

Making better PDF

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Overview

Introduction

Quick rough tour through a PDF file

Glyph positioning in pdfT_EX — story of a tiny pdfT_EX patch

Conclusion

Introduction

Why look into a PDF file?

- ▶ Get some background: Learn what PDF is.
- ▶ Get a rough idea how it's created by pdfT_EX.
- ▶ This might help to solve problems around PDF.
- ▶ Maybe you get interest in writing own PDF code.
- ▶ Maybe you might even want to tweak pdfT_EX.

This might ultimately lead to “better PDF”.

PDF tour

The \LaTeX example input file:

foo.tex

```
\documentclass[12pt,a4paper]{article}
\usepackage[margin=1in]{geometry}
\usepackage{graphicx}
\pdfcompresslevel=0
\pagestyle{empty}
\begin{document}
\noindent
Euro\TeX\ 2006 \bfseries Ahoi!
\bigskip\par\noindent
\includegraphics[width=\textwidth]{campushotel1.jpg}
\end{document}
```

PDF tour

The PDF output looks like this A4 sheet:

EuroT_EX 2006 Ahoi!



PDF tour — global structure of the PDF file

<pre>%PDF-1.4</pre>	Header
<pre>... many objects: page descriptions, fonts, images, etc. ... 11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj 14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj 15 0 obj << /Producer (pdfTeX-1.40.0) /CreationDate (D:20060701211003+02'00') ... >> endobj</pre>	Body
<pre>xref 0 16 0000000000 65535 f 0000000411 00000 n 0000073302 00000 n 0000000299 00000 n 0000000015 00000 n 0000079926 00000 n 0000076450 00000 n 0000079788 00000 n 0000076047 00000 n 0000073416 00000 n 0000075907 00000 n 0000080332 00000 n 0000076255 00000 n 0000080141 00000 n 0000080390 00000 n 0000080441 00000 n</pre>	Cross reference table (object numbers → byte offsets)
<pre>trailer << /Size 16 /Root 14 0 R /Info 15 0 R ... >> startxref 80710 %%EOF</pre>	Trailer

PDF tour — how a PDF reader scans the PDF file

→ %PDF-1.4

```
... many objects: page descriptions, fonts, images, etc. ...  
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj  
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj  
15 0 obj << /Producer (pdfTeX-1.40.0)  
/CreationDate (D:20060701211003+02'00') ... >> endobj
```

xref

```
0 16  
0000000000 65535 f  
0000000411 00000 n  
0000073302 00000 n  
0000000299 00000 n  
0000000015 00000 n  
0000079926 00000 n  
0000076450 00000 n  
0000079788 00000 n  
0000076047 00000 n  
0000073416 00000 n  
0000075907 00000 n  
0000080332 00000 n  
0000076255 00000 n  
0000080141 00000 n  
0000080390 00000 n  
0000080441 00000 n
```

Start: Is it PDF? Which version?

trailer

```
<< /Size 16  
/Root 14 0 R  
/Info 15 0 R ... >>
```


startxref

```
80710  
%%EOF
```

PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Jump to end of file.



PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Search backward for startxref.



PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Get byte offset for xref.

(all byte offsets from begin of file)



PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
```

```
xref
0 16
0000000000 65535 f
1 0000000411 00000 n
2 0000073302 00000 n
3 0000000299 00000 n
4 0000000015 00000 n
5 0000079926 00000 n
6 0000076450 00000 n
7 0000079788 00000 n
8 0000076047 00000 n
9 0000073416 00000 n
10 0000075907 00000 n
11 0000080332 00000 n
12 0000076255 00000 n
13 0000080141 00000 n
14 0000080390 00000 n
15 0000080441 00000 n
```

Get cross reference table by offset.
(left: object numbers)

```
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```


PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
```

```
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
```

Search backward for trailer.

```
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```



PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
```

```
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
```

Read trailer dictionary.

```
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
```

```
startxref
```

```
80710
```

```
%%EOF
```

PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
```

```
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
```

Lookup offset of /Catalog object.
(/Root \equiv /Catalog)

14

```
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Read /Catalog object.

14

PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog [ /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Lookup offset of /Pages object.

11

PDF tour — how a PDF reader scans the PDF file

```
%PDF-1.4
... many objects: page descriptions, fonts, images, etc. ...
11 0 obj << /Type /Pages /Count 1 /Kids [3 0 R] >> endobj
14 0 obj << /Type /Catalog /Pages 11 0 R >> endobj
15 0 obj << /Producer (pdfTeX-1.40.0)
/CreationDate (D:20060701211003+02'00') ... >> endobj
xref
0 16
0000000000 65535 f
0000000411 00000 n
0000073302 00000 n
0000000299 00000 n
0000000015 00000 n
0000079926 00000 n
0000076450 00000 n
0000079788 00000 n
0000076047 00000 n
0000073416 00000 n
0000075907 00000 n
0000080332 00000 n
0000076255 00000 n
0000080141 00000 n
0000080390 00000 n
0000080441 00000 n
trailer
<< /Size 16
/Root 14 0 R
/Info 15 0 R ... >>
startxref
80710
%%EOF
```

Read /Pages object.

(gives access to all /Page objects)

11

PDF tour — gathering stuff for building a page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

Jump to first /Page object.
(there is only one in our file)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 [/Kids [3 0 R]]
>> endobj
```



PDF tour — gathering stuff for building a page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

Get all `/Resources` for this page.

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — gathering stuff for building a page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

There are two fonts needed...

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — gathering stuff for building a page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

... and there is one image needed.
(which is formally an `/XObject`)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — gathering stuff for building a page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
endstream
endobj
```

Fonts and images are referenced
by (arbitrary) internal names.



```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — gathering stuff for building a page

```
4 0 obj <<  
  /Length 227  
>>  
stream  
BT  
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ  
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ  
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ  
ET  
1 0 0 1 72 507.702 cm  
q 0.54967 0 0 0.54967 0 0 cm  
q  
821 0 0 427 0 0 cm  
/Im1 Do  
Q  
Q  
endstream  
endobj
```

The actual page contents is defined by a stream object.

```
3 0 obj <<  
  /Type /Page /Contents [ /Contents 4 0 R ] /Resources 2 0 R  
  /MediaBox [0 0 595.276 841.89]  
  /Parent 11 0 R  
>> endobj
```

```
2 0 obj <<  
  /Font << /F15 7 0 R /F16 10 0 R >>  
  /XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]  
>> endobj
```

```
11 0 obj <<  
  /Type /Pages /Count 1 /Kids [3 0 R]  
>> endobj
```

PDF tour — reading the page stream

```
4 0 obj <<  
  /Length 227  
>>  
stream  
BT  
  /F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ  
  31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ  
  /F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ  
ET  
1 0 0 1 72 507.702 cm  
q 0.54967 0 0 0.54967 0 0 cm  
q  
821 0 0 427 0 0 cm  
/Im1 Do  
Q  
Q  
endstream  
endobj
```

A stream object has a dictionary.
(/Length; often filter for decompression)

```
3 0 obj <<  
  /Type /Page /Contents 4 0 R /Resources 2 0 R  
  /MediaBox [0 0 595.276 841.89]  
  /Parent 11 0 R  
>> endobj
```

```
2 0 obj <<  
  /Font << /F15 7 0 R /F16 10 0 R >>  
  /XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]  
>> endobj
```

```
11 0 obj <<  
  /Type /Pages /Count 1 /Kids [3 0 R]  
>> endobj
```


PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream [ ] ←
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream [ ] ←
endobj
```

The actual stream data are bracketed by keywords.

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

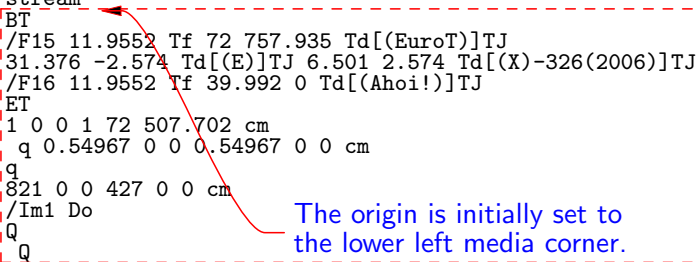
PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
endstream
endobj
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

The page stream is made up from various operators with parameters.

PDF tour — reading the page stream

```
4 0 obj <<  
  /Length 227  
>>  
stream  
BT  
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ  
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ  
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ  
ET  
1 0 0 1 72 507.702 cm  
q 0.54967 0 0 0.54967 0 0 cm  
q  
821 0 0 427 0 0 cm  
/Im1 Do  
Q  
Q  
endstream  
endobj
```

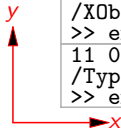


The origin is initially set to the lower left media corner.

```
3 0 obj <<  
  /Type /Page /Contents 4 0 R /Resources 2 0 R  
  /MediaBox [0 0 595.276 841.89]  
  /Parent 11 0 R  
>> endobj
```

```
2 0 obj <<  
  /Font << /F15 7 0 R /F16 10 0 R >>  
  /XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]  
>> endobj
```

```
11 0 obj <<  
  /Type /Pages /Count 1 /Kids [3 0 R]  
>> endobj
```



PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

There are text sections.
(here happens the 'typesetting')

PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

There are coordinate transforms
(this is a movement)

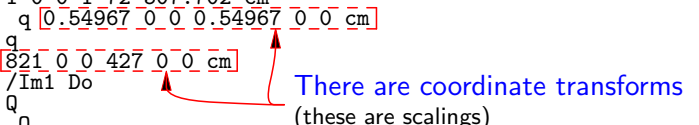
```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
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/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```



There are coordinate transforms
(these are scalings)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q 821 0 0 427 0 0 cm
/Im1 Do
Q
endstream
endobj
```

Grouping limits operator scopes.
(e.g. scaling of /Im1)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — reading the page stream

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
```

Grouping limits operator scopes.
(e.g. scaling of /Im1)

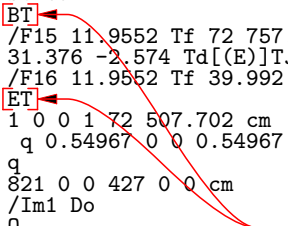
```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```


PDF tour — reading the page stream

```
4 0 obj <<
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>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
endstream
endobj
```



Begin and end text also groups regarding transforms.

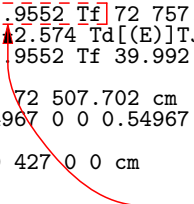
```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — putting text on the page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```



Select a font and its size.
(operator Tf)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — putting text on the page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf [72 757.935 Td][(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

Move relative to current point.
(operator Td)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — putting text on the page

```
4 0 obj <<
/Length 227
>>
stream
BT
/F15 11.9552 Tf 72 757.935 Td[(EuroT)]TJ
31.376 -2.574 Td[(E)]TJ 6.501 2.574 Td[(X)-326(2006)]TJ
/F16 11.9552 Tf 39.992 0 Td[(Ahoi!)]TJ
ET
1 0 0 1 72 507.702 cm
q 0.54967 0 0 0.54967 0 0 cm
q
821 0 0 427 0 0 cm
/Im1 Do
Q
Q
endstream
endobj
```

Output string of glyphs.
(operator TJ)

```
3 0 obj <<
/Type /Page /Contents 4 0 R /Resources 2 0 R
/MediaBox [0 0 595.276 841.89]
/Parent 11 0 R
>> endobj
```

```
2 0 obj <<
/Font << /F15 7 0 R /F16 10 0 R >>
/XObject << /Im1 1 0 R >> /ProcSet [ /PDF /Text /ImageC ]
>> endobj
```

```
11 0 obj <<
/Type /Pages /Count 1 /Kids [3 0 R]
>> endobj
```

PDF tour — The glyph positioning operator TJ

This takes an array as operand, glyphs alternating with movements:

```
[(W)82(e)-234(t)1(hriv)27(e)-233(in)-233(informa)1(tio)1(n)]TJ
```



The glyphs in brackets (= implicit movements).

PDF tour — The glyph positioning operator TJ

This takes an array as operand, glyphs alternating with movements:

```
[(W)82(e)-234(t)1(hriv)27(e)-233(in)-233(informa)1(tio)1(n)]TJ
```



Explicit movements (units of fontsize/1000; move left = pos.).

PDF tour — The glyph positioning operator TJ

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```
[(W)82(e)-234(t)1(hriv)27(e)-233(in)-233(informa)1(tio)1(n)]TJ
```



Explicit movements (units of fontsize/1000; move left = pos.).

- ▶ The implicit movements per glyph (glyph width) are taken from the `/Widths` array in the font object.
- ▶ These `/Widths` entries are from the TFM file.

PDF tour — The glyph positioning operator TJ

This takes an array as operand, glyphs alternating with movements:

```
[(W)82(e)-234(t)1(hriv)27(e)-233(in)-233(informa)1(tio)1(n)]TJ
```



Explicit movements (units of fontsize/1000; move left = pos.).

- ▶ The implicit movements per glyph (glyph width) are taken from the `/Widths` array in the font object.
- ▶ These `/Widths` entries are from the TFM file.
- ▶ Example with `cmr12` font on next slide...

Glyph positioning as of pdfTeX-1.30.6

```
BT
/F15 11.955 Tf 72 757.935 Td[(W)82(e)-234(t)1(hriv)
27(e)-233(in)-233(informa)1(tio)1(nl))-1(|thic)27(k)
-232(w)27(orlds)-233(b)-27(ec)-1(a)1(use)-234(o)
1(f)-233(our)-233(ma)1(rv)27(elo)1(us)-234(a)
1(nd)-233(ev)27(eryda)28(y)-233(capa)1(cit)27(y)
]TJ 0 -14.446 Td[(to)-296(select,)-303(edit,)-302(single)
-296(out,)-302(structur)1(e)-1(,)-302(hig)1(hligh)
27(t,)-302(gr)1(oup,)-302(pair,)-302(merg)1(e)-1(,)-
-302(ha)1(rmonize,)-303(syn)28(thes)-1(i)1(z)-1(e,)-
]TJ 0 -14.446 Td[(fo)-27(cus,)-453(org)1(anize,)-453(c)
-1(o)1(ndense)-1(,)-453(r)1(e)-1(duce,)-453(b)-27(oil)
-427(do)27(wn,)-453(c)27(ho)-27(o)1(s)-1(e,)-453(cat)
1(e)-1(g)1(orize,)-453(cat)1(alog)1(,)-453(classif)-1(y)
more lines...
ET
```

The glyph /Widths array.

```
6 0 obj <<
/Type /Font /Subtype /Type1
/Encoding 8 0 R /FirstChar 11 /LastChar 124
/Widths 9 0 R
/BaseFont /HNUPFH+CMR12 /FontDescriptor 4 0 R
>> endobj
```

```
9 0 obj
[571 544 544 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 272 326 272 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1006 0 0 0 0 0 0 0 0 0 490 544 435 544 435 299 490 544
272 0 517 272 816 544 490 544 0 381 386 381 544 517 707
517 517 435 0 979 ]
endobj
```


Glyph positioning as of pdfTeX-1.30.6

```
BT
/F15 11.955 Tf 72 757.935 Td[(W)82(e)-234(t)1(hriv)
27(e)-233(in)-233(informa)1(tio)1(nl)-1(|thic)27(k)
-232(w)27(orlds)-233(b)-27(ec)-1(a)1(use)-234(o)
1(f)-233(our)-233(ma)1(rv)27(elo)1(us)-234(a)
1(nd)-233(ev)27(eryda)28(y)-233(capa)1(cit)27(y)
]TJ 0 -14.446 Td[(to)-296(select,-)303(edit,-)302(single)
-296(out,-)302(structur)1(e)-1(,)302(hig)1(hligh)
27(t,-)302(gr)1(oup,-)302(pair,-)302(merg)1(e)-1(,)
-302(ha)1(rmonize,-)303(syn)28(thes)-1(i)1(z)-1(e,-)
]TJ 0 -14.446 Td[(fo)-27(cus,-)453(org)1(anize,-)453(c)
-1(o)1(ndense)-1(,)453(r)1(e)-1(duce,-)453(b)-27(oil)
-427(do)27(wn,-)453(c)27(ho)-27(o)1(s)-1(e,-)453(cat)
1(e)-1(g)1(orize,-)453(cat)1(alog)1(,)453(classif)-1(y)
more lines...
```

ET

Look: These are no TeX kerns!

```
6 0 obj <<
/Type /Font /Subtype /Type1
/Encoding 8 0 R /FirstChar 11 /LastChar 124
/Widths 9 0 R
/BaseFont /HNUPFH+CMR12 /FontDescriptor 4 0 R
>> endobj
```

```
9 0 obj
[571 544 544 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 272 326 272 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1006 0 0 0 0 0 0 0 0 490 544 435 544 435 299 490 544
272 0 517 272 816 544 490 544 0 381 386 381 544 517 707
517 517 435 0 979 ]
endobj
```

Glyph positioning as of pdfT_EX-1.30.6

Observation:

- ▶ Many tiny correcting movements ± 1 between strings of glyphs.
- ▶ These happen particularly for CM and LM fonts. . .

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- ▶ Same also with older pdfT_EX versions.

Glyph positioning as of pdfT_EX-1.30.6

Observation:

- ▶ Many tiny correcting movements ± 1 between strings of glyphs.
- ▶ These happen particularly for CM and LM fonts. . .
- ▶ . . . but not for the 35 Adobe standard Type 1 fonts!
- ▶ Same also with older pdfT_EX versions.
- ▶ These movements with CM/LM fonts look strange.
- ▶ Why are they there?

Glyph positioning as of pdfT_EX-1.30.6

The PDF reader's view:

- ▶ The PDF reader positions stuff on the page only from the info in the PDF file.

Glyph positioning as of pdfT_EX-1.30.6

The PDF reader's view:

- ▶ The PDF reader positions stuff on the page only from the info in the PDF file.
- ▶ Movements are incremental.
- ▶ The PDF file gives movements as decimal real numbers.
- ▶ They might be *rounded* to some precision, e. g. by pdfT_EX.
- ▶ The PDF reader takes these numbers as exact.

Glyph positioning as of pdfT_EX-1.30.6

The PDF reader's view:

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- ▶ The PDF file gives movements as decimal real numbers.
- ▶ They might be *rounded* to some precision, e. g. by pdfT_EX.
- ▶ The PDF reader takes these numbers as exact.

How far the PDF reader moves forward after placement of a glyph:

- ▶ The `/Widths` array tells this for any used glyph.

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's view:

- ▶ pdfT_EX internally keeps positions on a 'scaled point' raster.
- ▶ These T_EX positions are exact, no rounding.
- ▶ No accumulation of rounding errors in the T_EX coordinate system.

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's view:

- ▶ pdfT_EX internally keeps positions on a 'scaled point' raster.
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- ▶ But pdfT_EX *has to* round values when writing to PDF file.

Glyph positioning as of pdfT_EX-1.30.6

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pdfT_EX's strategy against accumulation of positional rounding errors of the PDF reader:

- ▶ pdfT_EX constantly keeps track of *two* positions:
 1. The position in the T_EX coordinate system.

Glyph positioning as of pdfT_EX-1.30.6

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pdfT_EX's strategy against accumulation of positional rounding errors of the PDF reader:

- ▶ pdfT_EX constantly keeps track of *two* positions:
 1. The position in the T_EX coordinate system.
 2. The position where the PDF reader *thinks* it is on the page.

Glyph positioning as of pdfT_EX-1.30.6

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- ▶ pdfT_EX internally keeps positions on a 'scaled point' raster.
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- ▶ No accumulation of rounding errors in the T_EX coordinate system.
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pdfT_EX's strategy against accumulation of positional rounding errors of the PDF reader:

- ▶ pdfT_EX constantly keeps track of *two* positions:
 1. The position in the T_EX coordinate system.
 2. The position where the PDF reader *thinks* it is on the page.
- ▶ pdfT_EX then can correct a rounding error in the next movement command.

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's algorithm to prevent accumulation of position rounding errors:

- ▶ Output glyph into TJ array. (a

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's algorithm to prevent accumulation of position rounding errors:

- ▶ Output glyph into TJ array. (a
- ▶ Update T_EX position by glyph width from TFM file.
- ▶ Update PDF position by glyph width from the `/Widths` array.

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's algorithm to prevent accumulation of position rounding errors:

- ▶ Output glyph into TJ array. (a)
- ▶ Update T_EX position by glyph width from TFM file.
- ▶ Update PDF position by glyph width from the `/Widths` array.
- ▶ Calculate position error between PDF and T_EX positions.
- ▶ If (error > 1/2000 fontsize) then
 - ▶ Output correcting movement into TJ array. (a)-1

Glyph positioning as of pdfT_EX-1.30.6

pdfT_EX's algorithm to prevent accumulation of position rounding errors:

- ▶ Output glyph into TJ array. (a)
- ▶ Update T_EX position by glyph width from TFM file.
- ▶ Update PDF position by glyph width from the `/Widths` array.
- ▶ Calculate position error between PDF and T_EX positions.
- ▶ If (error > 1/2000 fontsize) then
 - ▶ Output correcting movement into TJ array. (a)-1
 - ▶ Update PDF position accordingly.

Glyph positioning as of pdfT_EX-1.30.6

Still: Why are there these tiny ± 1 corrections in the TJ matrix for CM and LM fonts?

Glyph positioning as of pdfT_EX-1.30.6

Still: Why are there these tiny ± 1 corrections in the TJ matrix for CM and LM fonts? Reason:

- ▶ CM fonts are not designed on a $1/1000$ fontsize *raster*.
- ▶ CM predates PostScript fonts.

Glyph positioning as of pdfT_EX-1.30.6

Still: Why are there these tiny ± 1 corrections in the TJ matrix for CM and LM fonts? Reason:

- ▶ CM fonts are not designed on a $1/1000$ fontsize *raster*.
- ▶ CM predates PostScript fonts.
- ▶ Glyph 'a' in `cmr12.tfm` has width $0.489578 \times \text{fontsize}$
- ▶ In the `/Widths` array there is 490, not 489.578!
- ▶ pdfT_EX-1.30.6 rounds to *integer* `/Width` array values.

Glyph positioning as of pdfTeX-1.30.6

Still: Why are there these tiny ± 1 corrections in the TJ matrix for CM and LM fonts? Reason:

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- ▶ In the `/Widths` array there is 490, not 489.578!
- ▶ pdfTeX-1.30.6 rounds to *integer* `/Width` array values.
- ▶ After three 'a' the accumulated rounding error is $> 1/1000$ fontsize!
- ▶ That might be the reason for these `)1(` and `)-1(` corrections.

Glyph positioning as of pdfTeX-1.30.6

Still: Why are there these tiny ± 1 corrections in the TJ matrix for CM and LM fonts? Reason:

- ▶ CM fonts are not designed on a $1/1000$ fontsize *raster*.
- ▶ CM predates PostScript fonts.
- ▶ Glyph 'a' in `cmr12.tfm` has width $0.489578 \times \text{fontsize}$
- ▶ In the `/Widths` array there is 490, not 489.578!
- ▶ pdfTeX-1.30.6 rounds to *integer* `/Width` array values.
- ▶ After three 'a' the accumulated rounding error is $> 1/1000$ fontsize!
- ▶ That might be the reason for these `)1(` and `)-1(` corrections.
- ▶ Most standard PostScript fonts are designed on a $1/1000$ fontsize raster, therefore integer `/Widths` array values are *exact*.

Glyph positioning as of pdfT_EX-1.30.6

A rather straight-forward solution:

- ▶ Add one digit after the decimal point for the `/Widths` entries.
- ▶ Then the rounding error accumulates ten times slower.
- ▶ The `)1(` and `)-1(` corrections will happen about ten times less often — which is just ok.

Glyph positioning as of pdfTeX-1.30.6

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- ▶ Then the rounding error accumulates ten times slower.
- ▶ The `)1(` and `)-1(` corrections will happen about ten times less often — which is just ok.

Side effects:

- ▶ Tidier page stream.
- ▶ Up to 3% smaller PDF file when using CM or LM fonts.

Result on next slide...

Conclusion

- ▶ PDF is no inscrutable data format.
- ▶ PDF files generated by pdfT_EX are rather readable with a standard text editor when `\pdfcompresslevel=0`.
- ▶ An example was presented on a tiny improvement of the PDF file quality.

Conclusion

- ▶ PDF is no inscrutable data format.
- ▶ PDF files generated by pdfT_EX are rather readable with a standard text editor when `\pdfcompresslevel=0`.
- ▶ An example was presented on a tiny improvement of the PDF file quality.

Thank you very much for your attention.

