```
>> AutoRegression

sys_1 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.982 z^-1 + 0.9831 z^-2

  B1(z) = 482.6 + 3.679 z^-1 - 235.1 z^-2 - 45.21 z^-3 - 122.2 z^-4 - 64.22 z^-5

  B2(z) = 783 - 432.3 z^-1 + 221.4 z^-2 - 206.4 z^-3 - 50.44 z^-4 - 200.9 z^-5

  B3(z) = 0.1799

  B4(z) = 239 - 153.4 z^-1 - 107.2 z^-2

  B5(z) = 0

  B6(z) = 0

  B7(z) = 874.4

  B8(z) = 0

  B9(z) = 0

  B10(z) = 0

  B11(z) = 0

  B12(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[6 6 1 3 0 0 1 0 0 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1 1 1]
   Number of free coefficients: 19
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 99.91% (prediction focus)
FPE: 5.867e-05, MSE: 5.724e-05

fig =

  Figure (1) with properties:

      Number: 1
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'

  Show all properties
```

```
Goodness of fit for Linear ARX Regression: 93.766404%, Root Mean Square Error for↙
Linear ARX Regression: 2.264471,
sys_12i_1o_l =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.982 z^-1 + 0.9831 z^-2

  B1(z) = 482.6 + 3.679 z^-1 - 235.1 z^-2 - 45.21 z^-3 - 122.2 z^-4 - 64.22 z^-5

  B2(z) = 783 - 432.3 z^-1 + 221.4 z^-2 - 206.4 z^-3 - 50.44 z^-4 - 200.9 z^-5

  B3(z) = 0.1799

  B4(z) = 239 - 153.4 z^-1 - 107.2 z^-2

  B5(z) = 0

  B6(z) = 0

  B7(z) = 874.4

  B8(z) = 0

  B9(z) = 0

  B10(z) = 0

  B11(z) = 0

  B12(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[6 6 1 3 0 0 1 0 0 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1 1 1]
   Number of free coefficients: 19
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 99.91% (prediction focus)
FPE: 5.867e-05, MSE: 5.724e-05

fit_Bay_12i_1o_l =

   93.7664


RMSE_arx_12i_1o_l =

    2.2645

    "Ran 12i 1o linear"
```

```
sys_1 =
Discrete-time ARX model:
  Model for output "y1": A(z)y_1(t) = - A_i(z)y_i(t) + B(z)u(t) + e_1(t)
    A(z) = 1 - 1.984 z^-1 + 0.9854 z^-2

    A_2(z) = 0.001668 z^-1 - 0.001552 z^-2

    B1(z) = 22.74 - 5.581 z^-1 - 28.92 z^-2 + 85.32 z^-3 + 27.63 z^-4 - 83.86 z^-5

    B2(z) = 101.7 - 152.4 z^-1 + 65.21 z^-2 - 171.3 z^-3 + 97.64 z^-4 + 38.55 z^-5

    B3(z) = 11.68

    B4(z) = 90.81 - 41.18 z^-1 - 35.43 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 24.26

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

    B11(z) = 0

    B12(z) = 0

  Model for output "y2": A(z)y_2(t) = - A_i(z)y_i(t) + B(z)u(t) + e_2(t)
    A(z) = 1 - 1.982 z^-1 + 0.9828 z^-2

    A_1(z) = 0.01306 z^-1 - 0.01219 z^-2

    B1(z) = 457.7 + 8.047 z^-1 - 238.2 z^-2 - 39.65 z^-3 - 122.2 z^-4 - 33.4 z^-5

    B2(z) = 805.8 - 434.9 z^-1 + 223.1 z^-2 - 214.3 z^-3 - 52.65 z^-4 - 237.6 z^-5

    B3(z) = 9.975

    B4(z) = 246.6 - 153.3 z^-1 - 94.44 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 806.9

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0
```

```
    B11(z) = 0

    B12(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[2 2;2 2]
   nb=[6 6 1 3 0 0 1 0 0 0 0 0;6 6 1 3 0 0 1 0 0 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1 1 1;0 0 0 0 1 1 0 1 1 1 1 1]
   Number of free coefficients: 42
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [99.82;99.92]% (prediction focus)
FPE: 3.64e-10, MSE: 6.318e-05

fig =

  Figure (2) with properties:

      Number: 2
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'

  Show all properties

Goodness of fit for Linear ARX Regression: 97.145486%, 244.923170%
Root Mean Square Error for Linear ARX Regression: 0.693857, 16.015950

sys_12i_2o =
Discrete-time ARX model:
  Model for output "y1": A(z)y_1(t) = - A_i(z)y_i(t) + B(z)u(t) + e_1(t)
    A(z) = 1 - 1.984 z^-1 + 0.9854 z^-2

    A_2(z) = 0.001668 z^-1 - 0.001552 z^-2

    B1(z) = 22.74 - 5.581 z^-1 - 28.92 z^-2 + 85.32 z^-3 + 27.63 z^-4 - 83.86 z^-5

    B2(z) = 101.7 - 152.4 z^-1 + 65.21 z^-2 - 171.3 z^-3 + 97.64 z^-4 + 38.55 z^-5

    B3(z) = 11.68

    B4(z) = 90.81 - 41.18 z^-1 - 35.43 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 24.26
```

```
    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

    B11(z) = 0

    B12(z) = 0

  Model for output "y2": A(z)y_2(t) = - A_i(z)y_i(t) + B(z)u(t) + e_2(t)
    A(z) = 1 - 1.982 z^-1 + 0.9828 z^-2

    A_1(z) = 0.01306 z^-1 - 0.01219 z^-2

    B1(z) = 457.7 + 8.047 z^-1 - 238.2 z^-2 - 39.65 z^-3 - 122.2 z^-4 - 33.4 z^-5

    B2(z) = 805.8 - 434.9 z^-1 + 223.1 z^-2 - 214.3 z^-3 - 52.65 z^-4 - 237.6 z^-5

    B3(z) = 9.975

    B4(z) = 246.6 - 153.3 z^-1 - 94.44 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 806.9

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

    B11(z) = 0

    B12(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[2 2;2 2]
   nb=[6 6 1 3 0 0 1 0 0 0 0 0;6 6 1 3 0 0 1 0 0 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1 1 1;0 0 0 0 1 1 0 1 1 1 1 1]
   Number of free coefficients: 42
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [99.82;99.92]% (prediction focus)
FPE: 3.64e-10, MSE: 6.318e-05

fit_Bay_12i_2o_1 =
```

```
   97.1455  244.9232


RMSE_arx_12i_2o_1 =

    0.6939   16.0159

    "Ran 12i 2o linear"


sys_1 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.982 z^-1 + 0.9831 z^-2

  B1(z) = 482.6 + 3.679 z^-1 - 235.1 z^-2 - 45.21 z^-3 - 122.2 z^-4 - 64.22 z^-5

  B2(z) = 783 - 432.3 z^-1 + 221.4 z^-2 - 206.4 z^-3 - 50.44 z^-4 - 200.9 z^-5

  B3(z) = 0.1799

  B4(z) = 239 - 153.4 z^-1 - 107.2 z^-2

  B5(z) = 0

  B6(z) = 0

  B7(z) = 874.4

  B8(z) = 0

  B9(z) = 0

  B10(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[6 6 1 3 0 0 1 0 0 0]   nk=[0 0 0 0 1 1 0 1 1 1]
   Number of free coefficients: 19
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 99.91% (prediction focus)
FPE: 5.867e-05, MSE: 5.724e-05

fig =

  Figure (3) with properties:

      Number: 3
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'
```

```
  Show all properties

Goodness of fit for Linear ARX Regression: 93.766404%, Root Mean Square Error for
Linear ARX Regression: 2.264471,
sys_10i_1o_l =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.982 z^-1 + 0.9831 z^-2

  B1(z) = 482.6 + 3.679 z^-1 - 235.1 z^-2 - 45.21 z^-3 - 122.2 z^-4 - 64.22 z^-5

  B2(z) = 783 - 432.3 z^-1 + 221.4 z^-2 - 206.4 z^-3 - 50.44 z^-4 - 200.9 z^-5

  B3(z) = 0.1799

  B4(z) = 239 - 153.4 z^-1 - 107.2 z^-2

  B5(z) = 0

  B6(z) = 0

  B7(z) = 874.4

  B8(z) = 0

  B9(z) = 0

  B10(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[6 6 1 3 0 0 1 0 0 0]   nk=[0 0 0 0 1 1 0 1 1 1]
   Number of free coefficients: 19
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 99.91% (prediction focus)
FPE: 5.867e-05, MSE: 5.724e-05

fit_Bay_10i_1o_l =

   93.7664


RMSE_arx_10i_1o_l =

    2.2645

    "Ran 10i 1o linear"


sys_1 =
Discrete-time ARX model:
```

```
  Model for output "y1": A(z)y_1(t) = - A_i(z)y_i(t) + B(z)u(t) + e_1(t)
    A(z) = 1 - 1.984 z^-1 + 0.9854 z^-2

    A_2(z) = 0.001668 z^-1 - 0.001552 z^-2

    B1(z) = 22.74 - 5.581 z^-1 - 28.92 z^-2 + 85.32 z^-3 + 27.63 z^-4 - 83.86 z^-5

    B2(z) = 101.7 - 152.4 z^-1 + 65.21 z^-2 - 171.3 z^-3 + 97.64 z^-4 + 38.55 z^-5

    B3(z) = 11.68

    B4(z) = 90.81 - 41.18 z^-1 - 35.43 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 24.26

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

  Model for output "y2": A(z)y_2(t) = - A_i(z)y_i(t) + B(z)u(t) + e_2(t)
    A(z) = 1 - 1.982 z^-1 + 0.9828 z^-2

    A_1(z) = 0.01306 z^-1 - 0.01219 z^-2

    B1(z) = 457.7 + 8.047 z^-1 - 238.2 z^-2 - 39.65 z^-3 - 122.2 z^-4 - 33.4 z^-5

    B2(z) = 805.8 - 434.9 z^-1 + 223.1 z^-2 - 214.3 z^-3 - 52.65 z^-4 - 237.6 z^-5

    B3(z) = 9.975

    B4(z) = 246.6 - 153.3 z^-1 - 94.44 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 806.9

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[2 2;2 2]   nb=[6 6 1 3 0 0 1 0 0 0;6 6 1 3 0 0 1 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1;0 0 0 0 1 1 0 1 1 1]
```

```
   Number of free coefficients: 42
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [99.82;99.92]% (prediction focus)
FPE: 3.64e-10, MSE: 6.318e-05

fig =

  Figure (4) with properties:

      Number: 4
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'

  Show all properties

Goodness of fit for Linear ARX Regression: 97.145486%, 244.923170%
Root Mean Square Error for Linear ARX Regression: 0.693857, 16.015950

sys_10i_2o =
Discrete-time ARX model:
  Model for output "y1": A(z)y_1(t) = - A_i(z)y_i(t) + B(z)u(t) + e_1(t)
    A(z) = 1 - 1.984 z^-1 + 0.9854 z^-2

    A_2(z) = 0.001668 z^-1 - 0.001552 z^-2

    B1(z) = 22.74 - 5.581 z^-1 - 28.92 z^-2 + 85.32 z^-3 + 27.63 z^-4 - 83.86 z^-5

    B2(z) = 101.7 - 152.4 z^-1 + 65.21 z^-2 - 171.3 z^-3 + 97.64 z^-4 + 38.55 z^-5

    B3(z) = 11.68

    B4(z) = 90.81 - 41.18 z^-1 - 35.43 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 24.26

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

  Model for output "y2": A(z)y_2(t) = - A_i(z)y_i(t) + B(z)u(t) + e_2(t)
    A(z) = 1 - 1.982 z^-1 + 0.9828 z^-2

    A_1(z) = 0.01306 z^-1 - 0.01219 z^-2
```

```
    B1(z) = 457.7 + 8.047 z^-1 - 238.2 z^-2 - 39.65 z^-3 - 122.2 z^-4 - 33.4 z^-5

    B2(z) = 805.8 - 434.9 z^-1 + 223.1 z^-2 - 214.3 z^-3 - 52.65 z^-4 - 237.6 z^-5

    B3(z) = 9.975

    B4(z) = 246.6 - 153.3 z^-1 - 94.44 z^-2

    B5(z) = 0

    B6(z) = 0

    B7(z) = 806.9

    B8(z) = 0

    B9(z) = 0

    B10(z) = 0

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[2 2;2 2]   nb=[6 6 1 3 0 0 1 0 0 0;6 6 1 3 0 0 1 0 0 0]
   nk=[0 0 0 0 1 1 0 1 1 1;0 0 0 0 1 1 0 1 1 1]
   Number of free coefficients: 42
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [99.82;99.92]% (prediction focus)
FPE: 3.64e-10, MSE: 6.318e-05

fit_Bay_10i_2o_l =

   97.1455  244.9232


RMSE_arx_10i_2o_l =

    0.6939   16.0159

    "Ran 10i 2o linear"


sys_1 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.009 z^-1

  B1(z) = 2.328e05 + 4551 z^-1 - 2.081e05 z^-2


  B2(z) = 2.478e04 - 5022 z^-1 + 7026 z^-2 + 5875 z^-3 + 928.3 z^-4 - 3782 z^-5 - 2410↙
z^-6
                                                    - 5023 z^-7 + 6189 z^-8 - 3.758e04↙
```

```
z^-9

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=1   nb=[3 10]   nk=[0 0]
   Number of free coefficients: 14
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 98.79% (prediction focus)
FPE: 0.01182, MSE: 0.01155

fig =

  Figure (5) with properties:

      Number: 5
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'

  Show all properties

Goodness of fit for Linear ARX Regression: 69.689918%, Root Mean Square Error for↙
Linear ARX Regression: 3.863726,
sys_2i_1o_l =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.009 z^-1

  B1(z) = 2.328e05 + 4551 z^-1 - 2.081e05 z^-2


  B2(z) = 2.478e04 - 5022 z^-1 + 7026 z^-2 + 5875 z^-3 + 928.3 z^-4 - 3782 z^-5 - 2410↙
z^-6
                                                    - 5023 z^-7 + 6189 z^-8 - 3.758e04↙
z^-9

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=1   nb=[3 10]   nk=[0 0]
   Number of free coefficients: 14
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: 98.79% (prediction focus)
FPE: 0.01182, MSE: 0.01155

fit_Bay_2i_1o_l =

   69.6899
```

```
RMSE_arx_2i_1o_1 =

    3.8637

    "Ran 2i 1o linear"


sys_1 =
Discrete-time ARX model:
  Model for output "y1": A(z)y_1(t) = B(z)u(t) + e_1(t)
    A(z) = 1 - 0.9963 z^-1

    B1(z) = 3.849e04 + 4129 z^-1 - 4.699e04 z^-2


    B2(z) = 6049 - 1708 z^-1 + 1464 z^-2 + 1114 z^-3 + 227.6 z^-4 - 677.8 z^-5 - 434↙
z^-6
                                                          - 647.7 z^-7 + 417 z^-8 - 4943↙
z^-9

  Model for output "y2": A(z)y_2(t) = B(z)u(t) + e_2(t)

    A(z) = 1 - 2.391 z^-1 + 1.633 z^-2 - 0.1295 z^-3 - 0.06294 z^-4 - 0.07809 z^-5 -↙
0.001854 z^-6
                                                                + 0.08386 z^-7 - 0.05289↙
z^-8

    B1(z) = 865.7

    B2(z) = 184.9 z^-1 - 117.9 z^-2 - 1.369 z^-3 - 244.2 z^-4 + 237.5 z^-5 - 138.9 z^-↙
6

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[1 0;0 8]   nb=[3 10;1 6]   nk=[0 0;0 1]
   Number of free coefficients: 29
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [98.42;99.93]% (prediction focus)
FPE: 2.019e-08, MSE: 0.0004953

fig =

  Figure (6) with properties:

      Number: 6
        Name: ''
       Color: [0.9400 0.9400 0.9400]
    Position: [403 246 560 420]
       Units: 'pixels'
```

```
  Show all properties

Goodness of fit for Linear ARX Regression: 58.126655%, 244.923170%
Root Mean Square Error for Linear ARX Regression: 0.643100, 16.015950

sys_2i_2o =
Discrete-time ARX model:
  Model for output "y1": A(z)y_1(t) = B(z)u(t) + e_1(t)
    A(z) = 1 - 0.9963 z^-1

    B1(z) = 3.849e04 + 4129 z^-1 - 4.699e04 z^-2


    B2(z) = 6049 - 1708 z^-1 + 1464 z^-2 + 1114 z^-3 + 227.6 z^-4 - 677.8 z^-5 - 434↙
z^-6
                                                          - 647.7 z^-7 + 417 z^-8 - 4943↙
z^-9

  Model for output "y2": A(z)y_2(t) = B(z)u(t) + e_2(t)

    A(z) = 1 - 2.391 z^-1 + 1.633 z^-2 - 0.1295 z^-3 - 0.06294 z^-4 - 0.07809 z^-5 -↙
0.001854 z^-6
                                                               + 0.08386 z^-7 - 0.05289↙
z^-8

    B1(z) = 865.7

    B2(z) = 184.9 z^-1 - 117.9 z^-2 - 1.369 z^-3 - 244.2 z^-4 + 237.5 z^-5 - 138.9 z^-↙
6

Sample time: 0.01 seconds

Parameterization:
   Polynomial orders:   na=[1 0;0 8]   nb=[3 10;1 6]   nk=[0 0;0 1]
   Number of free coefficients: 29
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "Di".
Fit to estimation data: [98.42;99.93]% (prediction focus)
FPE: 2.019e-08, MSE: 0.0004953

fit_Bay_2i_2o_1 =

   58.1267  244.9232


RMSE_arx_2i_2o_1 =

    0.6431   16.0159

    "Ran 2i 2o linear"

Error using nlarx (line 290)
```

```
A nonlinearity estimator must be specified in the "nlarx" command. Use 'linear' to↙
denote absence of
nonlinearity.

Error in nonlinear_arx (line 8)
                    sys_2=nlarx(Di, "na", 2, "nb", [6 1 1 0 0 0 1 0 0 0 0 0], "nk", [0↙
0 0 1 1 1 0 1
                    1 1 1 1])

Error in AutoRegression (line 39)
[sys_12i_1o_nl,fit_Bay_12i_1o_nl,RMSE_nlarx_12i_1o_nl]=nonlinear_arx(Di_12i_1o)

IdleTimeout has been reached.
Parallel pool using the 'local' profile is shutting down.
>>
```