Companion software for "Volker Ziemann, *Hands-on Accelerator physics using MATLAB, CRCPress, 2019*" (https://www.crcpress.com/9781138589940)

Point-to-point focusing (Section 3.6.3)

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In this example we verify the iamging equation for a lens $\frac{1}{b}+\frac{1}{g}=\frac{1}{f}$, where b and g are the distance between the source and the image plane and the lens , respectively.

We select $g=1$ m and $b=2$ m and then try to determine the focal length f of the lens that images the start of the `beamline` to its end, which implies that ant ray starting with an angle must cross the optical axis at the end. And this implies that the transfer matrix element that correlates the angle at the start (second index=2) to the position at the end (first index=1), must be zero, or $R_{12}=0$. This is the point-to-point imaging condition.

```
clear all
addpath ./2D
global beamline  % make available in chisq_R12() function
beamline=[1,  1,  1,  0;    % g
          2,  1,  0,  3;    % f
          1,  1,  2,  0]    % b
```

```
beamline = 3×4
     1     1     1     0
     2     1     0     3
     1     1     2     0
```

Having defined the beamline, we employ `fminsearch()` to find a focal length f that makes the R_{12} zero, a constraint that we encode in the function `chisq_R12()` that is defined in the Appendix.

```
f0=3;  % starting guess
[f,fval]=fminsearch(@chisq_R12,f0)
```

```
f = 0.6667
fval = 5.3647e-09
```

Here fminsearch() finds that $f=2/3$m which indeed satisfies the imaging conditions.

Appendix

the function chisq_R12() receives teh focal length f as input and returns the squared R_{12}. Note that beamline(2,4) is the entry where the focal length of the lens is stored.

```
function chisq=chisq_R12(f)
global beamline
beamline(2,4)=f;
[Racc,spos,nmat,nlines]=calcmat(beamline);
chisq=Racc(1,2,end)^2;
end
```