The `cora-macs` Package

Tobias Ladner, Lukas Koller
TUM - Cyber-Physical Systems Group
`tobias.ladner@tum.de, lukas.koller@tum.de`

2024-10-25

Abstract

The `cora-macs` package provides tools for working with continuous sets, operations, neural networks, and color schemes tailored for use in the context of cyber-physical systems. This document serves as the official documentation for the package, detailing the available commands and options.

Contents

1 Introduction

The `cora-macs` package is designed to assist in the representation and manipulation of various mathematical objects such as sets, intervals, zonotopes, and

operations often encountered in cyber-physical systems analysis. It also includes predefined color schemes based on the TUM corporate design and other custom colors.

2 Installation

To install the `cora-macs` package, follow these steps:

1. Place the `cora.sty` file in your working directory or in a directory where LaTeX can find it (e.g., in the local `texmf` tree).

2. Include the package in your LaTeX document with the command:

   ```
   \usepackage{cora}
   ```

3 Package Options

The `cora-macs` package provides several options that can be passed when loading the package. These options control the inclusion of different sets of commands.

- `sets`: Includes commands for continuous set notation and operations.

- `operations`: Includes commands for various mathematical operations.

- `nn`: Includes commands for working with neural networks.

- `colors`: Defines a set of colors specific to the `cora-macs` package.

- `tumcolors`: Defines TUM-specific colors.

Example usage:

```
\usepackage[sets, operations]{cora}
```

4 Commands and Environments

4.1 Sets (`sets` option)

When the `sets` option is enabled, the package provides several commands for defining and manipulating continuous sets.

- `\contSet{name}`: Defines a set in calligraphic font, e.g., $\mathcal{A}$.

- `\shortContSet[abbr]{content}{set}`: Defines a short-hand notation for continuous sets with optional abbreviation.

- `\defContSet{elements}{conditions}`: Defines a set using the format $\{x \mid \text{conditions}\}$.

- `\defContSetSplit{elements}{conditions}`: Defines a set with split conditions for better formatting in large equations.

- `\shortI{a}{b}`: Defines a closed interval $[a, b]$.

- `\defZ`: Defines a zonotope.

- `\defPZ`: Defines a polynomial zonotope.

4.2 Operations (`operations` option)

Enabling the `operations` option introduces a variety of operations that are useful in mathematical and cyber-physical systems contexts.

- `\operator{name}{args}`: Defines a custom operator with the given name and arguments.

- `\opEnclose{set1}{set2}`: Encapsulates a set within another.

- `\opIntervalEnclosure{interval}`: Specifies an interval enclosure.

- `\opProject{dimension}`: Projects a set onto a given dimension.

- `\diag{matrix}`: Produces the diagonal matrix of the given input.

4.3 Neural Networks (`nn` option)

The `nn` option introduces commands related to neural networks, including notation for layers, inputs, outputs, and propagations.

- `\NN`: Represents the symbol for a neural network Φ.

- `\nnLayer{layer}{input}`: Represents a neural network layer with a specified input.

- `\nnInput`, `\nnOutput`: Notation for input and output points in a neural network.

4.4 Colors (`colors` and `tumcolors` options)

The `colors` and `tumcolors` options define a variety of colors that can be used in your documents.

- `\definecolor{CORAcolorReachSet}`: A predefined color for reachability sets (blue).

- `\definecolor{TUMblue}`: TUM corporate blue color.

5 Examples

Here are some examples demonstrating how to use the commands from the `cora-macs` package.

5.1 Set Notation

```
\contSet{X} = \shortContSet{a}{b}{X}
```

This code will produce $\mathcal{X} = \langle a, b \rangle_X$.

5.2 Operations

```
\diag{A} = \operator{diag}{A}
```

This code will produce $\operatorname{diag}(A) = \operatorname{diag}(A)$.

5.3 Neural Networks

```
\NN(\nnInput) = \nnLayer{1}{\nnInput}
```

This code will produce $\Phi(x) = L_1(x)$.

6 Concluding Remarks

The `cora-macs` package offers a comprehensive set of tools for researchers working in cyber-physical systems. By providing a consistent notation and color scheme, this package simplifies the process of documenting complex mathematical objects and operations.

For more information, visit the TUM CPS Group website.