Ilutrükk

Ilutrükkimine

- Ilutrükkimise (ingl. pretty printing) eesmärgiks on:
  - programmi/andmestruktuuri teisendamine stringiks;
  - tulemus peaks olema loetava paigutusega.
- Ilutrükkimise soovitavad omadused:
  - vahendid erinevate paigutuste esitamiseks;
  - sobivate paigutuste valik vastavalt teksti soovitud laiusele;
  - efektiivsus.

Kirjandus

- P.Wadler, *A prettier printer*. The Fun of Programming. 2003.
- J.Hughes, *The Design of a Pretty-printing Library*. AFP 1995, LNCS 925, pp. 53–96.

Ilutrükk kasutades stringe

Näide: aritmeetilised avaldised

$$
\begin{aligned}
&\mathbf{data}\ Expr = Num\ Int \mid Add\ Expr\ Expr \\
&showExpr\ (Num\ x) = show\ x \\
&showExpr\ (Add\ e1\ e2) = showExpr\ e1 \mathbin{+\!\!+} \\
&\qquad\qquad\qquad\quad \text{"+"} \qquad\quad \mathbin{+\!\!+} \\
&\qquad\qquad\qquad\quad showExpr\ e2
\end{aligned}
$$

NB!

- Väga ebaefektiivne (ruutkeerukusega!)
- Loetavate paigutuste tekitamine keeruline

Ilutrükk ver. 1 — abstraktne liides

Dokumentide konstrueerimine ja trükkimine

$$
\begin{aligned}
&\mathit{nil} && :: \mathit{Doc}\\
&\mathit{text} && :: \mathit{String} \to \mathit{Doc}\\
&(<>) && :: \mathit{Doc} \to \mathit{Doc} \to \mathit{Doc}\\
&\mathit{pretty} && :: \mathit{Doc} \to \mathit{String}
\end{aligned}
$$

Näide

$$
\begin{aligned}
&\mathit{showExpr} = \mathit{pretty} \circ \mathit{showE}\\
&\quad \textbf{where}\ \mathit{showE}\ (\mathit{Num}\ x) &&= \mathit{text}\ (\mathit{show}\ x)\\
&\qquad\quad \mathit{showE}\ (\mathit{Add}\ e1\ e2) &&= \mathit{showE}\ e1\ <>\\
&\qquad\qquad\qquad\qquad &&\quad \mathit{text}\ \text{"+"}\ <>\\
&\qquad\qquad\qquad\qquad &&\quad \mathit{showE}\ e2
\end{aligned}
$$

Ilutrükk ver. 1 — realisatsioon

Dokumendi esitamine

$$
\begin{aligned}
\textbf{data}\ \mathit{Doc} = {} & \mathit{Nil} \\
\mid {} & \mathit{Text}\ \mathit{String} \\
\mid {} & \mathit{Doc} :\!\!<\!\!> \mathit{Doc}
\end{aligned}
$$

Dokumentide konstrueerimine

$$
\begin{aligned}
\mathit{nil} &= \mathit{Nil} \\
\mathit{text} &= \mathit{Text} \\
(<\!\!>) &= (:\!\!<\!\!>)
\end{aligned}
$$

Ilutrükk ver. 1 — realisatsioon

Dokumentide trükkimine

$$
\begin{aligned}
&\mathit{pretty}\ d = \mathit{convert}\ [d] \\
&\mathit{convert}\ [\,] &&= \text{""} \\
&\mathit{convert}\ (\mathit{Nil} : ds) &&= \mathit{convert}\ ds \\
&\mathit{convert}\ (\mathit{Text}\ s : ds) &&= s +\!\!+ \mathit{convert}\ ds \\
&\mathit{convert}\ (d1 :\!\!<\!\!> d2 : ds) &&= \mathit{convert}\ (d1 : d2 : ds)
\end{aligned}
$$

Ilutrükk ver. 2 — paigutus ja taanded

Abstraktne liides

$$line :: Doc$$
$$nest :: Int \to Doc \to Doc$$

Näide

$$\mathbf{data}\ Tree = Node\ String\ [Tree]$$
$$tree = Node\ \texttt{"aa"}\ [Node\ \texttt{"b"}\ [Node\ \texttt{"c"}\ []],\ Node\ \texttt{"dd"}\ [],\ Node\ \texttt{"e"}\ [Node\ \texttt{"f"}\ []]]$$

Ilutrükk ver. 2 — paigutus ja taanded

Näide

```
ppTree (Node s ts) = text s <>
                     nest (length s) (ppBracket ts)
  where ppBracket []     = nil
        ppBracket ts     = text "[" <>
                           nest 1 (ppTrees ts) <>
                           text "]"
        ppTrees [t]      = ppTree t
        ppTrees (t : ts) = ppTree t <> text "," <>
                           line <> ppTrees ts
```

```
Main> putStr ∘ pretty ∘ ppTree $ tree
aa[b[c],
   dd,
   e[f]]
```

Ilutrükk ver. 2 — paigutus ja taanded

Näide

```
ppTree (Node s ts) = text s <> ppBracket ts
  where ppBracket [] = nil
        ppBracket ts = text "[" <>
                       nest 2 (line <> ppTrees ts) <>
                       line <> text "]"

Main> putStr ∘ pretty ∘ ppTree $ tree
aa[
  b[
    c
  ],
  dd,
  e[
    f
  ]
]
```

Ilutrükk ver. 2 — realisatsioon

Dokumendi esitamine

$$\begin{aligned}\mathbf{data}\ Doc = \ & ... \\ & \mid Line \\ & \mid Nest\ Int\ Doc\end{aligned}$$

Dokumentide konstrueerimine

$$\begin{aligned}line &= Line \\ nest &= Nest\end{aligned}$$

Ilutrükk ver. 2 — realisatsioon

Dokumentide trükkimine

$$
\begin{aligned}
&pretty\ d = convert\ [(d, 0)] \\
&convert\ [\,] &&= \text{""} \\
&convert\ ((Nil, i) : ds) &&= convert\ ds \\
&convert\ ((Text\ s, i) : ds) &&= s +\!\!+ convert\ ds \\
&convert\ ((d1\ :\!<\!>\ d2, i) : ds) &&= convert\ ((d1, i) : (d2, i) : ds) \\
&convert\ ((Line, i) : ds) &&= \text{"\textbackslash n"} +\!\!+ copy\ i\ \text{' '} \\
&&&\quad +\!\!+ convert\ ds \\
&convert\ ((Nest\ n\ d, i) : ds) &&= convert\ ((d, n + i) : ds)
\end{aligned}
$$

Ilutrükk ver. 3 — paigutuste valik

Abstraktne liides

$$group :: Doc \to Doc$$
$$pretty :: Int \to Doc \to String$$

Näide

$$ppTree\ (Node\ s\ ts) = group\ (text\ s <> nest\ (length\ s)\ (ppBracket\ ts))$$

```
Main> putStr ∘ pretty 10 ∘ ppTree $ tree
aa[b[c],
   dd,
   e[f]]
Main> putStr ∘ pretty 20 ∘ ppTree $ tree
aa[b[c], dd, e[f]]
```

Ilutrükk ver. 3 — realisatsioon

Dokumendi esitamine

$$\begin{aligned}\mathbf{data}\ Doc = {} & \ldots \\ \mid {} & Doc :\!<\!|\!>\ Doc\end{aligned}$$

Dokumentide konstrueerimine

$$group\ x = flatten\ x :\!<\!|\!>\ x$$

$$\begin{aligned}
flatten\ Nil &= Nil \\
flatten\ (Text\ s) &= Text\ s \\
flatten\ (d1 :\!<\!>\ d2) &= flatten\ d1 :\!<\!>\ flatten\ d2 \\
flatten\ Line &= Text\ "\ " \\
flatten\ (Nest\ i\ d) &= Nest\ i\ (flatten\ d) \\
flatten\ (d1 :\!<\!|\!>\ d2) &= flatten\ d1
\end{aligned}$$

Ilutrükk ver. 3 — realisatsioon

Dokumentide trükkimine

$$
\begin{aligned}
&pretty\ w\ d = convert\ w\ 0\ [(d, 0)] \\
&convert\ w\ c\ [\,] \qquad\qquad\quad = \text{""} \\
&convert\ w\ c\ ((Nil, i) : ds) = convert\ w\ c\ ds \\
&convert\ w\ c\ ((Text\ s, i) : ds) \\
&\qquad\qquad = s +\!\!+ convert\ w\ (c + length\ s)\ ds \\
&convert\ w\ c\ ((d1 :\!\!<\!\!> d2, i) : ds) \\
&\qquad\qquad = convert\ w\ c\ ((d1, i) : (d2, i) : ds) \\
&convert\ w\ c\ ((Line, i) : ds) \\
&\qquad\qquad = \text{"\textbackslash n"} +\!\!+ copy\ i\ \text{' '} +\!\!+ convert\ w\ i\ ds \\
&convert\ w\ c\ ((Nest\ n\ d, i) : ds) \\
&\qquad\qquad = convert\ w\ c\ ((d, n + i) : ds)
\end{aligned}
$$

Ilutrükk ver. 3 — realisatsioon

Dokumentide trükkimine (järg)

$$\begin{aligned} &\mathit{convert}\ w\ c\ ((\mathit{d1} :<|> \mathit{d2}, i) : \mathit{ds}) \\ &\qquad = \mathit{better}\ w\ c\ (\mathit{convert}\ w\ c\ ((\mathit{d1}, i) : \mathit{ds}))\ (\mathit{convert}\ w\ c\ ((\mathit{d2}, i) : \mathit{ds})) \end{aligned}$$

Parima dokumendi valimine

$$\begin{aligned} &\mathit{better}\ w\ c\ \mathit{s1}\ \mathit{s2} = \mathbf{if}\ \mathit{fits}\ (w - c)\ \mathit{s1}\ \mathbf{then}\ \mathit{s1}\ \mathbf{else}\ \mathit{s2} \\ &\mathit{fits}\ w\ \mathit{xs} = w \geqslant 0 \wedge (\mathit{null}\ \mathit{xs} \vee \mathit{head}\ \mathit{xs} == \text{'\textbackslash n'} \\ &\qquad \vee \mathit{fits}\ (w - 1)\ (\mathit{tail}\ \mathit{xs})) \end{aligned}$$