

\$SPAD/src/input pdecomp0.as

The Axiom Team

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**Abstract**

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# 1 License

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— \* —

```
#pile
#include "axiom.as"

--% Polynomial composition and decomposition functions
-- If  $f = g \circ h$  then  $g = \text{leftFactor}(f, h)$  &  $h = \text{rightFactor}(f, g)$ 
-- SMW Dec 86

--% PolynomialComposition
--)abbrev package PCOMP PolynomialComposition
--)abbrev package PDECOMP PolynomialDecomposition

PolynomialComposition(UP: UnivariatePolynomialCategory(R), R: Ring): with
  compose: (UP, UP) -> UP
```

```

== add
    compose(g:UP, h:UP):UP ==
        r: UP := 0
        while g ~= 0 repeat
            r := leadingCoefficient(g)*h**degree(g) + r
            g := reductum g
        r

-- Ref: Kozen and Landau, Cornell University TR 86-773

--% PolynomialDecomposition

PolynomialDecomposition(UP:UPC F, F:Field): PDcat == PDdef where
    UPC ==> UnivariatePolynomialCategory
    NNI ==> NonNegativeInteger
    LR ==> Record(left: UP, right: UP)

PDcat ==> with
    decompose: UP -> List UP
    decompose: (UP, NNI, NNI) -> Union(value1:LR, failed:'failed')
    leftFactor: (UP, UP) -> Union(value1:UP, failed:'failed')
    rightFactorCandidate: (UP, NNI) -> UP
PDdef ==> add

    import from F
    import from LR
    import from Union(value1:UP, failed:'failed')
    import from Float
    import from NNI
    import from UniversalSegment NNI
    import from Record(quotient:UP, remainder:UP);

    leftFactor(f:UP, h:UP):Union(value1:UP, failed:'failed') ==
        g: UP := 0
        for i in 0.. while f ~= 0 repeat
            fr := divide(f, h)
            f := fr.quotient
            r := fr.remainder
            degree r > 0 => return [failed]
            g := g + r * monomial(1, i)
        [g]

    decompose(f:UP, dg:NNI, dh:NNI):Union(value1:LR, failed:'failed') ==
        df := degree f
        dg*dh ~= df => [failed]
        h := rightFactorCandidate(f, dh)
        g:Union(value1:UP, failed:'failed') := leftFactor(f, h)

```

```

g case failed => [failed]
[[g.value1, h]]

decompose(f:UP):List UP ==
  df := degree f
  for dh in 2..df-1 | df rem dh = 0 repeat
    h := rightFactorCandidate(f, dh)
    g := leftFactor(f, h)
    g case value1 => return
      append(decompose(g.value1), decompose h)
  [f]

rightFactorCandidate(f:UP, dh:NNI):UP ==
  f := f / leadingCoefficient f
  df := degree f
  dg := df quo dh
  h := monomial(1, dh)
  for k in 1..dh repeat
    hdg:= h**dg
    c := (coefficient(f,df-k)-coefficient(hdg,df-k))/
      (dg::Integer::F)
    h := h + monomial(c, dh-k)
  h - monomial(coefficient(h, 0), 0) -- drop constant term

```

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## References

- [1] nothing