PCEnv, COR & OpenCell

Justin Marsh & Alan Garny





INTRODUCTION (I)

- Since its release in 2001, several CellML tools and techniques have become available. They are dedicated to:
 - Editing (both visual and textual);
 - Validation (both CellML and units);
 - Sharing and curation (through an online repository);
 - Code generation (for external use); and
 - Simulation of CellML models.

INTRODUCTION (II)

	$ m AGOS^{a}$	$CESE^{b}$	$\mathrm{COR}^{\mathrm{c}}$	JSim^d	$\mathrm{PCEnv}^{\mathrm{e}}$	$\operatorname{PyCml}^{\mathrm{f}}$	VCell ^g
CellML version editing	1.0 import	1.0 import	1.0 yes	1.0 import/ export	1.0/1.1 some	1.0 no	1.0 import/ export
validation units (validation/ conversion)	some no	some no	yes validation	some yes	some some	yes yes	some no
code generation simulation environment supported ⁱ	yes yes I	no yes W/L/M	yes yes W	no yes W/L/M	yes^{h} yes W/L	yes no I/W/L/M	no yes W/L/M

^aAPI generator for ODE Solution (AGOS; see http://www.fisiocomp.ufjf.br/).

^bCell Electrophysiology Simulation Environment (CESE; see http://cese.sourceforge.net/).

^cCellular Open Resource (COR; see http://cor.physiol.ox.ac.uk/).

^dJSim (see http://www.physiome.org/jsim/).

^ePhysiome CellML Environment (PCEnv; see http://www.cellml.org/tools/pcenv/).

^fPyCml (see https://chaste.ediamond.ox.ac.uk/cellml/).

^gVirtual Cell (VCell; see http://www.nrcam.uchc.edu/).

^hVia CCGS (see \$3d(i)).

ⁱI, Internet (through a Web interface); W, Microsoft Windows; L, Linux; M, Mac OS X.

Garny et al. CellML and associated tools and techniques. Phil Trans R Soc A 366: 3017-3043 (2008).

INTRODUCTION (II)

	$\mathrm{AGOS}^{\mathrm{a}}$	$CESE^{b}$	COR ^c	$\operatorname{JSim}^{\operatorname{d}}$	PCEnv ^e	$\mathrm{PyCml}^{\mathrm{f}}$	$\mathrm{VCell}^\mathrm{g}$
CellML version editing	1.0 import	1.0 import	1.0 yes	1.0 import/	1.0/1.1 some	1.0 no	1.0 import/
validation	some	some	yes	some	some	yes	some
units (validation/ conversion)	no	no	validation	yes	some	yes	no
code generation	yes	no	yes	no	$\mathrm{yes}^{\mathrm{h}}$	yes	no
simulation	yes	yes	yes	yes	yes	no	yes
$\begin{array}{c} \text{environment} \\ \text{supported}^{\text{i}} \end{array}$	Ι	W/L/M	W	W/L/M	W/L	I/W/L/M	W/L/M

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CellML version editing	1.0 import	1.0 import	1.0 yes	1.0 import/ export	1.0/1.1 some	1.0 no	1.0 import/ export
validation	some	some	yes	some	some	yes	some
units (validation/ conversion)	no	no	validation	yes	some	yes	no
code generation	yes	no	yes	no	$\mathrm{yes}^{\mathrm{h}}$	yes	no
simulation	yes	yes	yes	yes	yes M	no	yes
$\begin{array}{c} \text{environment} \\ \text{supported}^{\text{i}} \end{array}$	Ι	W/L/M	W	W/L/M	W/L	I/W/L/M	W/L/M

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 - PCEnv 0.4: graphical rendering of mathematics, units, etc., as well as C export of generated code;



- Several versions of PCEnv have been released over the past year. Some key features include:
 - PCEnv 0.4: graphical rendering of mathematics, units, etc., as well as C export of generated code;
 - PCEnv 0.5: visual validator, experimental DAE solver; and

Unit Units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionless units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to have dimensionally inconsistent units Image: Spected all arguments to MathML apply to	$F_V = \begin{cases} \frac{V \max V}{V_{\max}(x) + (x) + $	$FV = \begin{cases} \frac{V \text{ max} - V}{V_{\text{max} + (x0) + cv1 \times L + xv2 \times L^2^{\circ}) \times V} \\ \frac{V \text{ max} - V}{V_{\text{max} + (x0) + cv1 \times L + xv2 \times L^2^{\circ}) \times V} \\ \frac{V \text{ max} - V}{V_{\text{max} + V}} \text{ if } V \le 0.0 \end{cases}$	File Tools Minur Hale		Physi		
V ming: Expected all arguments to MathML apply to have the same units Pype Value D = 0°L dimensionless D = 0°L dimensionless D = 0°L dimensionless D = 0°L first_order_rate_constant D = 0°L dimensionless	$FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \begin{cases} \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \\ FV = \frac{V - max - V}{V_{max} + (cv0 + cv1 \times L) \times V} & \text{if } V \le 0.0 \end{cases} & \text{therewise} \\ From Mapping variable 1 has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but variable 2 also has public interface of in but v$	$F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V}{br + ((arot + art \times L + arg2 \times L^{20}) \times V)} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (crot + crit \times L + arg2 \times L^{20}) \times V} \text{ otherwise} \\ F_{V} = f_{V} =$		🔄 🛱 🗌 (dt			
$ \int \frac{V_{\text{max}} - V}{V_{\text{max}} + (V + V + V + V) \times V} $ if $V \le 0.0$ $ \int \frac{V_{\text{max}} - V}{V_{\text{max}} + (V + V + V + X) \times V} $ if $V \le 0.0$ $ \int V_{\text{max}} - V = \int \frac{V_{\text{max}} - V}{V_{\text{max}} + (V + V + V + X) \times V} $ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$ $ \int V_{\text{max}} + (V + V + V + X) \times V$ if $V \le 0.0$	$FV = \begin{cases} \frac{V_{max} - 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V}{V_{max} + (av0 + av1xL + av2xL^{2}) \times V} \text{ otherwise} \end{cases} \text{ for } V \leq 0.0 \\ F_{V} = \frac{V_{max} - V}{V_{max} + (av0 + av1xL + av2xL^{2}) \times V} \text{ otherwise} \end{cases} \text{ for } V \leq 0.0 \\ F_{V} = \frac{V_{max} - V}{V_{max} + (av0 + av1xL + av2xL^{2}) \times V} \text{ otherwise} \end{cases} \text{ for } V \leq 0.0 \\ F_{V} = \frac{V_{max} - V}{V_{max} + (av0 + av1xL + av2xL^{$	● ^V (●) (♥) #			Waming: Expected all arguments to MathML apply to have the same units	
V Image: L dimensionless Image: L dimensionless Image: L dimensionless Image: L dimensionless dimas dimensionless	$FV = \begin{cases} \frac{V_{max} - V}{V_{max} + (xv) + (xv) + xv} if V \le 0.0 \\ \frac{V_{max} - V}{V_{max} + (xv) + xv + 2xL^{20} \times V) \\ \frac{V_{max} + (xv) + xv + 2xU^{20} \times V) \\ \frac{V_{max} + (xv) + xv + 2xU^{20} \times V) \\ V_{max$	$F_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V}{bV + ((x0) + xV1 \times L + aV2 \times L^{20}) \times V} \\ f_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V} \\ \frac{V \max - ((x0) + xV1 \times L + aV2 \times L^{20}) \times V}{bV + V} \\ \end{bmatrix} $ $F_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V} \\ \frac{V \max - ((x0) + xV1 \times L + aV2 \times L^{20}) \times V \\ bV + V \\ \end{cases} $ $F_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V} \\ \frac{V \max - ((x0) + xV1 \times L + aV2 \times L^{20}) \times V \\ bV + V \\ \end{cases} $ $F_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V \\ bV + V \\ \end{cases} $ $F_{V} = \begin{cases} \frac{V \max - V}{V_{\max} + (x0) + (x1) \times L + aV2 \times L^{20}) \times V \\ \frac{V \max - ((x0) + xV1 \times L + aV2 \times L^{20}) \times V \\ V + V + V \\ \frac{V + V + V \\ \frac{V + V + V \\ \frac{V + V + V + V \\ \frac{V + V + V + V \\ \frac{V + V + V + V \\ \frac{V + V + V \\ $	Type	Value	Units		
$\int_{\mathbb{T}} \frac{V_{\text{max}} - V}{V_{\text{max}} + (x0 + cx1 \times L) \times V}} \text{ if } V \leq 0.0$ $\int_{\mathbb{T}} V = \int_{\mathbb{T}} \frac{V_{\text{max}} - V}{V_{\text{max}} + (x0 + cx1 \times L) \times V}} \text{ if } V \leq 0.0$ $\int_{\mathbb{T}} V = \int_{\mathbb{T}} \frac{V_{\text{max}} - V}{V_{\text{max}} + (x0 + cx1 \times L) \times V}} \text{ if } V \leq 0.0$	$FV = \begin{cases} \frac{V \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - 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V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum \max - V \sum - V \sum \frac{V \sum - V}{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum - V \sum - V \sum \frac{V \sum - V \sum - V \sum - V }{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ \frac{V \sum - V }{V_{\max} + (xv0 + cv1 \times L + av2 \times L^{20}) \times V} \\ V \sum - V \sum $	$F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V}}{W - ((x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - V}{V_{\text{max}} + (x^0 + x^1 \times L + x^2 \times L^{2^0}) \times V} \right\} \text{ otherwise}$ $F_V = \left\{ \frac{V_{\text{max}} - 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The second s	$FV = \frac{V \operatorname{max} - V}{V \operatorname{max} + (xv + xv + xv + xv + xv + xv + xv + x$	$F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$ $F_{V} = \left\{ \underbrace{\frac{V_{max} - V}{V_{max} + (x0 + cv1 \times L) \times V}}_{bv + V} \text{ if } V \leq 0.0 \right\}$	Þo ^v ∨		first_order_rate_constant	Waming: Expected all arguments to MathML apply to have the same units	
Equation $P_{u} \in Af$ $P_{u} \in FO$ $P_{u} \in F \subseteq F$ $P_{u} \in F \subseteq F $ $P_$	$FV = \frac{V_{max} - V}{V_{max} + (x0 + cx1 \times L + av2 \times L^{20}) \times V}$ otherwise	$FV = \begin{cases} \frac{V_{max} - V}{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V} \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ \frac{V_{max} + (cv0 + cv1 \times L + av2 \times L^2^0) \times V \\ V_{ma$	⊽‡∓ Mathematio	s 5			unit
$\int \Phi_{a}^{c} F O$ $\int \Phi_{a}^{c} F O O$ $\int \Phi_{a}^{c} F O O O$ $\int \Phi_{a}^{c} F O O O O O O O O O O O O O O O O O O $	$FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$ $FV = \frac{V_{max} - V}{V_{max} + (x0) + cv1 \times L/2xV_{x}}$ if $V \le 0.0$	$F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (rv0 + rv1 \times L + av2 \times L^{2}^{0}) \times V}{bv + V} \text{ otherwise}} \text{ if } V \leq 0.0$	💳 Equation			Warning: MathML equals element has inconsistent units between the sides	um
$\int e^{c}F_{0}$ $\int e^{c}F_{0}$ $\int e^{c}F_{1}CE$ $\int e^{c}F$	$F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ if } V \leq 0.0 \\ \frac{V_{max} + (cv0 + cv1 \times L) \times V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ otherwise} \end{cases}$ $F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ if } V \leq 0.0 \\ \frac{V_{max} + (cv0 + cv1 \times L) \times V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ otherwise} \end{cases}$ $F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ if } V \leq 0.0 \\ \frac{V_{max} + (cv0 + cv1 \times L) \times V}{V_{max} + (cv0 + cv1 \times L) \times V} \text{ otherwise} \end{cases}$	$F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (v0 + cv1 \times L1 + av2 \times L^{2}^{0}) \times V}{bv + V} \text{ otherwise} \end{cases} \text{ if } V \leq 0.0$	▷ 🖬 º Af			Error: Connection of two variables which have dimensionally inconsistent units	
$FV = piecewise(case V \le 0.0 {units="dimensionless"} then (V_mainstructure) in the public interface of in but variable_2 also has public interface of in but variable$	$FV = piecewise(case V \leq 0.0 {units="dimensionless"} then (V_max)}$ $FV = piecewise(case V \leq 0.0 {units="dimensionless"} then (V_max)}$ $FV = \frac{V_max - V}{V_max + (cv0 + cv1 \times L) \times V} \text{ if } V \leq 0.0 {units= 0$	$F_{V} = \begin{cases} \frac{V_{max} - V}{V_{max} + (xv) + xv) xL^{20} \times V} \\ \frac{V_{max} + (xv) + xv + xv + xv + xv^{20} \times V)}{bv + V} \\ \text{otherwise} \end{cases}$	▷ ■ ^c F0			Fror: Mapping variable 1 has public interface of in but variable 2 also has public interface of in	
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- Several versions of PCEnv have been released over the past year. Some key features include:
 - PCEnv 0.4: graphical rendering of mathematics, units, etc., as well as C export of generated code;
 - PCEnv 0.5: visual validator, experimental DAE solver; and
 - PCEnv 0.6: export to MATLAB and Python in addition to C (incl. DAE models), as well as Mac OS X support.



PCEnv and COR: two CellML environments with similar goals.



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- PCEnv and COR: two CellML environments with similar goals.
- PCEnv's strength is on running simulations, while COR's strength is on editing CellML files.
 The aim is therefore to...



- A three-step process:
 - Organising;
 - Editing; and
 - Simulating.

A three-step process:

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CONCLUSION

- OpenCell = PCEnv + COR.
- The current priority on this integration of COR with PCEnv is on the editing of CellML files using a COR-like format.
- OpenCell offers inherent support for a wide range of modelling paradigms.
- This does, however, require the involvement of modellers, as well as more people to implement those paradigms.

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