controltheory

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```
library(controltheory)
```

This package helps to treat linear systems in R. Specifically root locus and a time domain simulation (using deSolve) are implemented.

Polynomials are represented as vectors, as done in `base::polyroot` and the `polynom` package. A shorthand for `polynom::polynomial` is defined:

```
p( 1, 2, 3 )

## 1 + 2*x + 3*x^2
```

The root locus of the transfer function:

$$G_1 = N/D = \frac{(5+s)(1+s)}{s(3+s)(2+2s+s^2)} \tag{1}$$

shows where the poles of the closed-loop system, $kG_1/(1+kG_1)$, move as k increases from 0. Specifically, the poles are defined by the roots of the characteristic polynomial which will be called Δ ($\Delta = kN + D$). Points of interest, such as break-points and asymptotes are calculated following `http://lpsa.swarthmore.edu/Root_Locus/RootLocusReviewRules.html`

```
r1 <- rlocus( p(5, 1) *p(1, 1), p() * p(3, 1) * p(2, 2, 1),
             k.expand.f = 2)
lapply(r1, head, 3)

## $poles
##   k.idx pole k.int.idx Im         Re     k    k.int stability
## 1     1    1         1  0 -0.0008334 0.001 [0,14.5]    stable
## 2     1    2         1  1 -0.9994500 0.001 [0,14.5]    stable
## 3     1    3         1 -1 -0.9994500 0.001 [0,14.5]    stable
##
## $asymptotes
##     f pole  Re     Im
## 1 0.0    2 0.5 0.0000
```

```
## 2 0.0    3 0.5 0.0000
## 3 0.1    2 0.5 0.7879
##
## $points
##   type Re         Im
## 1    z -1 -5.457e-15
## 2    z -5  5.457e-15
## 3    p  0  0.000e+00
##
## $ks.stable
## $ks.stable$pp
##         ppInts sign
## 1 (-Inf,-2.34]   -1
## 2 (-2.34,14.5]    1
## 3  (14.5, Inf]   -1
##
## $ks.stable$cuts
## [1]   -Inf -2.343 14.510    Inf
```

```
library(ggplot2)
plot(ggplot( r1$poles, aes(Re, Im)) +
    geom_path(aes(group=interaction(pole, stability),
              col=pole, linetype=stability)) +
    geom_path(data=r1$asymptotes, linetype=3,
              aes(group=pole, col=pole)) +
    geom_point(data=subset(r1$points, type != 'centroid'),
              aes(shape=type))
    )
```

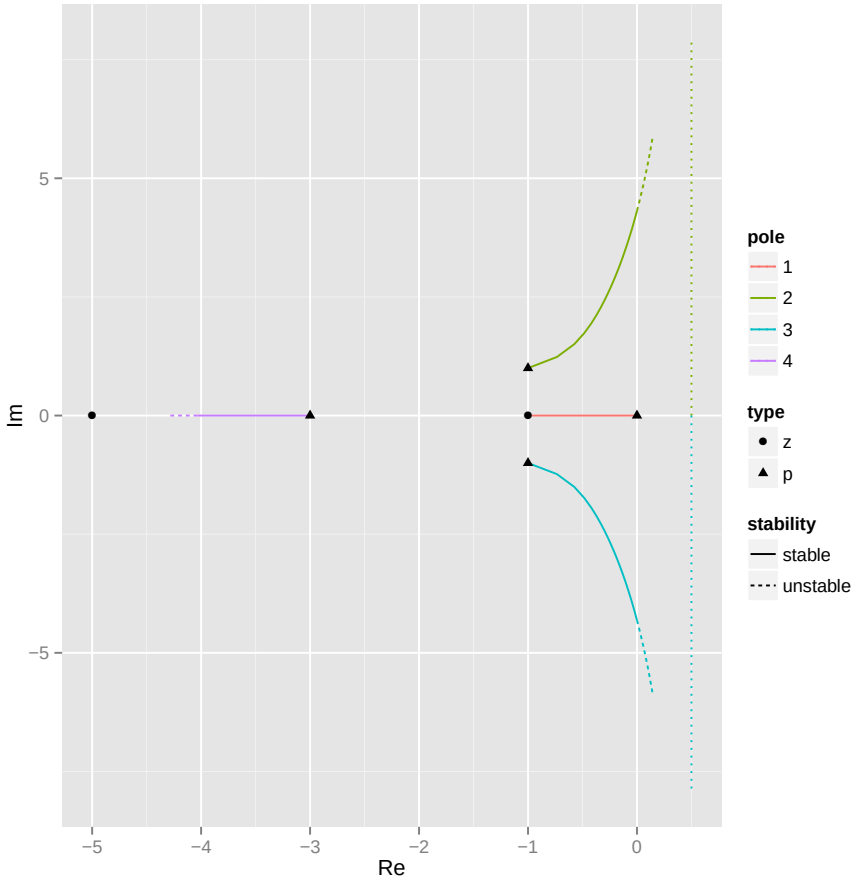

Figure 1: Root locus for equation (1)