

The numodel-coach package

Export numodel models to CMA Coach 7

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Abstract

numodel-coach writes a model declared with numodel as a modelling activity for CMA Coach 7 (a .cma7 file), in Coach's text mode. Pupils open the file in Coach and get exactly the model of the text, without retyping it from the PDF. The model rules and initial values are numodel's Coachtaal rendering (numodel.plaintext); the file can also be embedded in the PDF.

1 Usage

Load the package after numodel (LuaLaTeX only):

```
\usepackage[syntax=NL]{numodel}
\usepackage{numodel-coach}
```

After the model is declared, \coachmodel writes it:

```
\newmodelprefix{ball}
\mvar{T}{t}{0}{\s}{2}{systeem}
\mvar{Dt}{dt}{0.05}{\s}{2}{systeem}
\mvar{V}{v}{0}{\m\per\s}{3}{voorraad}
\mvar{Y}{y}{100}{\m}{3}{voorraad}
\mvar{G}{g}{-9.81}{\m\per\s\squared}{3}{constante}
\mrule{V}{\ballV + \ballG * \ballDt}
\mrule{Y}{\ballY + \ballV * \ballDt}
\mrule{T}{\ballT + \ballDt}
\mstop{\ballY <= 2}
\textmodel
\coachmodel{vrije-val}
```

This writes `vrije-val.cma7` with the model rules

```
v := v + g*dt
y := y + v*dt
t := t + dt
Als y <= 2 Dan Stop EindAls
```

and the initial values

```
t := 0      's
dt := 0,05  's
v := 0      'm/s
y := 100    'm
g := -9,81  'm/s^2
```

All variables are listed in Coach's variable list (for tables and graphs) with their units.

`\coachmodel` `\coachmodel[⟨options⟩]{⟨name⟩}` writes the model with the current prefix to `⟨name⟩.cma7` (no extension is added when `⟨name⟩` has one). Options: `prefix=⟨prefix⟩` for another model, and `dir`, `attach` and `switch` as below.

`\coachsetup` `\coachsetup{⟨options⟩}` sets defaults for all following `\coachmodel` calls:

dir=⟨directory⟩ Directory for the files, relative to the working directory; created when missing. Default: the working directory.

attach=true/false Also embed the file in the PDF (with embedfile). Default false. Whether readers can open embedded files depends on the PDF viewer.

blanks=open/filled (\coachmodel only) Write the pupil's version, in which every rule, stop condition and start value declared with numodel's blank key becomes a comment ' F_z := ... to complete in Coach, or the answer version in full. Default: numodel's blanks setting (open).

switch=true/false Allow switching between Coach's text and graphical view. Default false: Coach derives the text view from the graphical model, which numodel-coach leaves empty, so switching would lose the model.

2 Instruction text

`coachinstruction` The environment `coachinstruction[⟨prefix=⟨prefix⟩⟩]` defines the instruction text of a model (by *env.*) default the current one). It typesets nothing.

`coachinstructiontext` `\coachinstructiontext[⟨prefix=⟨prefix⟩⟩]` typesets that text in the PDF, wherever you want it and as often as you like (or not at all), and `\coachmodel` writes it to Coach's instruction window. The PDF and Coach thus share one source:

```
\begin{coachinstruction}
Een bal valt vanuit rust van \qty{100}{\m}. Neem
$g = \qty{9.81}{\m\per\s\squared}$.

Opgachten:
\begin{enumerate}
\item Bereken de \textbf{eindsnelheid} $v_{\text{eind}}$.
\end{enumerate}
\end{coachinstruction}
```

```
\coachinstructiontext % the text in the PDF
\coachmodel{vrije-val} % the same text in Coach
```

A model has one instruction text: a second `coachinstruction` for the same model replaces the first, with a warning. The text is typeset where `\coachinstructiontext` stands, so anything in it that depends on its position (a counter, say) takes its value there.

Coach shows HTML in its instruction window; the body is converted from the following LaTeX:

- paragraphs (blank lines), `\\`, `\newline`;
- `\textbf`, `\emph`, `\textit`, `\underline`, `\textsuperscript`, `\textsubscript`; `\text` and similar wrappers keep their text;
- `itemize` and `enumerate` with `\item`;
- inline math (`$...$`, `\langle...\rangle`): letters in italics, `_` and `^` as sub- and superscript, Greek letters, `\frac`, `\sqrt`, `\cdot`, relations such as `\leq`;
- `\qty`, `\num`, `\unit` (and `\SI`, `\si`): numbers with a decimal comma, units in Coach's notation;
- `~`, `--`, `---`, quotes, and a handful of symbols (`\ldots`, `\times`, `\degree`, ...).

Any other command gives a warning; its braced argument is kept as text. Display math, tables and pictures are not converted.

3 What is exported

- *Model rules* in the order of `\textmodel`: `\mrule` as an assignment, conditional rules as `Als ... Dan ... Anders ... EindAls` (on several lines for `\mrule*`), `\mstop` as `Als ... Dan Stop EindAls`. A `\mruletext` row becomes a comment, with a warning. The display keys `alias`, `aliasleft` and `aliasright` do not apply: Coach gets the calculation.
- *Initial values* of all variables with a start value, with the unit as a comment.

- *Variable list*: every variable, with its unit, so it can be put in Coach's table and graphs. The axis range Coach uses for a new graph or meter is the range of the variable's graph in the document: the axis limits `\diagrammodel` drew (the union, when the variable appears in several diagrams). A variable that is not drawn gets the range a diagram of its computed series would have (the same rounding to whole ticks); only a model that was never computed keeps Coach's default 0 to 10. Call `\coachmodel` after `\computemodel` and the diagrams. Coach shows two decimals.
- *Names*: the display name without formatting (`F_{\text{res}}`) becomes `F_res`, `\Delta t` becomes `\Delta t`, `\lambda \lambda`). Names Coach does not accept bare (with a space or a slash), and its reserved words, are put in brackets: `[t_{1/2}]`, `[Max]`.
- *Units*: siunitx units in Coach's notation: `\m\per\s\squared` becomes `m/s^2`, `\mole\per\litre\per\second` becomes `mol/(L*s)`. A unit of your own (`\DeclareSIUnit{\animals}{animals}`) is exported as its symbol: `\animals\per\day` becomes `animals/d`.
- *Angle unit*: Coach's "hoekeenheid" follows `numodel`'s angles setting (`\numodelsetup{angles=degrees}` in the preamble; default radians), and so do the trigonometric functions: with degrees `sind(\alpha)` is exported as `Sin(alfa)`, `sin(x)` as `Sin(180/Pi*x)`, `asind(x)` as `Arccsin(x)` and `asin(x)` as `Pi/180*Arccsin(x)` (Coach's inverse functions answer in the angle unit too). `\textmodel` shows the same.
- *Iterations*: the number of iterations in Coach's model settings is `numodel`'s `maxiter` (`\numodelsetup{maxiter=...}`, default 20000). The Stop rule ends the run; `maxiter` is only the upper limit.

Expressions are translated with care for the differences between l3fp and Coachtaal: Coach gives unary minus and `^` the same priority, so `-x^2` is exported as `-(x^2)`; comparisons combined with EN/OF get the parentheses Coachtaal requires. Whatever cannot be exported exactly (a two-argument `atan`, a nested conditional, an unknown unit macro) is reported as a package warning naming the model and the file.

4 The file format

CMA does not document the `.cma7` format. `numodel-coach` starts from an empty modelling activity saved by Coach 7.0 in text mode (stored as Lua data in `numodel-coach-template.lua`) and fills in the model rules, initial values, variable list and iteration count. Files written this way were tested with Coach 7 on Chromebooks. A later Coach version may change the format; please report problems.