moments

Purpose Moments of roots of a polynomial.

Syntax

```
m = moments(p)
```

Description Consider a polynomial $p(s) = a_0 + a_1 s + a_2 s^2 + \ldots + a_n s^n$. Denote $\lambda_1, \lambda_2, \ldots, \lambda_n$ the set of roots of $p(s)$ including multiplicities. Then the k-th moment m_k is defined as

$$m_k = \sum_{i=1}^{n} \lambda_i^k$$

The function **moments** returns a vector $m = \begin{bmatrix} m_1 & m_2 & \cdots & m_n \end{bmatrix}$.

If the polynomial $p(s)$ is monic then the first n moments determine the coefficients of the polynomial uniquely.

Examples

```
>> p = prand(3)
p =
     1.2 - 0.038s + 0.33s^2 + 0.17s^3

>> m = moments(p)
m =
   -1.8741    3.9433   -28.2217
```

Algorithm Solution to the linear system

$$\begin{pmatrix} 1 & 0 & 0 & \cdots & 0 & 0 \\ a_{n-1} & 1 & 0 & \cdots & 0 & 0 \\ a_{n-2} & a_{n-1} & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ a_2 & a_3 & a_4 & \cdots & 1 & 0 \\ a_1 & a_2 & a_3 & \cdots & a_{n-1} & 1 \end{pmatrix} \begin{pmatrix} m_1 \\ m_2 \\ m_3 \\ \vdots \\ m_{n-1} \\ m_n \end{pmatrix} = \begin{pmatrix} -a_{n-1} \\ -2a_{n-2} \\ -3a_{n-3} \\ \vdots \\ -(n-1)a_1 \\ -na_0 \end{pmatrix}$$

where the coefficients a_i were taken from the monic polynomial $\tilde{p}(s) = p(s)/a_n$.

See also

`roots` Roots of a polynomial

References

Horn, R.A., Johnson, C.R.: *Matrix analysis*. Cambridge University Press, 1985, pp.44.