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An example: Computing rational recursions from C^2 -finite equations

> with(CodeTools, CPUTime) #to compute the CPU time of computations
[CPUTime] (1)

> with(NLDE, DalgSeq) #the DalgSeq subpackge from NLDE
[DalgSeq] (2)

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The C^2 -finite equation.

The inputs for the linear algebra approach and the Groebner bases approach differ by the presence of the index variable in the C-finite coefficient.

> C2feq1 := c[1](n)·s(n + 1) + c[0](n)·s(n) = 0
C2feq1 := $c_1(n) s(n + 1) + c_0(n) s(n) = 0$ (3)

> C2feq2 := c[1]·s(n + 1) + c[0]·s(n) = 0
C2feq2 := $c_1 s(n + 1) + c_0 s(n) = 0$ (4)

The C-finite equations

> Cfeq1 := c[1](n + 2) = c[1](n + 1) + c[1](n)
Cfeq1 := $c_1(n + 2) = c_1(n + 1) + c_1(n)$ (5)

> Cfeq2 := c[0](n + 2) = c[0](n + 1) + 3·c[0](n)
Cfeq2 := $c_0(n + 2) = c_0(n + 1) + 3 c_0(n)$ (6)

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The Groebner bases approach

> CPUTime(DalgSeq:-CCfiniteToDalg(C2feq2, s(n), [Cfeq1, Cfeq2], [c[1](n), c[0](n)]))
100.781, $s(n + 4) s(n + 3) s(n + 1) s(n) + s(n + 4) s(n + 2)^2 s(n) - 4 s(n + 3)^2 s(n + 2) s(n) - 6 s(n + 4) s(n + 2) s(n + 1)^2 + 3 s(n + 3)^2 s(n + 1)^2 + 9 s(n + 3) s(n + 2)^2 s(n + 1) = 0$ (7)

> solve((7)[2], s(n + 4))
$$\frac{s(n + 3) (3 s(n + 3) s(n + 1)^2 - 4 s(n + 3) s(n) s(n + 2) + 9 s(n + 1) s(n + 2)^2)}{s(n + 3) s(n + 1) s(n) + s(n) s(n + 2)^2 - 6 s(n + 1)^2 s(n + 2)}$$
 (8)

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The linear algebra approach

> CPUTime(DalgSeq:-CCfiniteToSimpleRatrec(C2feq1, s(n), [Cfeq1, Cfeq2], [c[1](n),
 c[0](n)]))
 0.187, s(n + 4) =

$$\frac{s(n+3) (3s(n+3)s(n+1)^2 - 4s(n+3)s(n)s(n+2) + 9s(n+1)s(n+2)^2)}{s(n+3)s(n+1)s(n) + s(n)s(n+2)^2 - 6s(n+1)^2s(n+2)}$$

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(9)