Types,
inference, and
F# data types

The
INFDEV@HR
Team

Introduction

Types, inference, and F# data types

The INFDEV@HR Team

Hogeschool Rotterdam
Rotterdam, Netherlands

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Introduction

Introduction

```
(λ(p:Boolean) (q:Boolean)→(((p Boolean) q) p)
   )
```

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$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}){\rightarrow}(((\texttt{p Boolean})\ \texttt{q})\ \texttt{p})$
$)$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}){\rightarrow}(((\texttt{p Boolean})\ \texttt{q})\ \texttt{p}))$

$(\lambda(\text{p:Boolean})\ (\text{q:Boolean}){\rightarrow}(((\text{p Boolean})\ \text{q})\ \text{p}))$

$(\lambda(\text{p:Boolean}) \ (\text{q:Boolean}) \rightarrow (((\text{p Boolean}) \ \text{q}) \ \text{p}))$

$(\lambda(\text{p:Boolean}) \ (\text{q:Boolean}) \rightarrow (((\boxed{\text{Boolean}} \ \text{Boolean}) \ \text{q}) \ \boxed{\text{Boolean}}))$

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```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    q) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    q) Boolean))
```

```
(λ(p:Boolean)(q:Boolean)→
    (((Boolean Boolean) q) Boolean))
```

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$$(\lambda(\text{p}:\text{Boolean})(\text{q}:\text{Boolean})\rightarrow$$
$$(((\text{Boolean } \underline{\text{Boolean}}) \text{ q}) \text{ Boolean}))$$

```
(λ(p:Boolean)(q:Boolean)→
    (((Boolean Boolean) q) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    Boolean) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    Boolean) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    Boolean) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((Boolean Boolean)
    Boolean) Boolean))
```

$(\lambda(\mathtt{p:Boolean})\ (\mathtt{q:Boolean}){\rightarrow}(((\underline{\mathtt{Boolean}}\ \mathtt{Boolean})$
$\mathtt{Boolean})\ \mathtt{Boolean}))$

$(\lambda(\text{p:Boolean}) \ (\text{q:Boolean}) \rightarrow (((\underline{\text{Boolean}} \ \text{Boolean}) \ \text{Boolean}) \ \text{Boolean}))$

$(\lambda(\text{p:Boolean}) \ (\text{q:Boolean}) \rightarrow (((\boxed{(\forall\alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))} \ \text{Boolean}) \ \text{Boolean}) \ \text{Boolean}))$

$(\lambda(\mathtt{p:Boolean})\ (\mathtt{q:Boolean}) \rightarrow((((\forall\alpha\ \Rightarrow(\alpha \rightarrow \alpha \rightarrow \alpha))$
$\mathtt{Boolean})\ \mathtt{Boolean})\ \mathtt{Boolean}))$

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))
    Boolean) Boolean) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))
    Boolean) Boolean) Boolean))
```

$(\lambda(p:Boolean)\ (q:Boolean) \rightarrow ((((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))$
$\underline{Boolean})\ Boolean)\ Boolean))$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow((((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))$
$\underline{\texttt{Boolean}})\ \texttt{Boolean})\ \texttt{Boolean}))$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow(((((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))$
$(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\ \texttt{Boolean})\ \texttt{Boolean}))$

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$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow ((((\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha)) \\ (\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))) \ \texttt{Boolean}) \ \texttt{Boolean}))$$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow ((((\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))$
$(\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha)))\ \texttt{Boolean})\ \texttt{Boolean}))$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow ((\underline{((\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))\ (\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha)))}\ \texttt{Boolean})$
$\texttt{Boolean}))$

```
(λ(p:Boolean) (q:Boolean)→((
    ((∀α ⇒(α→α→α)) (∀α ⇒(α→α→α))) Boolean)
    Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((
    (((∀α ⇒(α→α→α)) (∀α ⇒(α→α→α))) Boolean)
    Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((
    ((∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))
    Boolean) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))) Boolean)
    Boolean))
```

$(\lambda(\texttt{p:Boolean}) \ (\texttt{q:Boolean}) {\rightarrow} ((((\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha)) {\rightarrow} (\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha)) {\rightarrow} (\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha))) \ \texttt{Boolean}) \ \texttt{Boolean}))$

$(\lambda(\texttt{p:Boolean}) \ (\texttt{q:Boolean}) {\rightarrow} ((((\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha)) {\rightarrow} (\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha)) {\rightarrow} (\forall \alpha \Rightarrow (\alpha {\rightarrow} \alpha {\rightarrow} \alpha))) \ \underline{\texttt{Boolean}}) \ \texttt{Boolean}))$

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))) Boolean)
    Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))) Boolean)
    Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α)))
    (∀α ⇒(α→α→α)) ) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α)))  (∀α ⇒(α→
    α→α)))  Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α))) (∀α ⇒(α→
    α→α))) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→((((∀α ⇒(α→α→α))→
    (∀α ⇒(α→α→α))→(∀α ⇒(α→α→α)))
    (∀α ⇒(α→α→α))) Boolean))
```

$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow ((((\forall\alpha\ \Rightarrow(\alpha \rightarrow \alpha \rightarrow \alpha)) \rightarrow$$
$$(\forall\alpha\ \Rightarrow(\alpha \rightarrow \alpha \rightarrow \alpha)) \rightarrow (\forall\alpha\ \Rightarrow(\alpha \rightarrow \alpha \rightarrow \alpha)))$$
$$\underline{(\forall\alpha\ \Rightarrow(\alpha \rightarrow \alpha \rightarrow \alpha)))}\ \texttt{Boolean}))$$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow((((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))\rightarrow$
$\qquad(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\rightarrow(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))$
$\qquad\underline{(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))})\ \texttt{Boolean}))$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow($
$\qquad((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))\rightarrow(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\ \texttt{Boolean}))$

$(\lambda(\mathtt{p:Boolean})\ (\mathtt{q:Boolean}){\rightarrow}(((\forall\alpha\ {\Rightarrow}(\alpha{\rightarrow}\alpha{\rightarrow}\alpha)){\rightarrow}($ $\forall\alpha\ {\Rightarrow}(\alpha{\rightarrow}\alpha{\rightarrow}\alpha)))\ \mathtt{Boolean}))$

```
(λ(p:Boolean) (q:Boolean)→(((∀α ⇒(α→α→α))→(
    ∀α ⇒(α→α→α))) Boolean))
```

```
(λ(p:Boolean) (q:Boolean)→(((∀α ⇒(α→α→α))→(
    ∀α ⇒(α→α→α))) Boolean))
```

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow(((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))\rightarrow($
$\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\ \underline{\texttt{Boolean}}))$

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$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \to (((\forall \alpha \Rightarrow (\alpha \to \alpha \to \alpha)) \to (\forall \alpha \Rightarrow (\alpha \to \alpha \to \alpha)))\ \underline{\texttt{Boolean}}))$$

$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \to (((\forall \alpha \Rightarrow (\alpha \to \alpha \to \alpha)) \to (\forall \alpha \Rightarrow (\alpha \to \alpha \to \alpha)))\ \boxed{(\forall \alpha \Rightarrow (\alpha \to \alpha \to \alpha))}))$$

$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow(((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))\rightarrow(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\ (\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))))$$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow (((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)) \rightarrow ($
    $\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\ (\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))))$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}) \rightarrow ($
    $\underline{((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)) \rightarrow (\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))}$
    $\underline{(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))}))$

```
(λ(p:Boolean) (q:Boolean)→(
    ((∀α ⇒(α→α→α))→(∀α ⇒(α→α→α)))
    (∀α ⇒(α→α→α))))
```

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow($
$\underline{((\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))\rightarrow(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))}$
$\underline{(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))\,)}$

$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow \boxed{(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha))}\,)$

$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean})\rightarrow(\forall\alpha\ \Rightarrow(\alpha\rightarrow\alpha\rightarrow\alpha)))$$

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$$(\lambda(\texttt{p:Boolean}) \ (\texttt{q:Boolean}) \rightarrow \underline{(\forall \alpha \ \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))})$$

$$(\lambda(\texttt{p:Boolean})\ (\texttt{q:Boolean}){\rightarrow}(\forall\alpha\ {\Rightarrow}(\alpha{\rightarrow}\alpha{\rightarrow}\alpha)))$$

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$$(\lambda(\texttt{p:Boolean})~(\texttt{q:Boolean}) \rightarrow \underline{(\forall \alpha \Rightarrow (\alpha \rightarrow \alpha \rightarrow \alpha))})$$

$$(\lambda(\texttt{p:Boolean})~(\texttt{q:Boolean}) \rightarrow \boxed{\texttt{Boolean}})$$

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```
(λ(p:Boolean) (q:Boolean)→Boolean)
```

$(\lambda(\texttt{p:Boolean}) \ (\texttt{q:Boolean}) \rightarrow \texttt{Boolean})$

$(\lambda(\texttt{p:Boolean})(\underline{\texttt{q:Boolean}}) \rightarrow \underline{\texttt{Boolean}})$

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$$(\lambda(\mathtt{p:Boolean})(\mathtt{q:Boolean}) \rightarrow \underline{\mathtt{Boolean}})$$

$(\lambda(\texttt{p:Boolean})(\underline{\texttt{q:Boolean}})\rightarrow\underline{\texttt{Boolean}})$

$(\lambda(\texttt{p:Boolean})\rightarrow\boxed{\texttt{(Boolean}\rightarrow\texttt{Boolean)}})$

$$(\lambda(\mathtt{p:Boolean}) \rightarrow (\mathtt{Boolean} \rightarrow \mathtt{Boolean}))$$

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$(\lambda(\texttt{p:Boolean}){\rightarrow}(\texttt{Boolean}{\rightarrow}\texttt{Boolean}))$

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$(\text{Boolean} \rightarrow \text{Boolean} \rightarrow \text{Boolean})$

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The best of luck, and thanks for the attention!