

```
> restart
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Computations of examples from the paper:

On Rational Recursion for Holonomic Sequences (Examples 1-4)

Bertrand Teguia Tabuguia and James Worrell
Department of Computer Science, University of Oxford

The algorithm is implemented as a command of the **NLDE** package, available at
<https://github.com/T3gu1a/D-algebraic-functions>

```
> with(NLDE, HoloToSimpleRatrec)
```

```
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```

▼ **Example 1:**

Catalan numbers $\left(\frac{1}{n+1} \binom{2n}{n} \right)_n$

```
> p := (n + 2) · s(n + 1) − (4 · n + 2) · s(n)
```

```
> HoloToSimpleRatrec(p, s(n))
```

$((-1)^n + n)_n$

```
> p := (−2 n − 3) s(n) − 2 s(n + 1) + (2 n + 1) s(n + 2)
```

```
> HoloToSimpleRatrec(p, s(n))
```

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▼ **Example 2**

$(n!^2)_n$

```
> p := s(n + 1) − (n + 1)2 · s(n)
```

```
[> HoloToSimpleRatrec(p, s(n))
[>
[>
```

▼ Example 3

```
[
  (n!)^3_n
[
  > p1 := s(n + 1) - (n + 1)^3 · s(n)
  > HoloToSimpleRatrec(p1, s(n), method = GB)
[
  (n^2 + sin(n·π/4))^2_n
[
  > p2 := (-2·n^2 - 8·n - 11)·s(n) + (2·n^2 + 4·n + 5)·s(n + 1) + (-2·n^2 - 8
    ·n - 11)·s(n + 2) + (2·n^2 + 4·n + 5)·s(n + 3) = 0
  > HoloToSimpleRatrec(p2, s(n), method = GB)
[
  >
[
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```

▼ Example 4

```
[
  ((2·n choose n) · (3·n choose n))_n
[
  > p3 := s(n + 1) · (n + 1)^2 - 3 · (3·n + 1) · (3·n + 2) · s(n)
  > HoloToSimpleRatrec(p3, s(n), method = LA)
[
  (n^4/2^n + 3^n)_n
[
  > p4 := (15 n^4 + 48 n^3 + 36 n^2 - 24 n - 30) s(n) - (7 n^2 + 4 n + 4) (5 n^2 - 4 n - 4) s(n
    + 1) + (10 n^4 - 8 n^3 - 12 n^2 - 8 n - 2) s(n + 2)
  > HoloToSimpleRatrec(p4, s(n), method = LA)
[
  Random polynomial (not necessarily the same as in the paper).
[
  > p5 := s(n) + randpoly(n, degree = 5)
  > HoloToSimpleRatrec(p5, s(n), method = LA)
[
  >
[
  >
```

Other examples

$$(n!)^4_n$$

```
> p := s(n + 1) + (n + 1)^4 · s(n)
> HoloToSimpleRatrec(p, s(n)) #LA method by default
> HoloToSimpleRatrec(p, s(n), method = GB)
```

We use the **HolonomicRE** command of **HyperTypeSeq** to find recurrence equations from general terms. The package is available at

<https://github.com/T3gula/HyperTypeSeq>

$$(n!^2 + n!)_n$$

```
> p := HyperTypeSeq:-HolonomicRE(n!^2 + n!, s(n))
> HoloToSimpleRatrec(p, s(n)) #LA method by default
> HoloToSimpleRatrec(p, s(n), method = GB)
```

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