Accessibility

what it is about

context **2024** meeting

What is accessibility

Accessible pdf documents are a somewhat hot topic (for a while). Here are some definitions:

- **Greenwich:** An accessible document is a document created to be as easily readable by a low vision or non-sighted reader as a sighted reader.
- **Harvard:** Accessible documents are easier to understand and read for all of your users, not just users with disabilities.
- **University of California San Francisco:** An accessible digital document is well-structured, providing visual information in a non-visual format.
- **Carlton:** Accessible documents provide all text and other elements in an accessible format, so that everyone can access the information in the documents in some manner.

Such definitions are often followed by a similar list of suggestions, likely taken from some (government) directive.

Note: This talk is a variant on the one done at BachoTEX 2024 but most examples are the same!

What is tagging

Tagging adds information to a pdf file so that:

- content can be extracted: apart from basic copying we're not interested in this
- the text can reflow: use an other format is that is needed
- text can be spoken: to some extend that can be useful

But it comes a at cost:

- There are no real good free tools that handle it and validation, fixing, standards with respect to pdf has always been a somewhat commercial enterprise.
- The standard is a confusing, and interpretation gets debated: it looks like little research went ahead of it.
- So we can best just start from common sense and usage and also realize that in the end (future) demands are different anyway (compare book printing).
- Nevertheless, we always end up with a bloated pdf file, which kind of contradicts other efforts to be lean and mean.

And so ...

- We basically end up implementing a feature for the sake of the feature that might be useful in the future.
- And that in the end might not work out as intended as it might be suboptimal.
- And we can not check its usability so it's mostly about conformance and playing safe.
- Also, we operate in a fast moving world when it comes to demands, presentation models, usage and maybe coming technologies that might make this obsolete.

Examples

So what are the consequences of tagging for a pdf file? Let's have a look at some simple examples.

untagged: test: $\boxed{x^2 = 4}$!

tagged: $x^2 = 4$

tagged: test: $x^2 = 4$

tagged: test: $\boxed{x^2 = 4}$!

```
stream
0 g 0 G
BT
/F1 10 Tf
1.195517 0 0 1.195517 3.941792 7.979264 Tm [<000100020003000100040005>] TJ
/F2 10 Tf
1.195517 0 0 1.195517 33.563574 7.979264 Tm [<0001>] TJ
0.836858 0 0 0.836858 40.398174 12.914036 Tm [<0002>] TJ
1.195517 0 0 1.195517 48.485127 7.979264 Tm [<0003>-278<0004>] TJ
ET
q
1 0 0 1 32.076871 2.455088 cm
[] 0 d 0 J 0.3985 w 0 0 36.486178 17.507437 re S
Q
BT
/F1 10 Tf
1.195517 0 0 1.195517 72.741182 7.979264 Tm [<0006>] TJ
ET
0 g 0 G
endstream
```

test: $\boxed{x^2 = 4}$!

```
stream
0 g 0 G
/math <</MCID 1>> BDC
BT
/F1 10 Tf
1.195517 0 0 1.195517 3.941792 4.073226 Tm [<0001>] TJ
0.836858 0 0 0.836858 10.776392 9.007999 Tm [<0002>] TJ
1.195517 0 0 1.195517 18.863344 4.073226 Tm [<0003>-278<0004>] TJ
ET
EMC
0 g 0 G
endstream
```

$$x^2 = 4$$

```
stream
0 g 0 G
/documentpart <</MCID 1>> BDC
BT
/F1 10 Tf
1.195517 0 0 1.195517 3.941792 4.073226 Tm [<00010002000300010004>] TJ
ET
EMC
/math <</MCID 2>> BDC
BT
/F2 10 Tf
1.195517 0 0 1.195517 31.877621 4.073226 Tm [<0001>] TJ
0.836858 0 0 0.836858 38.712221 9.007999 Tm [<0002>] TJ
1.195517 0 0 1.195517 46.799174 4.073226 Tm [<0003>-278<0004>] TJ
ET
EMC
0 g 0 G
endstream
```

test: $x^2 = 4$

```
stream
0 g 0 G
/documentpart <</MCID 1>> BDC
BT
/F1 10 Tf
1.195517 0 0 1.195517 3.941792 7.979264 Tm [<00010002000300010004>] TJ
ET
EMC
/math <</MCID 2>> BDC
BT
/F2 10 Tf
1.195517 0 0 1.195517 33.563574 7.979264 Tm [<0001>] TJ
0.836858 0 0 0.836858 40.398174 12.914036 Tm [<0002>] TJ
1.195517 0 0 1.195517 48.485127 7.979264 Tm [<0003>-278<0004>] TJ
ET
EMC
/Artifact BMC
q
1 0 0 1 32.076871 2.455088 cm
[] 0 d 0 J 0.3985 w 0 0 36.486178 17.507437 re S
Q
EMC
/documentpart <</MCID 3>> BDC
BT
/F1 10 Tf
1.195517 0 0 1.195517 72.741182 7.979264 Tm [<0005>] TJ
ET
EMC
0 g 0 G
endstream
```

test: $\boxed{x^2 = 4}$!

We need a lot so tracing options to figure out possible issues, like:

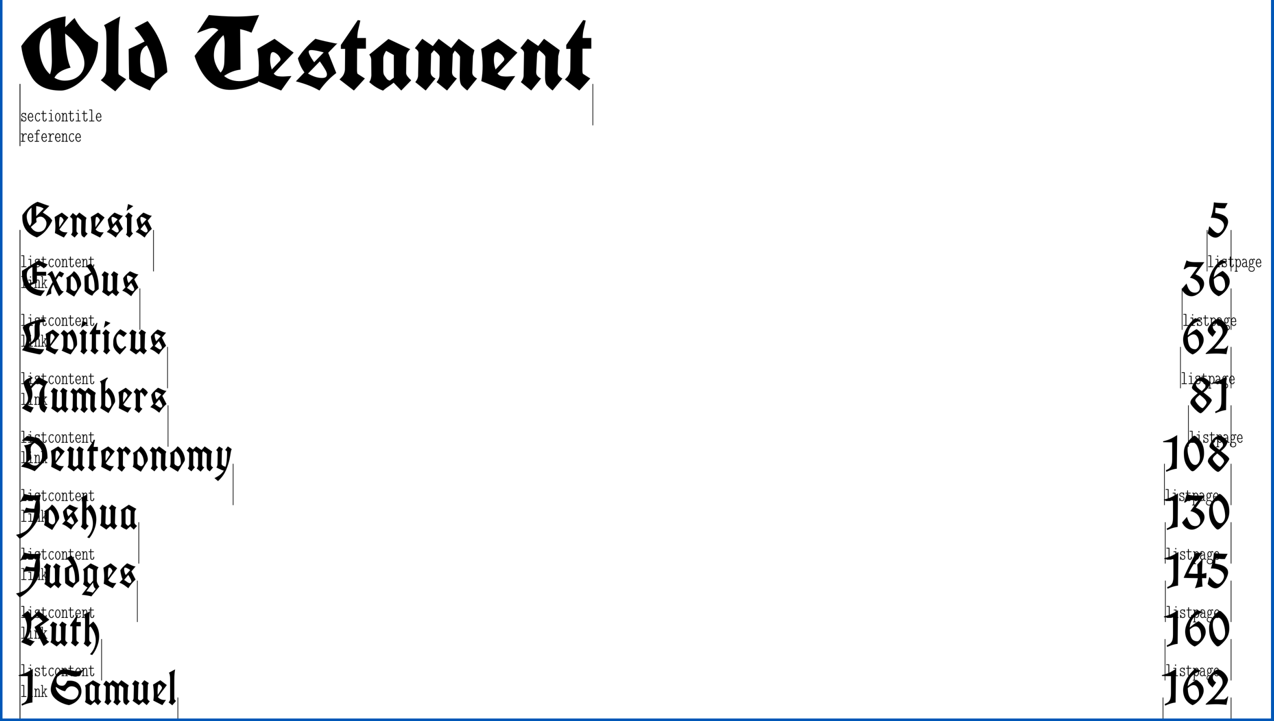
```
backend         > tags > begin page
backend         > tags >
backend         > tags > P    11 document>1 documentpart>1 navigationpage>1 : 1
backend         > tags > T     2 document>1 documentpart>1 : test:
backend         > tags > T     3 document>1 documentpart>1 math>1 : [2] = 4
backend         > tags >   -----
backend         > tags > T     2 document>1 documentpart>1 : !
backend         > tags >
backend         > tags > end page
backend         > tags >

backend         > tags >     1    1  document>1 (content)
backend         > tags >     2    1  document>1 documentpart>1 (content)
backend         > tags >     3    1  document>1 documentpart>1 navigationpage>1 (content)
backend         > tags >     4    1  document>1 documentpart>1 math>1 (content)
```

But we also have visual clues: tag labels, suspects, etc.

Checking if we're okay

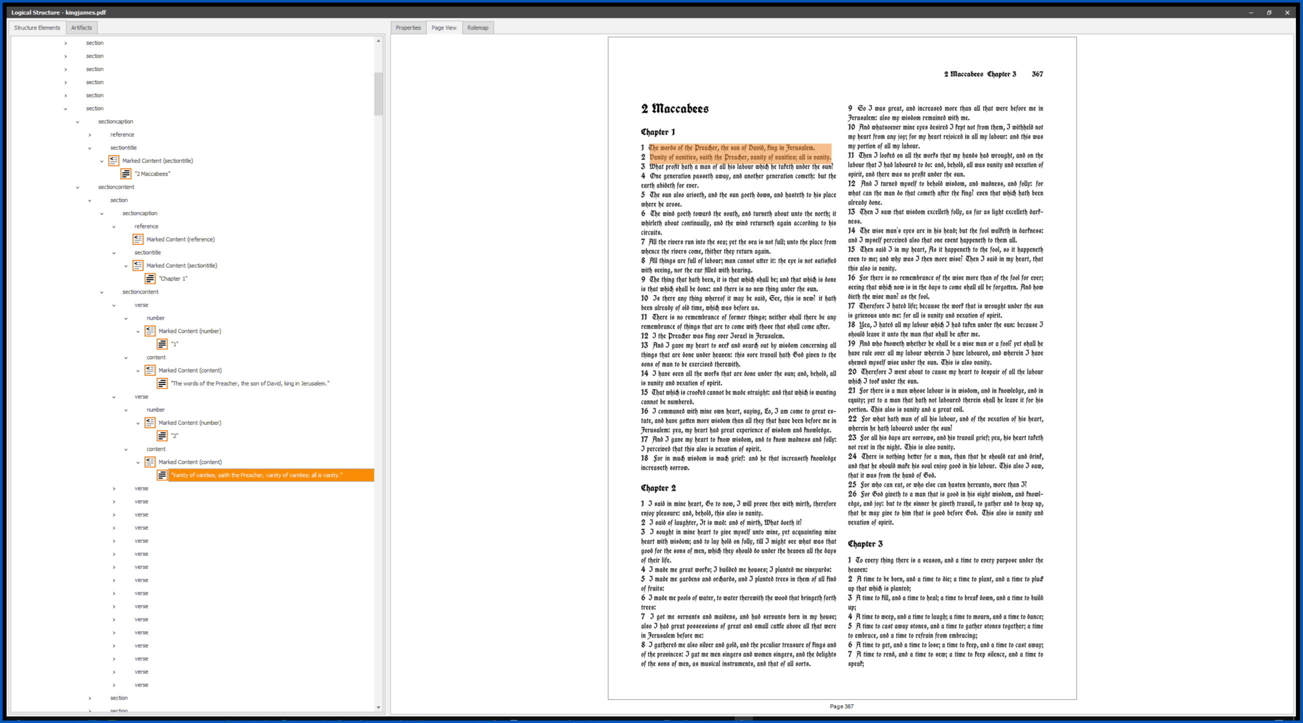
- We can look at the file and if it opens in viewers we know that we didn't mess up too badly. Looking at the pdf in an editor also works.
- The VeraPDF checker can be used but it's not always reliable. The order of reported issues can differ per run and when you fixed the last issue, suddenly a new one can be shown. (There are two parsers to choose from and results can differ.)
- The PAC 2021 checker is more powerful but hasn't been updated to handle pdf 2.0 (we can hack around that) an dit doesn't handle the role maps. But it has a nice preview, shows a tag tree, etc. It's a bit slow in analyzing.
- We're only interested in the file being okay because there is not way to know what is needed. We don't relate to pseudo html but users can do that if they want. We don't want to cook up something sub-optimal.
- As long as we add meaningful tags, we can expect future document analyzer to do a decent job, after all a ‘section’ says what it is.

Structure, meaning and rolemaps (1)



Old Testament

Structure, meaning and rolemaps (2)



```
›  section
›  section
›  section
›  section
›  section
⌄  section
    ⌄  sectioncaption
        ›  reference
        ⌄  sectiontitle
            ⌄  Marked Content (sectiontitle)
                   "2 Maccabees"
    ⌄  sectioncontent
        ⌄  section
            ⌄  sectioncaption
                ⌄  reference
                       Marked Content (reference)
                ⌄  sectiontitle
                    ⌄  Marked Content (sectiontitle)
                           "Chapter 1"
            ⌄  sectioncontent
                ⌄  verse
                    ⌄  number
                        ⌄  Marked Content (number)
                               "1"
                    ⌄  content
                        ⌄  Marked Content (content)
                               "The words of the Preacher, the son of David, king in Jerusalem."
                ⌄  verse
                    ⌄  number
                        ⌄  Marked Content (number)
                               "2"
                    ⌄  content
                        ⌄  Marked Content (content)
                               "Vanity of vanities, saith the Preacher, vanity of vanities; all is vanity."
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
                ›  verse
        ›  section
        ›  section
```

2 Maccabees Chapter 3 367

2 Maccabees

Chapter 1

1 The words of the Preacher, the son of David, king in Jerusalem.
2 Vanity of vanities, saith the Preacher, vanity of vanities; all is vanity.
3 What profit hath a man of all his labour which he taketh under the sun?
4 One generation passeth away, and another generation cometh: but the earth abideth for ever.
5 The sun also ariseth, and the sun goeth down, and hasteth to his place where he arose.
6 The wind goeth toward the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits.
7 All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.
8 All things are full of labour; man cannot utter it: the eye is not satisfied with seeing, nor the ear filled with hearing.
9 The thing that hath been, it is that which shall be; and that which is done is that which shall be done: and there is no new thing under the sun.
10 Is there any thing whereof it may be said, See, this is new? it hath been already of old time, which was before us.
11 There is no remembrance of former things; neither shall there be any remembrance of things that are to come with those that shall come after.
12 I the Preacher was king over Israel in Jerusalem.
13 And I gave my heart to seek and search out by wisdom concerning all things that are done under heaven: this sore travail hath God given to the sons of man to be exercised therewith.
14 I have seen all the works that are done under the sun; and, behold, all is vanity and vexation of spirit.
15 That which is crooked cannot be made straight: and that which is wanting cannot be numbered.
16 I communed with mine own heart, saying, Lo, I am come to great estate, and have gotten more wisdom than all they that have been before me in Jerusalem: yea, my heart had great experience of wisdom and knowledge.
17 And I gave my heart to know wisdom, and to know madness and folly: I perceived that this also is vexation of spirit.
18 For in much wisdom is much grief: and he that increaseth knowledge increaseth sorrow.

Chapter 2

1 I said in mine heart, Go to now, I will prove thee with mirth, therefore enjoy pleasure: and, behold, this also is vanity.
2 I said of laughter, It is mad: and of mirth, What doeth it?
3 I sought in mine heart to give myself unto wine, yet acquainting mine heart with wisdom; and to lay hold on folly, till I might see what was that good for the sons of men, which they should do under the heaven all the days of their life.
4 I made me great works; I builded me houses; I planted me vineyards:
5 I made me gardens and orchards, and I planted trees in them of all kind of fruits:
6 I made me pools of water, to water therewith the wood that bringeth forth trees:
7 I got me servants and maidens, and had servants born in my house; also I had great possessions of great and small cattle above all that were in Jerusalem before me:
8 I gathered me also silver and gold, and the peculiar treasure of kings and of the provinces: I gat me men singers and women singers, and the delights of the sons of men, as musical instruments, and that of all sorts.
9 So I was great, and increased more than all that were before me in Jerusalem: also my wisdom remained with me.
10 And whatsoever mine eyes desired I kept not from them, I withheld not my heart from any joy; for my heart rejoiced in all my labour: and this was my portion of all my labour.
11 Then I looked on all the works that my hands had wrought, and on the labour that I had laboured to do: and, behold, all was vanity and vexation of spirit, and there was no profit under the sun.
12 And I turned myself to behold wisdom, and madness, and folly: for what can the man do that cometh after the king? even that which hath been already done.
13 Then I saw that wisdom excelleth folly, as far as light excelleth darkness.
14 The wise man's eyes are in his head; but the fool walketh in darkness: and I myself perceived also that one event happeneth to them all.
15 Then said I in my heart, As it happeneth to the fool, so it happeneth even to me; and why was I then more wise? Then I said in my heart, that this also is vanity.
16 For there is no remembrance of the wise more than of the fool for ever; seeing that which now is in the days to come shall all be forgotten. And how dieth the wise man? as the fool.
17 Therefore I hated life; because the work that is wrought under the sun is grievous unto me: for all is vanity and vexation of spirit.
18 Yea, I hated all my labour which I had taken under the sun: because I should leave it unto the man that shall be after me.
19 And who knoweth whether he shall be a wise man or a fool? yet shall he have rule over all my labour wherein I have laboured, and wherein I have shewed myself wise under the sun. This is also vanity.
20 Therefore I went about to cause my heart to despair of all the labour which I took under the sun.
21 For there is a man whose labour is in wisdom, and in knowledge, and in equity; yet to a man that hath not laboured therein shall he leave it for his portion. This also is vanity and a great evil.
22 For what hath man of all his labour, and of the vexation of his heart, wherein he hath laboured under the sun?
23 For all his days are sorrows, and his travail grief; yea, his heart taketh not rest in the night. This is also vanity.
24 There is nothing better for a man, than that he should eat and drink, and that he should make his soul enjoy good in his labour. This also I saw, that it was from the hand of God.
25 For who can eat, or who else can hasten hereunto, more than I?
26 For God giveth to a man that is good in his sight wisdom, and knowledge, and joy: but to the sinner he giveth travail, to gather and to heap up, that he may give to him that is good before God. This also is vanity and vexation of spirit.

Chapter 3

1 To every thing there is a season, and a time to every purpose under the heaven:
2 A time to be born, and a time to die; a time to plant, and a time to pluck up that which is planted;
3 A time to kill, and a time to heal; a time to break down, and a time to build up;
4 A time to weep, and a time to laugh; a time to mourn, and a time to dance;
5 A time to cast away stones, and a time to gather stones together; a time to embrace, and a time to refrain from embracing;
6 A time to get, and a time to lose; a time to keep, and a time to cast away;
7 A time to rend, and a time to sew; a time to keep silence, and a time to speak;

Structure, meaning and rolemaps (3)

Let's get an idea what we're dealing with. You can forget about it after seeing it. The real content is this, when untagged we also have more efficient text streams (here between <>):

```
stream
0 g 0 G
BT
/F1 10 Tf
0.996264 0 0 0.996264 549.598217 791.184973 Tm [<0001>] TJ
2.066252 0 0 2.066252 42.097049 741.603508 Tm [<00020003000400050006000700080009000A000B000C>] TJ
/F2 10 Tf
0.996264 0 0 0.996264 42.097049 710.081548 Tm [<000100020003000400050006000700080009000A0006000B0008>] TJ
0.996264 0 0 0.996264 548.192356 710.081548 Tm [<000C>] TJ
0.996264 0 0 0.996264 42.097049 689.160004 Tm [<000D0006000E000400050006000700080009000A0006000B0008>] TJ
0.996264 0 0 0.996264 541.114406 689.160004 Tm [<000F00100010>] TJ
ET
0 g 0 G
endstream
```

When we tag we get entries like this in the page stream:

```
0 g 0 G
/Artifact BMC
BT
/F1 10 Tf
0.996264 0 0 0.996264 549.598217 791.184973 Tm [<0001>] TJ
ET
EMC
/documentpart <</MCID 1>> BDC
BT
/F1 10 Tf
2.066252 0 0 2.066252 42.097049 741.603508 Tm
            [<0002000300040005000600070008009000A000B000C>] TJ
ET
EMC
/link <</MCID 2>> BDC
EMC
/listcontent <</MCID 3>> BDC
BT
/F2 10 Tf
0.996264 0 0 0.996264 42.097049 710.081548 Tm
    [<00010002000300040005000600070008009000A0006000B0008>] TJ
ET
EMC
/listpage <</MCID 4>> BDC
```

```
BT
/F2 10 Tf
0.996264 0 0 0.996264 548.192356 710.081548 Tm [<000C>] TJ
ET
EMC
/link <</MCID 5>> BDC
EMC
/listcontent <</MCID 6>> BDC
BT
/F2 10 Tf
0.996264 0 0 0.996264 42.097049 689.160004 Tm
    [<000D0006000E00040005000600070008009000A0006000B0008>] TJ
ET
EMC
/listpage <</MCID 7>> BDC
BT
/F2 10 Tf
0.996264 0 0 0.996264 541.114406 689.160004 Tm [<000F00100010>]
                                                              TJ
ET
EMC
0 g 0 G
endstream
```

The `/MCID 3` points into an array related to the page. Let's start at the top parent (676):

```
676 0 obj
    <<
        /K          103359 0 R
        /Namespaces [ 678 0 R 681 0 R 682 0 R ]
        /ParentTree 677 0 R
        /Type       /StructTreeRoot
    >>
endobj
```

The top level kids array (103359) is

```
103359 0 obj
[ 683 0 R ]
endobj
```

The first entry (683) brings us to the document level

```
683 0 obj
    <<
        /K  [ 684 0 R ]
        /NS 678 0 R
        /P  676 0 R
        /Pg 1 0 R
        /S  /document
    >>
endobj
```

This element has only one kid (`684`) and sits in a name space (`678`). The parent is (`676`) a way to get back, the page object is also references (`1`).

```
678 0 obj
    <<
        /LMTXNameSpace /context
        /NS            <feff.....>>
        /RoleMapNS     103357 0 R
        /Type          /Namespace
    >>
endobj
```

The name space points to a role map (`103357`, we have many objects here) so we can use nice names as we like. We map most on the default `NonStruct` as the regular subset makes little sense for us.

```
103357 0 obj
    <<
        /document     [ /Document  681 0 R ]
        /documentpart [ /NonStruct 681 0 R ]
        /link         [ /Link      681 0 R ]
        /list         [ /NonStruct 681 0 R ]
        /listcontent  [ /NonStruct 681 0 R ]
        /listitem     [ /NonStruct 681 0 R ]
        ...
    >>
endobj
```

The mapped ones come from, a default set defines in (681):

```
681 0 obj
    <<
        /LMTXNameSpace /ua2
        /NS            <feff....>
        /Type          /Namespace
    >>
endobj
```

Back to the mapping from elements on the page to real ones:

```
677 0 obj
<<
    /Nums [
          0 [ 685 0 R 684 0 R 688 0 R 689 0 R 690 0 R 692 0 R 693 0 R 694 0 R ]
          1 [ 704 0 R ]
          2 [ .... ]
        ...
        738 77343 0 R
        739 77347 0 R
    ]
>>
endobj
```

The second element on the page (684) is:

```
684 0 obj
<<
    /K [ 685 0 R 1 686 0 R ... ]
    /NS 678 0 R
    /P 683 0 R
    /Pg 1 0 R
    /S /documentpart
>>
endobj
```

The kids can be followed (from 676) to (684):

```
684 0 obj
<<
    /K [ 685 0 R 1 686 0 R .... ]
    /NS 678 0 R
    /P 683 0 R
    /Pg 1 0 R
    /S /documentpart
>>
endobj
```

We go all the way down to:

```
686 0 obj
<< /K [ 687 0 R 691 0 R ] /NS 678 0 R /P 684 0 R /Pg 1 0 R /S /list >>
endobj
687 0 obj
<< /K [ 688 0 R 689 0 R 690 0 R ] /NS 678 0 R /P 686 0 R /Pg 1 0 R /S /listitem /T (chapter) >>
endobj
688 0 obj
<< /K [ 2 ] /NS 678 0 R /P 687 0 R /Pg 1 0 R /S /link >>
endobj
689 0 obj
<< /K [ 3 ] /NS 678 0 R /P 687 0 R /Pg 1 0 R /S /listcontent >>
endobj
690 0 obj
<< /K [ 4 ] /NS 678 0 R /P 687 0 R /Pg 1 0 R /S /listpage >>
endobj
691 0 obj
<< /K [ 692 0 R 693 0 R 694 0 R ] /NS 678 0 R /P 686 0 R /Pg 1 0 R /S /listitem /T (chapter) >>
endobj
```

And so on. Keep in mind that in the page stream we see the endpoints and in order to see where they come from one has to follow the chain back!

Annoyances

- One has to mark everything. There is no default to artifact, which would save a lot of (time and) file size as well as checking.
- Unicode lacks a code point that represents “no character, just ignore me when copying or speaking” so one has to mark private slots as artifact which is pain and dirties the backend.
- There are no code points that can help the speech engine, like pauses. One can argue that this should not be in Unicode but we do have linguistic and plenty odd symbols anyway.
- Often a nice looking and educational rich document has more than just text, otherwise one could as well emulate a typewriter. It's also about motivating and attraction. So there might be hard to catch artifacts.
- Validating can be fragile, so one never knows for sure if what is okay or bad today is bad or okay tomorrow. But we can decide to ignore some warnings, especially when it hard to explain why it matters.

- There are some weird demands. Why should for instance a hyperlink mark as artifact still resolve to a destination. Also, one assumes viewers to to not adapt so there are redundant entries (for no real reason like `/D` and `/SD` in destinations).

Math

- Math tagging is somewhat complex and often domain dependent the current state made us decide to just do what we think is best.
- As with math fonts it's not the TEX community that drives it (although of course there has been early adoption and feedback, e.g. by Ross Moore). We just have to follow the trends.
- We always had some kind of support for tagged math, not that there were applications out there that we could check it with.
- At EuroBachoTEX 2017 there has been ambitious plans for future projects with respect to tagged pdf (mentioning involvement of publishers and substantial funding) but if that happens it is outside the ConTEXt community scope.
- So … we just go our own way and ‘ritmik’ is what we came up with, which actually is a side track of our math upgrading project.

- Sidenote: we do the same with bibliographies but that is much simpler: serialize citations and embed bibTEX data.

How

- We decided to go for what we call “meaningful math”: instead of relying on unknown technology we make sure that when gets ‘read out’ reflects our intentions: we provide serialized math in addition to embedded MathML.
- We have quite some structure in ConTEXt and math is no exception. When we add features we normally also take care of tagging.
- We already had a way to extract MathML from formulas, but with (presentation) MathML being unstable (dropping features, support comes and goes) we have to adapt and anticipate the worst.
- We can now actually make use of the already present dictionary mechanisms and carry a bit more information around with symbols. This saves some extra processing and serves serializing well.
- We could actually remove some rendering related output (alignments using tables) by more natural solutions.

- But . . . we need some information from users, like usage patterns, specific support for ‘fields’, and translations.
- We don't want to adapt the engine because it's very macro package dependent and it's also more flexible.

Tests

- A university math book of some 300 pages with 3500 formulas, and a lot of (educational) structure.
- The upcoming math manual with many examples, fancy features, specific control, symbols, different structures, etc.
- For performance tests we use relatively simple text only documents, like the King James bible, novels from the Gutenberg project, etc.
- For meaningful math we have a (growing) document that shows examples in various languages as well as MathML from ConTEXt input.

We can show some examples.

Impact: King James Bible

from xml, two columns, using unifraktur:

fitclasses	passes	tagging	pages	runtime	uncompressed	runtime	compressed
default		no	670	14.2			
default	quality	no	670	14.2			
granular	quality	no	672	14.3	24.999	14.5	4.990
granular	quality	yes	672	17.5	39.660	18.4	7.134

Impact: Math in ConTEXt

all bells and whistles, interactive, screen, menus, many math fonts:

tagging	pages	runtime	uncompressed	runtime	compressed
no	433	15.8	43.467	15.9	7.204
yes	433	18.5	52.842	18.7	8.648

Impact: Infinitesimalkalkyl

a lot of structure, granular, passes, interactive, thousands of formulas, graphics:

synctex	**tagging**	**pages**	**runtime**	**uncompressed**	**runtime**	**compressed**
no	**no**	292			9.3	3.645
yes	**no**	292	9.7	17.379	9.8	3.645
yes	**yes**	292	15.3	27.652	15.8	5.815

```
April 25, 2024
Dell 7220 Laptop: Intel(R) Xeon(R) CPU E3-1505M v6 @ 3.00GHz, 48.0 GB, 2TB Samsung Pro SSD
Windows 10 Pro for Workstations
LuaMetaTeX 2.11.02 / 20240425 (MingW64)
```