

# **Automated Workflows for Mathematical Equation Processing and Rendering**

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*O'Reilly Media, Inc.*

**Or:**

$$-b \pm \frac{\sqrt{b^2 - 4ac}}{2a} \neq \text{☹}$$

**How should I  
produce books with  
complex  
mathematical  
content?**

**Publishers often  
go one of two  
routes for source  
files...**

# Typeset with L<sup>A</sup>T<sub>E</sub>X!

```
\section{Bayes's Theorem}
```

At this point we have everything we need to derive Bayes's Theorem.

We'll start with the observation that conjunction is commutative; that is

```
%
```

```
\[ \p{A \AND B} = \p{B \AND A} \]
```

```
%
```

for any events  $A$  and  $B$ .

```
\index{Bayes's Theorem derivation}
```

```
\index{conjunction}
```

Next, we write the probability of a conjunction:

```
%
```

```
\[ \p{A \AND B} = \p{A}~\p{B|A} \]
```

```
%
```

**(Source From *Think Bayes* [O'Reilly Media]:**

**<http://code.google.com/p/thinkstats/source/browse/trunk/thinkbayes/book.tex#634>)**

**OR...**

# Just Embed Images!

rules for numeric operations



## Math Magnets

Time for a little extra judging. Below are several problems that are partially worked out. Your job is to figure out what the next thing to do in the problem is. Use the order of operations, and place the correct magnet for the operation you'd do next.

For this one, what is the first thing you do inside the parentheses?

$$\frac{(6 - 3 \cdot 2 + 4^2)}{2} \dots\dots\dots$$

What goes next?

$$\frac{8}{12} - 1 - \frac{1}{3} - \left(\frac{2}{3}\right) \dots\dots\dots$$

What goes next?

Remember, a root is just an exponent

$$2 \cdot (-1) + \sqrt{4} - 3 \dots\dots\dots$$

$$-1\left(\frac{5+3}{12}\right) - \frac{1}{3} - 2^3$$

$$-1\left(\frac{8}{12}\right) - \frac{1}{3} - 2^3$$

$$-1\left(\frac{8}{12}\right) - \frac{1}{3} - 8 \dots\dots\dots$$

$$-0.4 + 0.1(6 + \sqrt{9})^3 \dots\dots\dots$$

inside

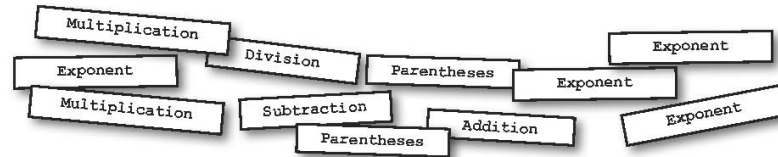
$$\frac{(12 + 13)^{1/2} + 7}{6}$$

This one is tricky - take your time, and you'll figure it out

$$\frac{(25)^{1/2} + 7}{6}$$

$$\frac{5 + 7}{6} \dots\dots\dots$$

then



(From *Head First Algebra* [O'Reilly Media])

# **Downsides of L<sup>A</sup>T<sub>E</sub>X approach:**

- **What if you don't want to build a T<sub>E</sub>X toolchain?**
- **L<sup>A</sup>T<sub>E</sub>X is great for PDF export, but what about output to EPUB/Mobi?**

# **Downsides of image approach:**

- **Maintenance is a pain!**
- **How to scale/optimize for different output formats?**



# O'Reilly's Solution: Embed L<sup>A</sup>T<sub>E</sub>X in Standard ASC or DB Source

Instead, we start with a small congestion window and double it for every roundtrip--i.e., exponential growth. As a result, the time required to reach a specific throughput target is a function (`<<SS_TIME>>`) of both the roundtrip time between the client and server and the initial congestion window size.

```
[[SS_TIME]]
[latexmath]
.Time to reach the cwnd size of size N
++++
\begin{aligned}
\mathrm{Time} &= \mathrm{RTT} \times \left\lceil \log_2 \left( \frac{\mathrm{N}}{\mathrm{initial\ cwnd}} \right) \right\rceil
\end{aligned}
++++
```

**(From *High Performance Browser Networking* [O'Reilly Media])**

**BUT...**

**How do I render  
embedded L<sup>A</sup>T<sub>E</sub>X for  
all my different  
(e)book outputs?**

# What about MathML?

*(<http://www.w3.org/Math/>)*

# MathML Rendered to PDF\*

*Equation 1-6.*

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

*Equation 1-7.*

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

*Equation 1-8.*

$$\binom{n}{k/2}$$

# MathML in EPUB (iBooks)

Equation 1-6.

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

Equation 1-7.

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

Equation 1-8.

$$\binom{n}{k/2}$$

Equation 1-9.

$$\binom{p}{2} x^2 y^{p-2} - \frac{1}{1-x} \frac{1}{1-x^2}$$

Equation 1-10.

$$\sum_{\substack{0 \leq i \leq m \\ 0 < j < n}} P(i, j)$$

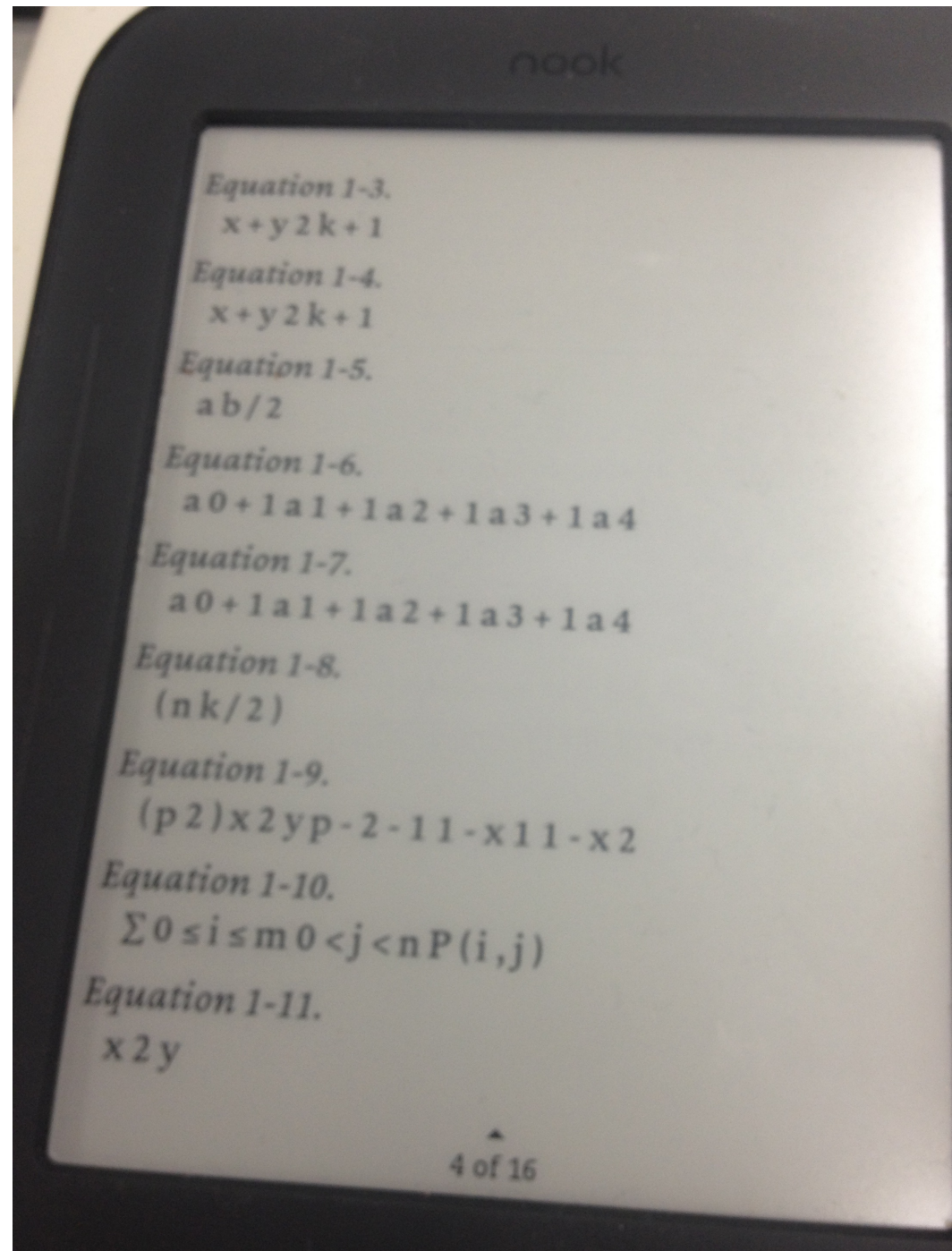
Equation 1-11.

$$x^{2y}$$

Equation 1-12.

$$\sum_{i=1}^p \sum_{j=1}^q \sum_{k=1}^r a_{ij} b_{jk} c_{ki}$$

# MathML in EPUB (NOOK)



# MathML in Mobi (Kindle Fire)

*Equation 1-6.*

$$a_0 + 1a_1 + 1a_2 + 1a_3 + 1a_4$$

*Equation 1-7.*

$$a_0 + 1a_1 + 1a_2 + 1a_3 + 1a_4$$

*Equation 1-8.*

$$\binom{n}{k} / 2$$

*Equation 1-9.*

$$(p^2)x^2y^{p-2} - 11 - x^{11} - x^2$$

*Equation 1-10.*

$$\sum_{0 \leq i \leq m} \sum_{0 < j < n} P(i, j)$$

*Equation 1-11.*

$$x^2y$$

*Equation 1-12.*

$$\sum_{i=1}^p \sum_{j=1}^q \sum_{k=1}^r a_{ij} b_{jk} c_{ki}$$

*Equation 1-13.*

$$1 + 1 + 1 + 1 + 1 + 1 + 1 + x$$



**OK, what about SVG?**

*(<http://www.w3.org/Graphics/SVG/>)*

# SVG Rendered to PDF\*

*Equation 1-6.*

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

*Equation 1-7.*

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

*Equation 1-8.*

$$\binom{n}{k/2}$$

# SVG in EPUB (iBooks)

Equation 1-4.

$$x + y^{\frac{2}{k+1}}$$

Equation 1-5.

$$\frac{a}{b/2}$$

Equation 1-6.

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

Equation 1-7.

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

Equation 1-8.

# SVG in Mobi (Kindle Paperwhite)

$$x + y^{\frac{2}{k+1}}$$

Equation 1-5.

$$\frac{a}{b/2}$$

Equation 1-6.

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

# SVG in Mobi (Kindle “classic”)

Equation 1-5.

Equation 1-6.

Equation 1-7.

Equation 1-8.

Equation 1-9.

Equation 1-10.

Equation 1-11.

Equation 1-12.

Equation 1-13.

Equation 1-14.

Equation 1-15.

Equation 1-16.

Equation 1-17.

Equation 1-18.

Equation 1-19.

Equation 1-20.

Equation 1-21.

Equation 1-22.

Equation 1-23.

Equation 1-24.

Equation 1-25.

Equation 1-26.

**Gah, what's left?**  
**JPEG or PNG?**

**Well, yes.  
Only standard  
bitmap image  
formats work  
reliably  
everywhere**

**BUT...**



**Why do we need a  
one-size-fits-all  
solution?**

**Can't we optimize  
equation output  
separately for  
each format?**

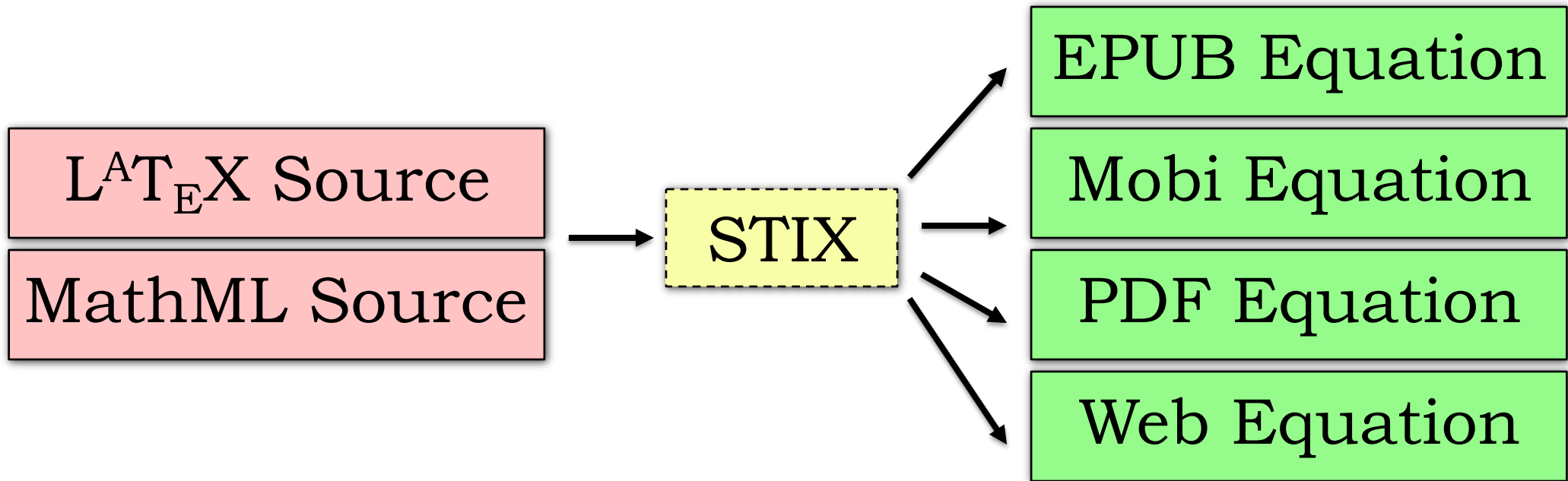


“Frustrated man at a desk” (by LaurMG; [http://commons.wikimedia.org/wiki/File:Frustrated\\_man\\_at\\_a\\_desk\\_\(cropped\).jpg](http://commons.wikimedia.org/wiki/File:Frustrated_man_at_a_desk_(cropped).jpg))

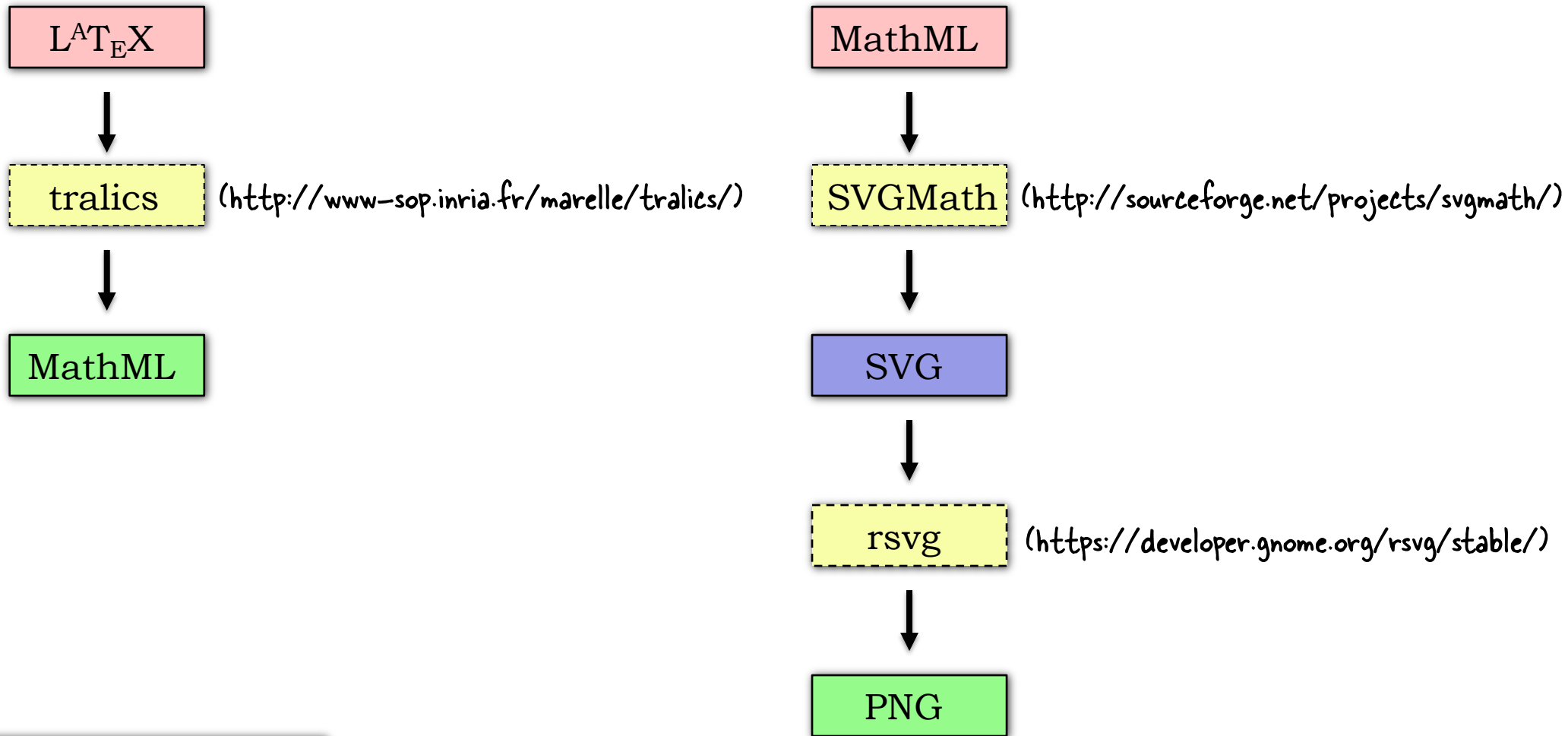
**Don't Worry!**

**Make an API!**

# O'Reilly Media's Math Conversion API (*a.k.a. STIX*)



# STIX: Under the Hood



Source Format

Conversion Tool

Intermediate Format

Output Format

# Equation Output Formats Per Ebook Format

EBOOK Format	Equation Output Format
EPUB	PNG
Mobi	PNG
PDF	MathML (rendered by AntennaHouse Formatter*)
HTML (for Web)	$\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ or MathML (with MathJax** for rendering)

\* <http://www.antennahouse.com/>

\*\* <http://www.mathjax.org/>



# Future Improvements

- **MathJax-based engine for STIX  
(à la `svgtex`)**

 <https://github.com/agrbin/svgtex>

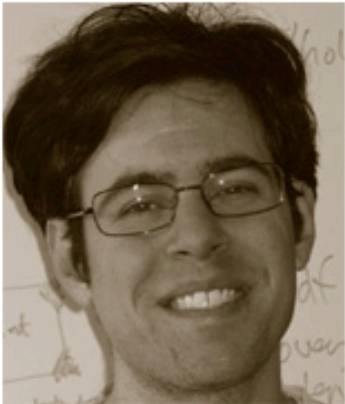
- **Improved Accessibility!  
(alt text for PNG via ChromeVox)**

 <http://kefletcher.blogspot.com/2013/07/next-steps-from-accessibility-sprint.html>

# Contact Me!

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## Sanders Kleinfeld

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### Areas of Expertise:

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- XSLT
- XPath
- XQuery
- RDF
- SPARQL
- EPUB
- Mobi
- HTML5
- speaking
- writing

**Biography**

Books

Blog

Multimedia

Sanders Kleinfeld has been employed at O'Reilly Media since 2004 and has held a variety of positions, including roles on O'Reilly's Production, Editorial, and Tools teams. Currently, he works as a Publishing Technologies Specialist, maintaining O'Reilly's XML-based toolchain for generating EPUB and Mobi formats of both frontlist and backlist titles. He also helps coordinate O'Reilly's digital distribution efforts to electronic sales channels, and is currently assisting in R&D efforts surrounding HTML5

### Hire Sanders Kleinfeld

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[press@oreilly.com](mailto:press@oreilly.com)

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Consultants

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### Recent Twitter posts:

- [@nbousquet](#) Most EPUBs out now use XHTML 1.1, so EPUB is already pretty Web-compliant. Maybe HTML5 ebooks will be more attractive to pirates? [2 days ago](#)

### Author Events

**Webcast: HTML5 for Publishers**