http://maximaximal.pages.sai.jku.at/mbmv23/

Boolean Format Multitool for the Next Generation

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March 23, 2023

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Propositional Logic, SAT, QBF, and Beyond

Propositional Logic $a \wedge (b \vee c)$

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SAT Finding solutions (assignments) for propositional logic

QBF Extension with quantifiers $\forall$ and $\exists$

QSAT Finding solutions (certificates) for QBF

SMT More theories on top of SAT – more complex formulas, more complex solvers

Formula Formats

Propositional Logic Infix like `a & (b | c)`, LaTeX

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Ideas LaTeX?

From Ideas to Formulas to Solutions . . .

1. Limboole for putting ideas into propositional formulas

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5. Common-Lisp and others for processing SMT-LIB

. . . to More Problems

How to combine tools?

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How to transform formulas?

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How to try out new encoding ideas?

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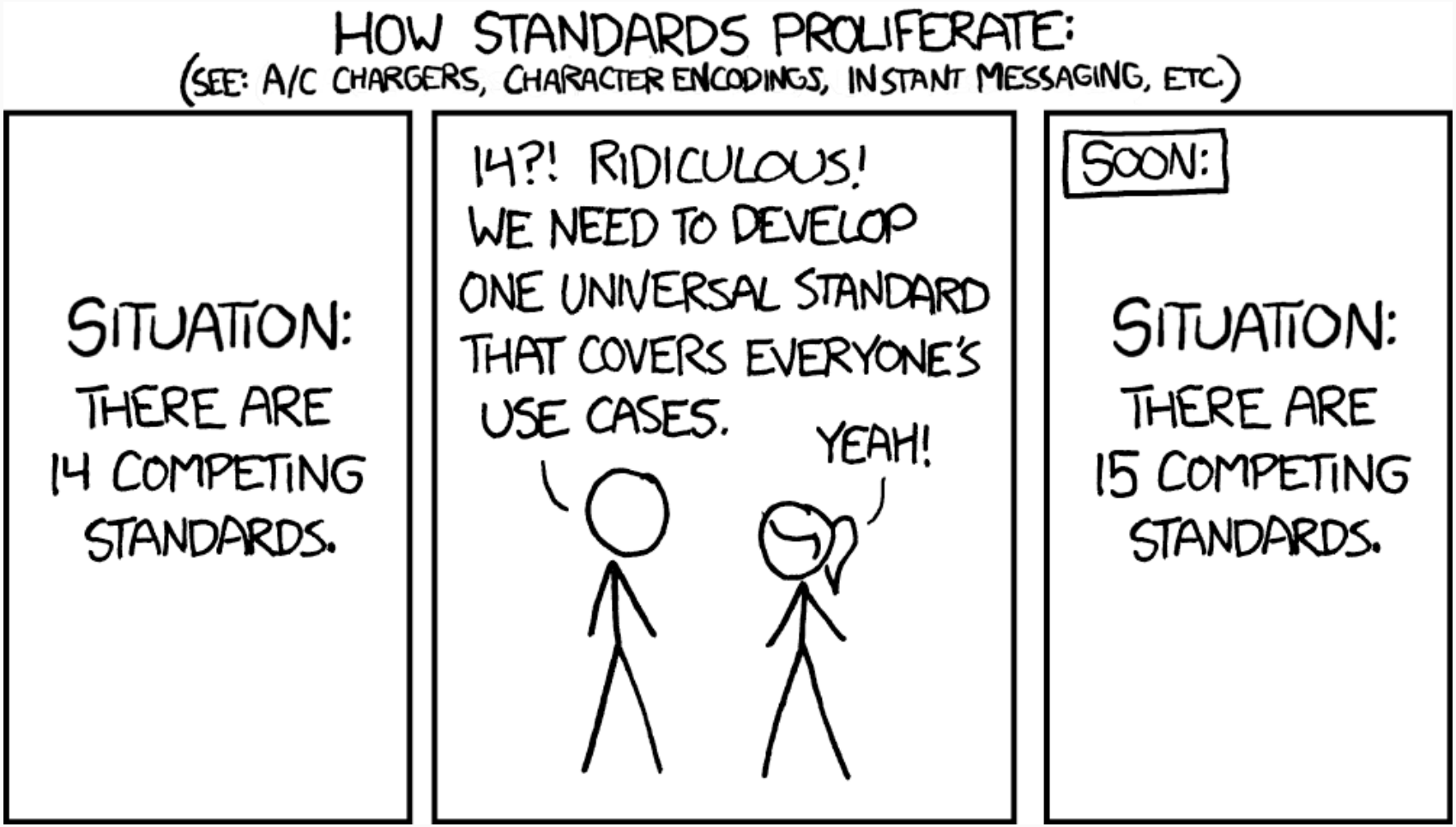
How to combine tools?

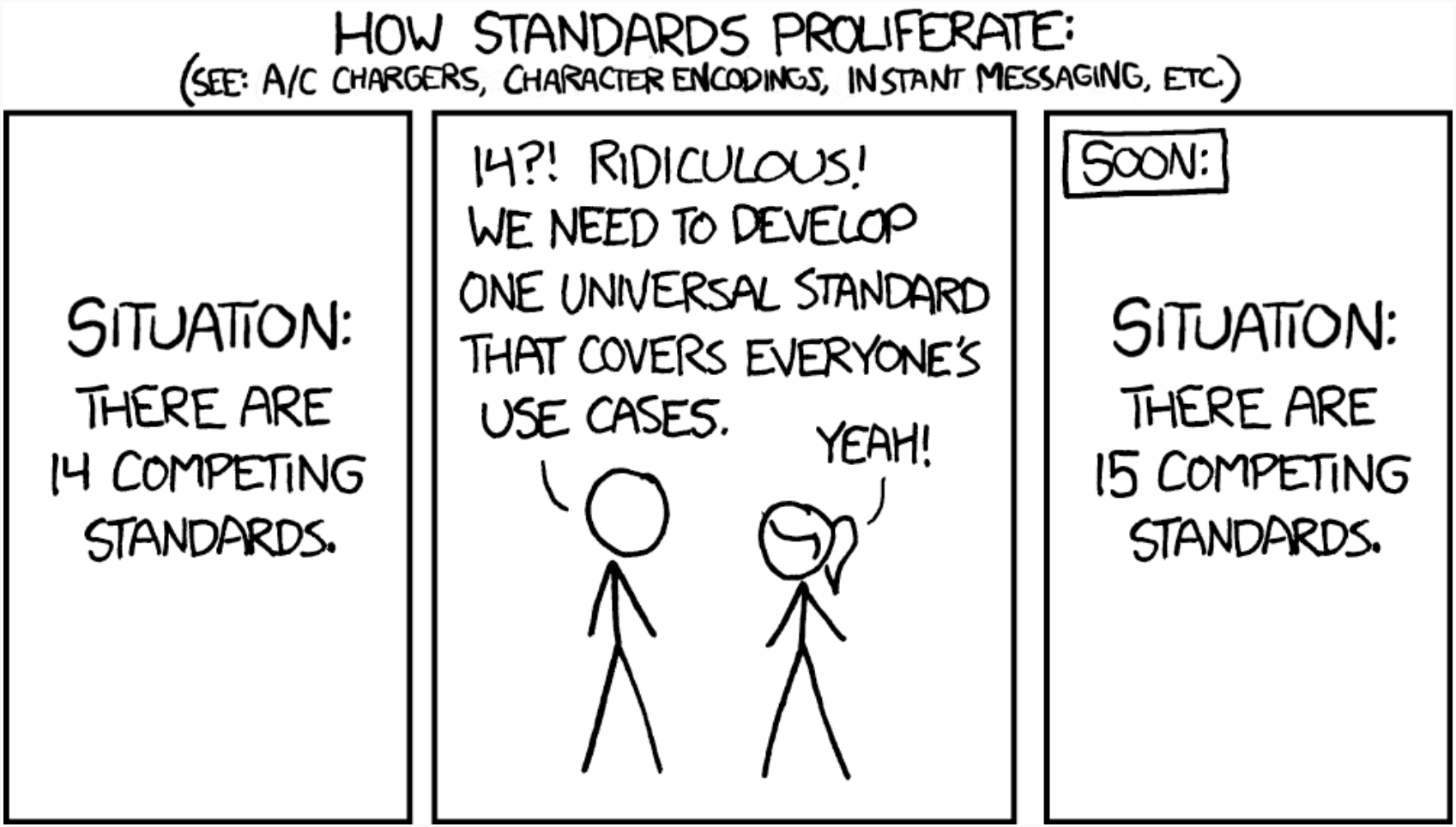
How to transform formulas?

How to try out new encoding ideas?

How to then use these new ideas somewhere else?


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)
SITUATION:
THERE ARE
14 COMPETING
STANDARDS.
14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.
YEAH!
SOON:
SITUATION:
THERE ARE
15 COMPETING
STANDARDS.

XKCD 927.



XKCD 927. Fortunately, the charging one has been solved now that we've all standardized on mini-USB. Or is it micro-USB? Shit.

Combining Standards

Let's create a conversion tool between standards with nice UX.

It worked for USB-C!

Boolean Formulas

The Next Generation

Booleguru

Goals:

1. Enough extension-points to allow adding new input and output formats 📝
    - Propositional Formulas à la Limboole ✓(Input & Output)
    - (Q)DIMACS ✓(Input & Output)
    - SMT-LIB 📝(Bit of Input)
    - QCIR 📝(Output)

Booleguru

Goals:

1. Enough extension-points to allow adding new input and output formats 
2. Efficient internal formula representation ✓
   - All nodes saved in `std::vector`
   - Built by hashing new nodes and finding already existing ones (using the *Ankerl* hash-map)
   - Internal references as 32-bit integers, smaller memory footprint than pointers
   - Nodes have available user-data fields

Booleguru

Goals:

1. Enough extension-points to allow adding new input and output formats 
2. Efficient internal formula representation ✓
3. Programmable and extendable ✓
    - Embedded *Lua* runtime and *fennel* (A Lua-based Lisp)
    - New operations can be defined in scripts, loaded at runtime
    - Composable in CLI and formulas
    - Parameterized formulas as functions for better formula re-use

Booleguru

Goals:

1. Enough extension-points to allow adding new input and output formats 
2. Efficient internal formula representation ✓
3. Programmable and extendable ✓
4. Nice Codebase for Collaboration ✓(?)
    - Everything split into well-separated internal sub-libraries
    - Extension-Points are clearly defined
    - Less toe-stepping (we hope)
    - Already collaborating SAI-internally on the tool

Booleguru

Goals:

1. Enough extension-points to allow adding new input and output formats 
2. Efficient internal formula representation ✓
3. Programmable and extendable ✓
4. Nice Codebase for Collaboration ✓(?)
5. User-friendly Web Interface 
    - Like Jupyter Notebook, but for Logic
    - Fully Client-side
    - Created by Alexander Mayr as a Bachelor's Thesis
    - Online at: logic.pizza
    - Including other cells is very WIP, rest is WIP.

Live Demonstration

Input Format Limboole-like: `a & !(b | c) -> d | (e <-> f)`

Embedded Code `a & f(v "b")` - uses Fennel-Lang (a Lua-Lisp)

Distribute to CNF `((a & b) | (c & d))`
`:(distribute-to-cnf *last-op*)`

Tseitin `((a & b) | (c & d)) :(tseitin *last-op*)`

Visualize `((?a #b a & b) | (?b #a a & b)) :(dotter *last-op*)`

Unquantified `(?a a & b) :(unquantified *last-op*)`

CLI Features

CLI-Support more advanced currently, supports loading Lua code from files.

`BOOLEGURU_LUA_PATH` adds load-paths to Lua.

Example:

```
export BOOLEGURU_LUA_PATH=lua
booleguru --eval formula.boole
booleguru f1.boole --and --not f2.dimacs --qdimacs
booleguru f1.boole --and f2.dimacs
':(*last-op*:rename "1" "a")'
```

Where to find Booleguru

gitlab.sai.jku.at/booleguru/booleguru/

logic.pizza

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