Metamath

What is it?

A Language

A Proof Explorer: us.metamath.org

A Proof Assistant: mmj2

Why is it cool?

Only one rule: Substitution

Simple to implement: 300 LOC + 19 verifiers

Confidence: 5 implementations in 5 language by 5 people

Fast: verifies whole codebase 40.000 theorems in a few seconds.

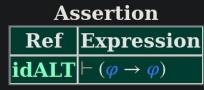Hyperlinked references: easy to follow

Other Features

Proof checking separate from authoring

-> Small kernel -> Few Bugs + Fast

-> Big proof assistant (mmj2) w/ many features

74/100 of the Formalizing Theorems Challenge

Linear time checking

Demo

Assertion

Ref	Expression
idALT	$\vdash (\varphi \to \varphi)$

Proof of Theorem idALT

Step	Hyp	Ref	Expression
1		ax-1 6	.2 $\vdash (\varphi \to (\varphi \to \varphi))$
2		ax-1 6	..3 $\vdash (\varphi \to ((\varphi \to \varphi) \to \varphi))$
3		ax-2 7	..3 $\vdash ((\varphi \to ((\varphi \to \varphi) \to \varphi)) \to ((\varphi \to (\varphi \to \varphi)) \to (\varphi \to \varphi)))$
4	2, 3	ax-mp 5	.2 $\vdash ((\varphi \to (\varphi \to \varphi)) \to (\varphi \to \varphi))$
5	1, 4	ax-mp 5	1 $\vdash (\varphi \to \varphi)$

Colors of variables: wff setvar class

Syntax hints: $\to$ wi 4

This theorem was proved from axioms: ax-mp 5 ax-1 6 ax-2 7

This theorem is referenced by: id1 27643

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http://us.metamath.org/mpeuni/idALT.html

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```
$( <MM> <PROOF_ASST> THEOREM=2p2e4   LOC_AFTER=9m1e8


df4::df-4              |- 4 = ( 3 + 1 )
df2::df-2              |- 2 = ( 1 + 1 )
df3::df-3              |- 3 = ( 2 + 1 )


1:df3:oveq1i |- ( 3 + 1 ) = ( ( 2 + 1 ) + 1 )
2:df2:oveq2i |- ( 2 + 2 ) = ( 2 + ( 1 + 1 ) )


d1::2cn                |- 2 e. CC
d2::ax-1cn             |- 1 e. CC
3:d1,d2,d2:addassi |-  ( ( 2 + 1 ) + 1 ) = ( 2 + ( 1 + 1 ) )


4:3,1,2:3eqtr4ri |- ( 2 + 2 ) = ( 3 + 1 )



!qed:4,df4:eqtr4i  |- ( 2 + 2 ) = 4

$=  ( c2 caddc co c3 c1 c4 2cn ax-1cn addassi df-3 oveq1i df-2 oveq2i
    3eqtr4ri df-4 eqtr4i ) AABCZDEBCZFAEBCZEBCAEEBCZBCRQAEEGHHIDSEBJK
    ATABLMNOP $.
$)
```

References

us.metamath.org

David A. Wheeler Metamath Tutorials

mmj2: built in tutorial

Lessons from Metamath by Mario Carneiro

Proof steps

Unique step id or hypothesis or "qed"

Dependencies to previous steps

Reference to axiom or theorem justifying step

StepId:Dependencies:Reference |- step

Things that live in metamath

Well formed formulas: greek letters

Set variables: lower case letters

Class variables: upper case letters