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Conversion of Chebyshev to Power and Power to Chebyshev Series

Subroutine subprograms RCHPWS, RPWCHS and DCHPWS, DPWCHS perform the conversion of a finite Chebyshev series to a finite power series (i.e. a polynomial) and *vice versa*.

Thus, given the coefficients c_j, $(j = 0, 1, \ldots, n)$ of a finite Chebyshev series, RCHPWS and DCHWPS calculate the coefficients a_j, $(j = 0, 1, \ldots, n)$ of the equivalent polynomial:

$$c_0 + c_1T_1(x) + \cdots + c_nT_n(x) \;=\; a_0 + a_1x + \cdots + a_nx^n.$$

Conversely, given the coefficients a_j, $(j = 0, 1, \ldots, n)$ of a power series, RPWCHS and DPWCHS calculate the coefficients c_j, $(j = 0, 1, \ldots, n)$ of the equivalent finite Chebyshev series:

$$a_0 + a_1x + \cdots + a_nx^n \;=\; c_0 + c_1T_1(x) + \cdots + c_nT_n(x).$$

In both cases, $T_j(x)$ is the Chebyshev polynomial of degree j.

Note that sometimes the constant term in the Chebyshev series is defined differently, i.e. $c_0/2$ instead of c_0. Here, the definition of Ref. 1 is used.

On computers other than CDC or Cray, only the double-precision versions DCHPWS and DPWCHS are available. On CDC and Cray computers, only the single-precision versions RCHPWS and RPWCHS are available.

Structure:

SUBROUTINE subprograms
User Entry Names: RCHPWS, RPWCHS, DCHPWS, DPWCHS
Files referenced: Unit 6

Usage:

For t = R (type REAL), t = D (type DOUBLE PRECISION),

```
CALL tCHPWS(N,C,A)
```

N (INTEGER) Degree n of last Chebyshev polynomial in the expansion.

C (type according to t) One-dimensional array of dimension (0:d), where d $\geq$ N. On entry, C must contain the coefficients c_j, $(j = 0, 1, \ldots, n)$ of the Chebyshev expansion.

A (type according to t) One-dimensional array of dimension (0:d), where d $\geq$ N. On exit, A contains the coefficients a_j, $(j = 0, 1, \ldots, n)$ of the power series expansion.

```
CALL tPWCHS(N,A,C)
```

N (INTEGER) Degree n of the polynomial.

A (type according to t) One-dimensional array of dimension (0:d), where 0 $\geq$ N. On entry, A must contain the coefficients a_j, $(j = 0, 1, \ldots, n)$ of the polynomial.

C (type according to t) One-dimensional array of dimension (0:d), where 0 $\geq$ N. On exit, C contains the coefficients c_j, $(j = 0, 1, \ldots, n)$ of the Chebyshev expansion.

Error handling:

Error `E408.1`: $\mathtt{N} < 0$ or $\mathtt{N} > 100$.
A message is written on `Unit 6`, unless subroutine `MTLSET` (N002) has been called.

References:

1. Y.L. Luke, Mathematical functions and their approximations, (Academic Press, New York 1975)

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