{ap}_1(\Lambda, 1)\leftarrow$

Read: $\mathbf{ap}_1(\Lambda, \Lambda 1)\leftarrow$

p.90, l.+11 **For:** $i(t_1, \ldots, t_n) = [t_1|[t_2|\ldots|[t_n|[\ ]]\ldots]])$

Read: $i(t_1, \ldots, t_n) = [t_1|[t_2|\ldots|[t_n|[\ ]]\ldots]]$

p.91, l.+15 **For:** $\mathbf{qs}(x, y, z) \leftarrow \cdots$

Read: $\mathbf{qs}([x|y], z) \leftarrow \cdots$

p.99, l.−12 In Exercise 5.2, assume that HU has more than one element.

p.100, l.+16 (2nd line proof Thm 5.16)
For: is a is a ground implication tree ...

Read: is a ground implication tree ...

p.107, l.+15 (Exercise 5.12)

For: Suppose that $C \xrightarrow{\alpha}_u D$ (A, R).

Read: Suppose that for some D, $C \xrightarrow{\alpha}_u D$ (A, R).

p.111, l.−2 Interchange α and β:

For: $C_m\alpha_{m,n+1}\sigma^{n+1} = C_m\sigma^m\beta_{m,n+1}$

Read: $C_m\beta_{m,n+1}\sigma^{n+1} = C_m\sigma^m\alpha_{m,n+1}$

p.112, l.+4 **For:** $y\beta_{n,m}\sigma^n\alpha_{n+1}$

Read: $y\beta_{m,n}\sigma^n\alpha_{n+1}$

p.113, l.+12 (Exercise 5.17)
For: Show: θ has a succesful derivation ...

Read: Show: $C\theta$ has a succesful unrestricted derivation ...

p.113, l.−12 Exercise 5.21 should be moved to next section.

p.113, l.−3/2 Replace the two occurrences of E by $\square$.

p.116, l.−6 **For:** Assume that $P \models C\sigma$,

Read: Let ρ be an arbitrary selection rule. Assume that $P \models C\sigma$,

p.117, l.+4/5 **For:** ... children of A in the implication tree for A ...

Read: ... children of $A\sigma^k$ in the implication tree for $A\sigma^k$ ...

p.117, l.+6–8 **For:** Lift this to a step $C_k \xrightarrow{\theta_{k+1}} C_{k+1}$ ... τ is such that ...

Read: This step has a lift of the form $C_k \xrightarrow{\theta_{k+1}} C_{k+1}$, and therefore $\Gamma_{0,k}$ can be prolonged into a ρ-derivation $\Gamma_{0,k+1}$ with some such lift, and there exists τ such that ...

p.120, l.-5 **For:** Theorem 5.49 appears to be new.

Read: Theorem 5.49 occurs as Theorem 9.2 on p.51 of [Lloyd 87].

p.118, l.-14 (Exercise 5.26)
For: Assume that the query C has an SLD-tree ...

Read: Assume that the query C has a finite SLD-tree ...

p.126, l.-6 **For:** *Hint.* Show ...

Read: *Hint.* Use the method of proof of Theorem 5.46.

p.166, l.+18 **For:** for some $C \subset X$,

Read: for some C true in X,

p.168, l.+10 **For:** ... is a forest, ...

Read: ... is a forest $\mathcal{T}$, ...

p.172, l.-10 **For:** $C\mathbf{R}(\alpha\sigma)|C$,

Read: $C\mathbf{R}(\alpha\sigma)|Var(C)$,

p.173, l.+7 **For:** $Var(C\alpha) \cap Var(D\sigma) \subset Var(C)$,

Read: $Var(C\alpha) \cap Var(D\sigma) \subset Var(D)$,

p.174, l.+2 **For:** Show that these rules do in fact define S and ...

Read: Show that for all $s, t, l \in HU$, $S(s, t, l)$ holds iff $\{x/s, z/t, v/l\}$ is a computed answer substitution for the query $\mathbf{s}(x, z, v)$ and ...

p.178, l.-2 **For:** Then $C = \square$. So, $\alpha = \epsilon$, and $comp(P) \models_s \square\epsilon$ is trivial.

Read: Then $C = \square$, or a positive literal $A \in C$ is selected to which no rule of P is applicable. In the first case, $\alpha = \epsilon$, and $comp(P) \models_s \square\epsilon$ is trivial. In the second case, $comp(P) \models_3 \neg A$, and hence, $comp(P) \models_3 \neg C$.

p.179 Use of the symbol α on this page should not be confused with that in the statement of 8.28 and can best be changed.

p.197 [Apt/Doets] appeared in *J. Logic Programming* 18 (1994) pp 177–190.

[Doets a] appeared in *Th. Computer Science* 124 (1994) pp 181–188.

[Doets b] appeared in *Logic and Computation* 3 (1993) pp 487–516.