matrixdiagrams.sty

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Overview

`matrixdiagrams` is a LaTeX package that draws schematic matrix diagrams in TikZ for the purposes of illustrating structure in matrices. All diagrams use `\matrixdiagram[scale][aspect]{content}`, where `content` is a sequence of small drawing commands (`\mdFill`, `\mdLabel`, `\mdDiagBand`, ...) working in a normalized coordinate system that automatically adapts to the diagram's scale and aspect ratio. This easily allows one to visualize structure in matrices such as bidiagonal, tridiagonal, upper triangular, and Hessenberg varieties. The sections below give a quick reference followed by every command with a runnable example.

Contents

1 Quick Reference

`\matrixdiagram [s][a][r]{c}`	Main command. `s` = scale (default 1), `a` = aspect (default 1). `r` = corner radius for interior drawings (default: the `roundedcorners` package option, else `0pt`). Position args below are $x, y \in [0, 1]$, any aspect.
`\mdDiag`	Main diagonal
`\mdDiagBand`	Tridiagonal band.
`\mdDiagBandN {n}`	n-diagonal band (n odd).
`\mdBidiagUpper`	Main diagonal + super-diagonal.
`\mdBidiagLower`	Main diagonal + sub-diagonal.
`\mdHessenberg`	Upper-triangular outline + sub-diagonal.
`\mdHessenberg [color]`	Same with filled interior.
`\mdDiagFrom {x1}{y1}{x2}{y2}`	Main diagonal from (x_1, y_1) to (x_2, y_2)
`\mdDiagBandFrom {x1}{y1}{x2}{y2}`	Tridiagonal band, clipped.
`\mdDiagBandNFrom {n}{x1}{y1}{x2}{y2}`	n-diagonal band, clipped.
`\mdFill [col]{x0}{y0}{x1}{y1}`	Filled rectangle. Default color `gray!20`.
`\mdVLine {x}`	Vertical line, full height.
`\mdHLine {y}`	Horizontal line, full width, at fractional height y.
`\mdLabel {x}{y}{text}`	Math-mode label at (x, y).
`\mdLabel [color]{x}{y}{text}`	Same with filled node label
`\mdLabelRaw {x}{y}{text}`	Raw-text label at (x, y).
`\mdLabelCenter {text}`	Math label at center (any aspect).
`\mdDiagLabel [pos][angle][fill]{text}`	Math label on the main diagonal; `pos` $\in [0, 1]$ (default 0.5), default fill `white`.
`\mdSpike {x}{y}{dir}`	L-corner; `dir` $\in$ {`tl, tr, bl, br`}.
`\mdBlank`	Empty content (brackets only).
`\mdH`	Expands to the aspect value, i.e. the top edge's y-coordinate.

2 Main command

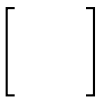
`\matrixdiagram[scale][aspect]{content}`

Inside `content`, the raw TikZ canvas runs $x \in [0, 1]$ and $y \in [0, \text{aspect}]$: `aspect` is literally the y-coordinate of the top edge, and `\mdH` expands to that value, so `(0,\mdH)–(1,\mdH)` is always the top edge, whatever the aspect. Every built-in positioning command (`\mdFill`, `\mdLabel`, `\mdLabelRaw`, `\mdHLine`, `\mdSpike`, and the `...From` diagonal variants) instead takes y as a plain fraction of the height, $y \in [0, 1]$, and multiplies by `\mdH` internally — so `y=0.5` always means mid-height, regardless of aspect. Raw `\draw` commands written directly inside `content` see the unscaled canvas, so they must reference `\mdH` themselves, e.g. `(1,\mdH)` for the top-right corner.

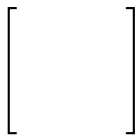
2.1 Scale (aspect = 1)

```
$\matrixdiagram[1]{\mdBlank}$
```

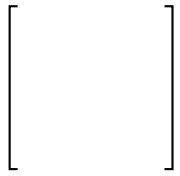
```
$\matrixdiagram[2]{\mdBlank}$
```



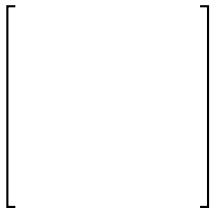
```
$\matrixdiagram[3]{\mdBlank}$
```



```
$\matrixdiagram[4]{\mdBlank}$
```



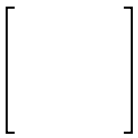
```
$\matrixdiagram[5]{\mdBlank}$
```



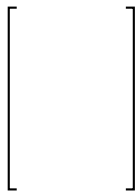
2.2 Aspect ratio (scale = 3)

```
$\matrixdiagram[3][0.5]{
  \mdBlank
}$
```

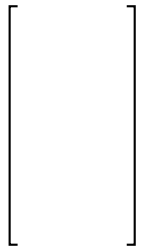
```
$\matrixdiagram[3][1]{
  \mdBlank
}$
```



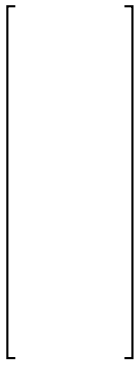
```
$\matrixdiagram[3][1.5]{
  \mdBlank
}$
```



```
$\matrixdiagram[3][2]{
  \mdBlank
}$
```



```
$\matrixdiagram[3][3]{
  \mdBlank
}$
```



2.3 Rounded corners

The corner radius used by every interior drawing (fills, outlines, spikes, ...) can be set two ways. Load the package with `roundedcorners=<dimen>` to round every diagram in the document:

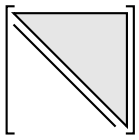
```
\usepackage[roundedcorners=2pt]{matrixdiagrams}
```

or override it for one diagram with the third optional argument to `\matrixdiagram`:

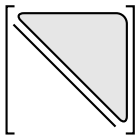
```
\matrixdiagram[scale][aspect][radius]{content}
```

All three must be given positionally, so pass the aspect explicitly even to keep its default. The default, for both the package option and the per-diagram argument, is `0pt`.

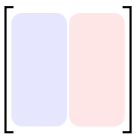
```
$\matrixdiagram[3]{
  \mdHessenberg[gray!20]
}$
```



```
$\matrixdiagram[3][1][4pt]{
  \mdHessenberg[gray!20]
}$
```



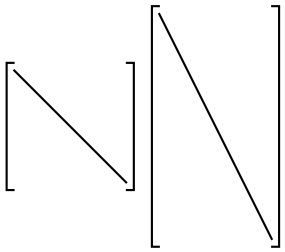
```
$\matrixdiagram[3][1][4pt]{
  \mdFill[blue!10]{0}{0}{0.49}{1}
  \mdFill[red!10]{0.51}{0}{1}{1}
}$
```



3 Diagonal commands

3.1 `\mdDiag` — main diagonal

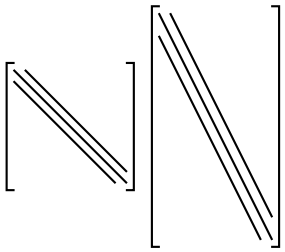
The single diagonal line from $(0, H)$ to $(1, 0)$.



```
$\matrixdiagram[3]{\mdDiag} \matrixdiagram[3][2]{\mdDiag}$
```

3.2 `\mdDiagBand` — tridiagonal band

Three parallel anti-diagonals with spacing $d = 0.1$.



```
$\matrixdiagram[3]{\mdDiagBand} \matrixdiagram[3][2]{\mdDiagBand}$
```

3.3 `\mdDiagBandN{n}` — variable band width

$n = 3, 5, 7, 9$ (spacing fixed at $d = 0.1$ per diagonal); `\mdDiagBandN{3}` is identical to `\mdDiagBand`:

```
$\matrixdiagram[3]{\mdDiagBandN{3}}$
```

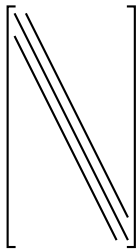
```
$\matrixdiagram[3]{\mdDiagBandN{5}}$
```

```
$\matrixdiagram[3]{\mdDiagBandN{7}}$
```

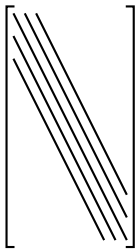
```
$\matrixdiagram[3]{\mdDiagBandN{9}}$
```

With aspect = 2:

```
$\matrixdiagram[3][2]{\mdDiagBandN{3}}$
```



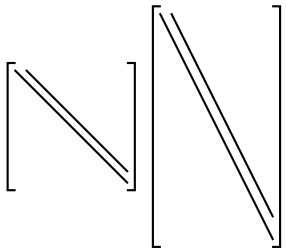
```
$\matrixdiagram[3][2]{\mdDiagBandN{5}}$
```



4 Bidiagonal commands

4.1 `\mdBidiagUpper` — main + super-diagonal

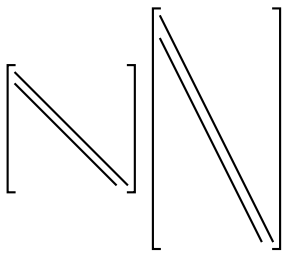
Main diagonal plus a single super-diagonal, offset $d = 0.1$ toward the top-right.



```
$\matrixdiagram[3]{\mdBidiagUpper} \matrixdiagram[3][2]{\mdBidiagUpper}$
```

4.2 `\mdBidiagLower` — main + sub-diagonal

Main diagonal plus a single sub-diagonal, offset $d = 0.1$ toward the bottom-left.

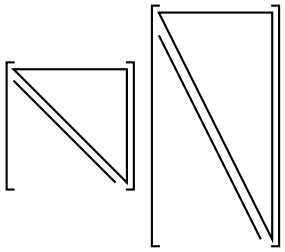


```
$\matrixdiagram[3]{\mdBidiagLower} \matrixdiagram[3][2]{\mdBidiagLower}$
```

5 Hessenberg command

5.1 `\mdHessenberg` — outline only (default)

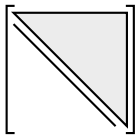
Upper-triangular outline $(0, H) \to (1, H) \to (1, 0)$ plus one sub-diagonal.



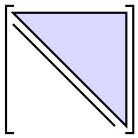
```
$\matrixdiagram[3]{\mdHessenberg} \matrixdiagram[3][2]{\mdHessenberg}$
```

5.2 `\mdHessenberg[color]` — with fill

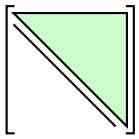
```
$\matrixdiagram[3]{\mdHessenberg[gray!15]}$
```



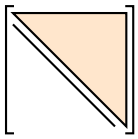
```
$\matrixdiagram[3]{\mdHessenberg[blue!15]}$
```



```
$\matrixdiagram[3]{\mdHessenberg[green!20]}$
```



```
$\matrixdiagram[3]{\mdHessenberg[orange!20]}$
```

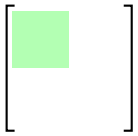


6 Fill and line commands

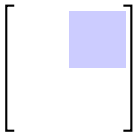
6.1 `\mdFill[color]{x0}{y0}{x1}{y1}`

The default color is `gray!20`:

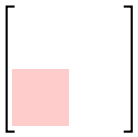
```
$\matrixdiagram[3]{
  \mdFill[green!30]{0}{0.5}{0.5}{1}
}$
```



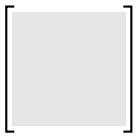
```
$\matrixdiagram[3]{
  \mdFill[blue!20]{0.5}{0.5}{1}{1}
}$
```



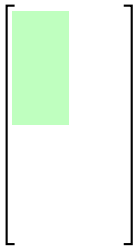
```
$\matrixdiagram[3]{
  \mdFill[red!20]{0}{0}{0.5}{0.5}
}$
```



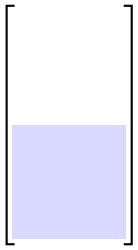
```
$\matrixdiagram[3]{
  \mdFill{0}{0}{1}{1}
}$
```



With aspect $= 2$ (y is still a fraction of the height, in $[0, 1]$):



```
$\matrixdiagram[3][2]{\mdFill[green!25]{0}{0.5}{0.5}{1}}$
```

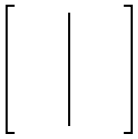


```
$\matrixdiagram[3][2]{\mdFill[blue!15]{0}{0}{1}{0.5}}$
```

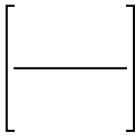
6.2 `\mdVLine{x}` and `\mdHLine{y}`

`\mdVLine{x}` runs the full height at $x \in [0,1]$; `\mdHLine{y}` runs the full width at height $y \in [0,1]$.

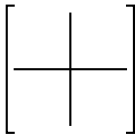
```
$\matrixdiagram[3]{
  \mdVLine{0.5}
}$
```



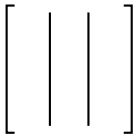
```
$\matrixdiagram[3]{
  \mdHLine{0.5}
}$
```



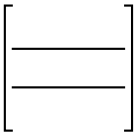
```
$\matrixdiagram[3]{
  \mdVLine{0.5}
  \mdHLine{0.5}
}$
```



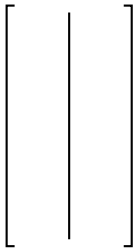
```
$\matrixdiagram[3]{
  \mdVLine{0.33}
  \mdVLine{0.67}
}$
```



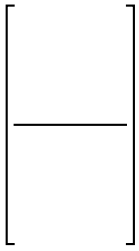
```
$\matrixdiagram[3]{
  \mdHLine{0.33}
  \mdHLine{0.67}
}$
```



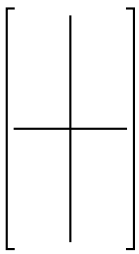
```
$\matrixdiagram[3][2]{
  \mdVLine{0.5}
}$
```



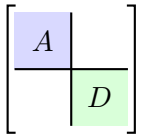
```
$\matrixdiagram[3][2]{
  \mdHLine{0.5}
}$
```



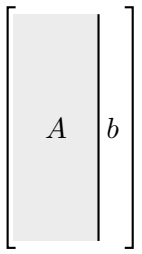
```
$\matrixdiagram[3][2]{
  \mdVLine{0.5}
  \mdHLine{0.5}
}$
```



Combined with fills (block partitioning):




```
$\matrixdiagram[3]{
  \mdFill[blue!15]{0}{0.5}{0.5}{1}
  \mdFill[green!15]{0.5}{0}{1}{0.5}
  \mdVLine{0.5}
  \mdHLine{0.5}
  \mdLabel{0.25}{0.75}{A}
  \mdLabel{0.75}{0.25}{D}
}$
```



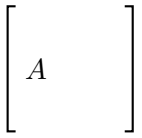

```
$\matrixdiagram[3][2]{
  \mdFill[gray!15]{0}{0}{0.75}{1}
  \mdVLine{0.75}
  \mdLabel{0.375}{0.5}{A}
  \mdLabel{0.875}{0.5}{b}
}$
```

7 Label commands

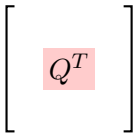
7.1 \mdLabel{x}{y}{text} — math mode

Places `text` in math mode at (x, y); the optional first argument fills the label's background node with that color.

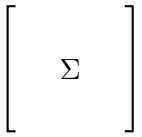
```
$\matrixdiagram[3]{
  \mdLabel{0.2}{0.5}{A}
}$
```



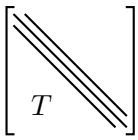

```
$\matrixdiagram[3]{
  \mdLabel[red!20]{0.5}{0.5}{Q^T}
}$
```




```
$\matrixdiagram[3]{
  \mdLabel{0.5}{0.5}{\Sigma}
}$
```




```
$\matrixdiagram[3]{
  \mdDiagBand
  \mdLabel{0.25}{0.2}{T}
}$
```



7.2 \mdLabelCenter{text} — always centered

Automatically placed at $(0.5, H/2)$ regardless of aspect ratio:

```
$\matrixdiagram[3][1]{
  \mdLabelCenter{Q}
}$
```

$$\matrixdiagram[3][1]{\mdLabelCenter{Q}}$$

```
$\matrixdiagram[3][2]{
  \mdLabelCenter{Q}
}$
```

$$\matrixdiagram[3][2]{\mdLabelCenter{Q}}$$

```
$\matrixdiagram[3][3]{
  \mdLabelCenter{Q}
}$
```

$$\matrixdiagram[3][3]{\mdLabelCenter{Q}}$$

```
$\matrixdiagram[3][0.5]{
  \mdLabelCenter{Q}
}$
```

$$\matrixdiagram[3][0.5]{\mdLabelCenter{Q}}$$

7.3 \mdLabelRaw{x}{y}{text} — raw text

Same placement as \mdLabel, but `text` is typeset as-is instead of in math mode — useful for plain words like "dense" or for text that already contains its own `$...$`.

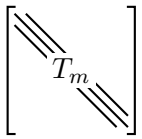
$$\matrixdiagram[3]{\mdLabelRaw{0.5}{0.5}{dense}}\matrixdiagram[3]{\mdLabelRaw{0.5}{0.5}{≈ 0}}$$

```
$\matrixdiagram[3]{
  \mdLabelRaw{0.5}{0.5}{dense}
}
\matrixdiagram[3]{
  \mdLabelRaw{0.5}{0.5}{$\approx 0$}
}$
```

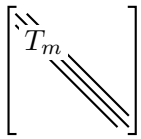
7.4 \mdDiagLabel{text} — on the diagonal

Places `text` in math mode on the main diagonal, at fractional position `pos` $\in [0, 1]$ measured from the top-left corner toward the bottom-right (default 0.5, the midpoint). The optional second argument is a rotation angle in degrees (default 0); the optional third argument fills the label's background node (default `white`), as with \mdLabel. Setting the color to `none` removes all fill, but will have the (likely undesired!) effect of putting the text behind any diagonal lines or content, which does not look good.

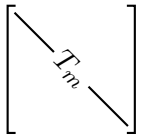
```
$\matrixdiagram[3]{
  \mdDiagBand
  \mdDiagLabel{T_m}
}$
```



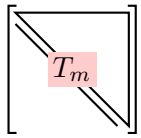

```
$\matrixdiagram[3]{
  \mdDiagBand
  \mdDiagLabel[0.25]{T_m}
}$
```




```
$\matrixdiagram[3]{
  \mdDiag
  \mdDiagLabel[0.5][-45]{T_m}
}$
```



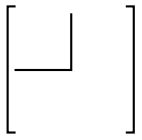

```
$\matrixdiagram[3]{
  \mdHessenberg
  \mdDiagLabel[0.5][0][red!20]{T_m}
}$
```



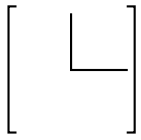
8 Spike commands

`\mdSpike{x}{y}{dir}` draws an L-shaped corner at (x, y). `tl` (top+left), `tr` (top+right), `bl` (bottom+left), `br` (bottom+right). Optionally, add a color fill via `\mdSpike[color]{x}{y}{dir}`.

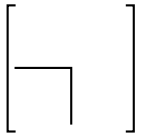
```
$\matrixdiagram[3]{
  \mdSpike{0.5}{0.5}{tl}
}$
```



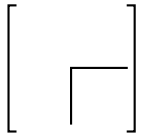
```
$\matrixdiagram[3]{
  \mdSpike{0.5}{0.5}{tr}
}$
```



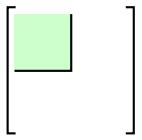
```
$\matrixdiagram[3]{
  \mdSpike{0.5}{0.5}{bl}
}$
```



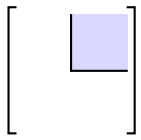
```
$\matrixdiagram[3]{
  \mdSpike{0.5}{0.5}{br}
}$
```



```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
}$
```

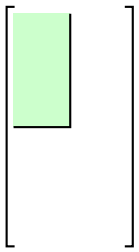


```
$\matrixdiagram[3]{
  \mdFill[blue!15]{0.5}{0.5}{1}{1}
  \mdSpike{0.5}{0.5}{tr}
}$
```

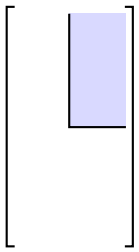


With aspect = 2, corner at mid-height $(0.5, 0.5)$:

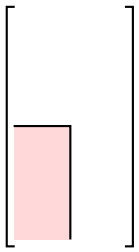
```
$\matrixdiagram[3][2]{
  \mdFill[green
      !20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
}$
```



```
$\matrixdiagram[3][2]{
  \mdFill[blue
      !15]{0.5}{0.5}{1}{1}
  \mdSpike{0.5}{0.5}{tr}
}$
```



```
$\matrixdiagram[3][2]{
  \mdFill[red
      !15]{0}{0}{0.5}{0.5}
  \mdSpike{0.5}{0.5}{bl}
}$
```

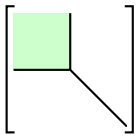


9 Clipped diagonal commands

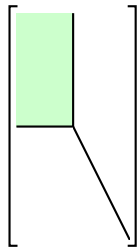
The `...From` variants force the diagonal band from $[x_1, y_1]$ to $[x_2, y_2]$. Always pair with `\mdSpike` at the same corner.

9.1 `\mdDiagFrom{x1}{y1}{x2}{y2}`

```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagFrom{0.5}{0.5}{1}{0}
}$
```

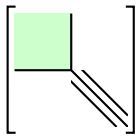


```
$\matrixdiagram[3][2]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagFrom{0.5}{0.5}{1}{0}
}$
```

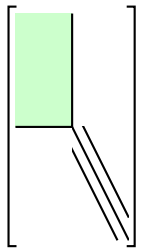


9.2 \mdDiagBandFrom{x1}{y1}{x2}{y2}

```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandFrom{0.5}{0.5}{1}{0}
}$
```



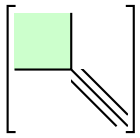
```
$\matrixdiagram[3][2]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandFrom{0.5}{0.5}{1}{0}
}$
```



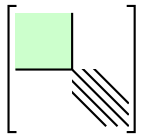
9.3 \mdDiagBandNFrom{n}{x1}{y1}{x2}{y2}

$n = 3, 5, 7$:

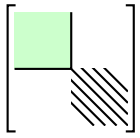
```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandNFrom{3}{0.5}{0.5}{1}{0}
}$
```



```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandNFrom{5}{0.5}{0.5}{1}{0}
}$
```



```
$\matrixdiagram[3]{
  \mdFill[green!20]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandNFrom{7}{0.5}{0.5}{1}{0}
}$
```



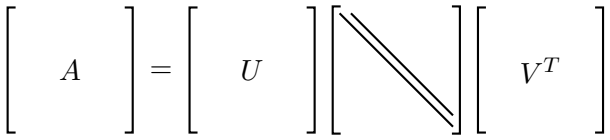
10 Realistic equations

10.1 QR decomposition: $A = QR$

$$\begin{bmatrix} \\ A \\ \\ \end{bmatrix} = \begin{bmatrix} \\ Q \\ \\ \end{bmatrix} \begin{bmatrix} \\ R \\ \\ \end{bmatrix}$$

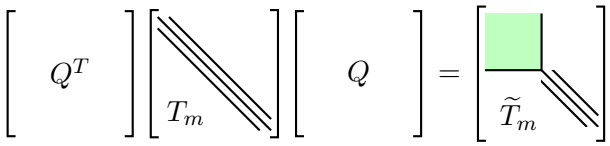
```
$\matrixdiagram[3][2]{\mdLabelCenter{A}}
=
\matrixdiagram[3][2]{\mdLabelCenter{Q}}
\matrixdiagram[3]{\mdLabelCenter{R}}$
```

10.2 Bidiagonalization: $A = UBV^T$



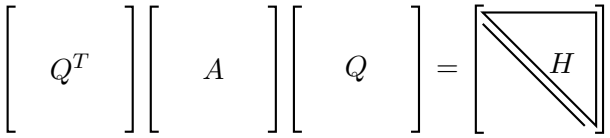

```
$\matrixdiagram[3]{\mdLabelCenter{A}}
=
\matrixdiagram[3]{\mdLabelCenter{U}}
\matrixdiagram[3]{\mdBidiagUpper}
\matrixdiagram[3]{\mdLabelCenter{V^T}}$
```

10.3 Similarity: $Q^T T_m Q = \widetilde{T}_m$



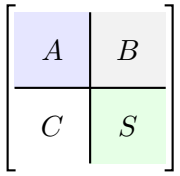

```
$\matrixdiagram[3]{\mdLabelCenter{Q^T}}
\matrixdiagram[3]{
  \mdDiagBand
  \mdLabel{0.25}{0.15}{T_m}
}
\matrixdiagram[3]{\mdLabelCenter{Q}}
=
\matrixdiagram[3]{
  \mdFill[green!25]{0}{0.5}{0.5}{1}
  \mdSpike{0.5}{0.5}{tl}
  \mdDiagBandFrom{0.5}{0.5}{1}{0}
  \mdLabel{0.3}{0.12}{\widetilde{T}_m}
}$
```

10.4 Hessenberg reduction: $Q^T A Q = H$




```
$\matrixdiagram[3]{\mdLabelCenter{Q^T}}
\matrixdiagram[3]{\mdLabelCenter{A}}
\matrixdiagram[3]{\mdLabelCenter{Q}}
=
\matrixdiagram[3]{
  \mdHessenberg
  \mdLabel{0.7}{0.55}{H}
}$
```

10.5 Schur complement structure




```
$\matrixdiagram[4]{
  \mdFill[blue!10]{0}{0.5}{0.5}{1}
  \mdFill[green!10]{0.5}{0}{1}{0.5}
  \mdFill[gray!10]{0.5}{0.5}{1}{1}
  \mdVLine{0.5}
  \mdHLine{0.5}
  \mdLabel{0.25}{0.75}{A}
  \mdLabel{0.75}{0.75}{B}
  \mdLabel{0.25}{0.25}{C}
  \mdLabel{0.75}{0.25}{S}
}$
```

11 Implementation

⟨∗package⟩
```
\RequirePackage{tikz}
\RequirePackage{xparse}
\RequirePackage{calc}
```

```
\RequirePackage{kvoptions}

%% ---------------------------------------------------------------------
%% Package options
%% roundedcorners=<dimen> sets the default corner radius used by every
%% interior drawing (fills, outlines, spikes, etc.); individual diagrams
%% can override it via \matrixdiagram's third optional argument. Default
%% Opt (sharp). Defines \md@roundedcorners.
%% ---------------------------------------------------------------------
\SetupKeyvalOptions{family=matrixdiagrams, prefix=md@}
\DeclareStringOption[0pt]{roundedcorners}
\ProcessKeyvalOptions*

\usetikzlibrary{arrows.meta, bending, matrix, positioning, calc, arrows}

%% ---------------------------------------------------------------------
%% Internal dimensions
%% ---------------------------------------------------------------------
\newdimen\md@bracewidth   % length of the horizontal tick at each bracket corner
\newdimen\md@innersep     % gap between the content and the brackets
\newdimen\md@baseunit     % size of one coordinate unit at scale=1
\newdimen\md@hsep         % margin added left and right of every \matrixdiagram
\md@bracewidth=3pt
\md@innersep=2pt
\md@baseunit=0.5cm
\md@hsep=3pt

%% \md@H: current aspect ratio = y-coordinate of top edge. Default 1.
\def\md@H{1}
%% \mdH: user-facing alias usable inside content arguments
\def\mdH{\md@H}

%% \md@bandstep: spacing between adjacent diagonals in a band, in x-units.
\def\md@bandstep{0.1}

%% ---------------------------------------------------------------------
%% Core drawing macro: \md@draw@box{scale}{aspect}{content}
%% ---------------------------------------------------------------------
\newcommand{\md@draw@box}[4]{%
  \def\md@H{#2}%
  \vcenter{\hbox{%
    \kern\md@hsep
    \tikz[baseline={(MDNODO.base)}]{%
      \node[inner sep=\md@innersep](MDNODO){%
        \tikz[baseline={($(MDcenter)-(0.25em,0.25em)$)},
              x={#1*\md@baseunit}, y={#1*\md@baseunit},
              rounded corners=#3]{%
          \coordinate (MDcenter) at (0.5,{#2*0.5});
          \draw[draw=none] (0,0) rectangle (1,#2);
          #4
        }%
      };
      \draw[thick]
        (MDNODO.north west)+(\md@bracewidth,0)
        -- (MDNODO.north west)
        -- (MDNODO.south west)
```

```
        -- ($(MDNODO.south west)+(\md@bracewidth,0)$);
      \draw[thick]
        (MDNODO.north east)+(-\md@bracewidth,0)
        -- (MDNODO.north east)
        -- (MDNODO.south east)
        -- ($(MDNODO.south east)+(-\md@bracewidth,0)$);
    }%
    \kern\md@hsep
  }}%
}

%% ------------------------------------------------------------------------
%% \matrixdiagram[scale][aspect][radius]{content} | radius, if omitted,
%% falls back to \md@roundedcorners (set by the roundedcorners package option)
%% ------------------------------------------------------------------------
\NewDocumentCommand{\matrixdiagram}{O{1} O{1} o m}{%
  \IfNoValueTF{#3}
    {\md@draw@box{#1}{#2}{\md@roundedcorners}{#4}}
    {\md@draw@box{#1}{#2}{#3}{#4}}%
}

%% ------------------------------------------------------------------------
%% Content commands | all use \md@H for the top edge
%% ------------------------------------------------------------------------

%% \md@superdiag{k} | super-diagonal offset by k*\md@bandstep
\newcommand{\md@superdiag}[1]{%
  \draw[thick] ({#1*\md@bandstep},\md@H) -- (1,{#1*\md@bandstep*\md@H});%
}
%% \md@subdiag{k} | sub-diagonal offset by k*\md@bandstep
\newcommand{\md@subdiag}[1]{%
  \draw[thick] (0,{\md@H-#1*\md@bandstep*\md@H}) -- ({1-#1*\md@bandstep},0);%
}

%% \mdDiagBandN{n} | n-diagonal band (n odd), spacing \md@bandstep between diagonals.
%% n=1 draws only the main diagonal. Max useful n is 9.
\newcommand{\mdDiagBandN}[1]{%
  \draw[thick] (0,\md@H) -- (1,0);%
  \pgfmathtruncatemacro{\md@half}{int((#1-1)/2)}%
  \ifnum\md@half>0
    \foreach \md@k in {1,...,\md@half}{%
      \md@subdiag{\md@k}%
      \md@superdiag{\md@k}%
    }%
  \fi
}

%% \mdDiag | main anti-diagonal (top-left to bottom-right)
\newcommand{\mdDiag}{\mdDiagBandN{1}}
\let\mdIdentity\mdDiag

%% \mdDiagBand | tridiagonal band
\newcommand{\mdDiagBand}{\mdDiagBandN{3}}

%% \mdFill[color]{x0}{y0}{x1}{y1} | y0,y1 are fractions of the height, in [0,1]
\newcommand{\mdFill}[5][gray!20]{%
```

```
  \fill[#1] (#2,{#3*\md@H}) rectangle (#4,{#5*\md@H});%
}

%% \mdLabel[fill]{x}{y}{text} | math-mode label, optional node fill color; y in [0,1]
\newcommand{\mdLabel}[4][none]{%
  \node[fill=#1] at (#2,{#3*\md@H}) {$#4$};%
}

%% \mdLabelRaw[fill]{x}{y}{text} | raw text label, optional node fill color; y in [0,1]
\newcommand{\mdLabelRaw}[4][none]{%
  \node[fill=#1] at (#2,{#3*\md@H}) {#4};%
}

%% \mdLabelCenter{text} | math label at the center (x=0.5, y=H/2)
\newcommand{\mdLabelCenter}[1]{%
  \node at (0.5,{0.5*\md@H}) {$#1$};%
}

%% \mdDiagLabel[pos][angle][fill]{text} | math-mode label on the main
%% diagonal; pos in [0,1] (default 0.5), measured from the top-left corner
%% toward the bottom-right; angle in degrees (default 0); fill is an
%% optional background color (default white)
\NewDocumentCommand{\mdDiagLabel}{O{0.5} O{0} O{white} m}{%
  \node[fill=#3, rotate=#2] at ({#1},{(1-#1)*\md@H}) {$#4$};%
}

%% \mdVLine{x} | full-height vertical line (0 to H)
\newcommand{\mdVLine}[1]{%
  \draw[thick] (#1,0) -- (#1,\md@H);%
}

%% \mdHLine{y} | full-width horizontal line; y is a fraction of the height, in [0,1]
\newcommand{\mdHLine}[1]{%
  \draw[thick] (0,{#1*\md@H}) -- (1,{#1*\md@H});%
}

%% ------------------------------------------------------------------------
%% Clipped diagonal commands
%% Draw diagonal bands clipped to the rectangle (x1,y1)--(x2,y2),
%% where (x1,y1) is the bottom-left corner and (x2,y2) is the top-right.
%%
%% \mdDiagFrom{x1}{y1}{x2}{y2}
%% \mdDiagBandFrom{x1}{y1}{x2}{y2}
%% \mdDiagBandNFrom{n}{x1}{y1}{x2}{y2}
%%   n=1 draws only the main diagonal (no off-diagonals).
%%
%% Typical spike usage | clip to the region outside the block:
%%   \mdSpike{0.5}{0.5}{tl}
%%   \mdDiagBandFrom{0.5}{0}{1}{0.5}    % bottom-left=(0.5,0), top-right=(1,0.5)
%% ------------------------------------------------------------------------

%% \mdDiagBandNFrom{n}{x1}{y1}{x2}{y2} | y1,y2 are fractions of the height, in [0,1]
\newcommand{\mdDiagBandNFrom}[5]{%
  \begin{scope}%
    \clip (#2,{#3*\md@H}) rectangle (#4,{#5*\md@H});%
    \mdDiagBandN{#1}%
```

```
  \end{scope}%
}

%% \mdDiagFrom{x1}{y1}{x2}{y2}
\newcommand{\mdDiagFrom}[4]{\mdDiagBandNFrom{1}{#1}{#2}{#3}{#4}}

%% \mdDiagBandFrom{x1}{y1}{x2}{y2}
\newcommand{\mdDiagBandFrom}[4]{\mdDiagBandNFrom{3}{#1}{#2}{#3}{#4}}

%% ---------------------------------------------------------------------
%% Spike commands | L-shaped block boundary corners
%%   tl: corner at (x,y), arms to top (y=H) and left (x=0)
%%   tr: corner at (x,y), arms to top (y=H) and right (x=1)
%%   bl: corner at (x,y), arms to bottom (y=0) and left (x=0)
%%   br: corner at (x,y), arms to bottom (y=0) and right (x=1)
%% ---------------------------------------------------------------------
\def\md@tl{tl}\def\md@tr{tr}\def\md@bl{bl}\def\md@br{br}

%% \mdSpike{x}{y}{dir} | y is a fraction of the height, in [0,1]
\newcommand{\mdSpike}[3]{%
  \def\md@spikedir{#3}%
  \ifx\md@spikedir\md@tl \draw[thick] (#1,\md@H) -- (#1,{#2*\md@H}) -- (0,{#2*\md@H});%
  \else\ifx\md@spikedir\md@tr \draw[thick] (#1,\md@H) -- (#1,{#2*\md@H}) -- (1,{#2*\md@H});%
  \else\ifx\md@spikedir\md@bl \draw[thick] (#1,0) -- (#1,{#2*\md@H}) -- (0,{#2*\md@H});%
  \else\ifx\md@spikedir\md@br \draw[thick] (#1,0) -- (#1,{#2*\md@H}) -- (1,{#2*\md@H});%
  \fi\fi\fi\fi
}

%% ---------------------------------------------------------------------
%% Bidiagonal commands
%%   upper: main diagonal + one super-diagonal
%%   lower: main diagonal + one sub-diagonal
%% ---------------------------------------------------------------------

%% \mdBidiagUpper | main diagonal + super-diagonal
\newcommand{\mdBidiagUpper}{%
  \draw[thick] (0,\md@H) -- (1,0);%
  \md@superdiag{1}%
}

%% \mdBidiagLower | main diagonal + sub-diagonal
\newcommand{\mdBidiagLower}{%
  \draw[thick] (0,\md@H) -- (1,0);%
  \md@subdiag{1}%
}

%% ---------------------------------------------------------------------
%% Hessenberg command
%% \mdHessenberg[fillcolor]
%%   No argument: outline only (default).
%%   With color argument: filled triangle + outline.
%% ---------------------------------------------------------------------
\newcommand{\mdHessenberg}[1][none]{%
  \def\md@hessarg{#1}\def\md@hessnone{none}%
  \ifx\md@hessarg\md@hessnone
    \draw[thick] (0,\md@H) -- (1,\md@H) -- (1,0) -- cycle;%
```

```
  \else
    \fill[#1] (0,\md@H) -- (1,\md@H) -- (1,0) -- cycle;%
    \draw[thick] (0,\md@H) -- (1,\md@H) -- (1,0) -- cycle;%
  \fi
  \md@subdiag{1}%
}

%% \mdBlank | empty content (brackets only)
\newcommand{\mdBlank}{}
```
⟨/package⟩