In[211]:=

```
fTable = {0.443179 0.469718 0.509651 0.523462 0.551931 0.551792 0.566707 0.551781 0.551341
```

Out[211]=

```
{{0.443179, 0.469718, 0.509651, 0.523462, 0.551931, 0.551792,
  0.566707, 0.551781, 0.551341, 0.521204, 0.503945, 0.458602, 0.42344,
  0.363326, 0.309594, 0.235574, 0.163046, 0.0764054, -0.014687, -0.112269,
  -0.221226, -0.327705, -0.45336, -0.566363, -0.707094, -0.823971}}
```

In[212]:=

```
a = 0.5; h = 0.06;
```

In[213]:=

```
data = N[Table[{a + i * h, fTable[[1, i + 1]]}, {i, 0, 25}]]
```

таблица значений

Out[213]=

```
{{0.5, 0.443179}, {0.56, 0.469718}, {0.62, 0.509651}, {0.68, 0.523462}, {0.74, 0.551931},
 {0.8, 0.551792}, {0.86, 0.566707}, {0.92, 0.551781}, {0.98, 0.551341},
 {1.04, 0.521204}, {1.1, 0.503945}, {1.16, 0.458602}, {1.22, 0.42344}, {1.28, 0.363326},
 {1.34, 0.309594}, {1.4, 0.235574}, {1.46, 0.163046}, {1.52, 0.0764054},
 {1.58, -0.014687}, {1.64, -0.112269}, {1.7, -0.221226}, {1.76, -0.327705},
 {1.82, -0.45336}, {1.88, -0.566363}, {1.94, -0.707094}, {2., -0.823971}}
```

In[214]:=

```
Q[x_] = Fit[data, {1, x, x^2, x^3, x^4, x^5}, x]
```

согласовать

Out[214]=

$$0.0125369 + 0.972187\,x + 0.00802146\,x^2 - 0.494995\,x^3 + 0.0131918\,x^4 + 0.0291203\,x^5$$

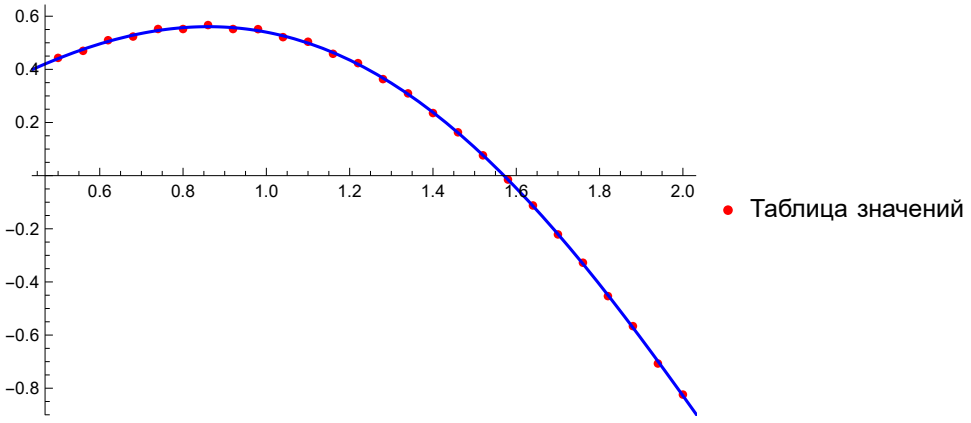
In[215]:=

```
Show[ListPlot[data, PlotStyle → Red, PlotLegends → {"Таблица значений"}],
 Plot[Q[x], {x, 0.5 - h, 2 + h}, PlotStyle → Blue]]
```

лок… диаграмма разбр… стиль графика кра… легенды графика

график функции стиль графика синий

Out[215]=



In[216]:=
```
(*Задание 1*)
data1 = data;
data2 = N[Table[{a + i * 2 * h, fTable[[1, 2 * i + 1]]}, {i, 0, 12}]]
```
таблица значений

Out[217]=
```
{{0.5, 0.443179}, {0.62, 0.509651}, {0.74, 0.551931}, {0.86, 0.566707}, {0.98, 0.551341},
 {1.1, 0.503945}, {1.22, 0.42344}, {1.34, 0.309594}, {1.46, 0.163046},
 {1.58, -0.014687}, {1.7, -0.221226}, {1.82, -0.45336}, {1.94, -0.707094}}
```

In[218]:=
```
data3 = N[Table[{a + i * 3 * h, fTable[[1, 3 * i + 1]]}, {i, 0, 8}]]
```
таблица значений

Out[218]=
```
{{0.5, 0.443179}, {0.68, 0.523462}, {0.86, 0.566707}, {1.04, 0.521204}, {1.22, 0.42344},
 {1.4, 0.235574}, {1.58, -0.014687}, {1.76, -0.327705}, {1.94, -0.707094}}
```

In[219]:=
```
data4 = N[Table[{a + i * 5 * h, fTable[[1, 5 * i + 1]]}, {i, 0, 5}]]
```
таблица значений

Out[219]=
```
{{0.5, 0.443179}, {0.8, 0.551792}, {1.1, 0.503945},
 {1.4, 0.235574}, {1.7, -0.221226}, {2., -0.823971}}
```

In[220]:=

In[221]:=

In[222]:=
```
(*12 степень*)
```

In[223]:=
```
Clear[Np]
```
очистить

In[224]:=
```
Np[x_] = InterpolatingPolynomial[data2, x]
```
интерполяционный многочлен

Out[224]=
$$-0.707094 + \left(-0.798801 + \left(-1.07137 + \left(-0.0389509 + \left(0.170364 + \left(0.0085697 + \left(-0.00826883 + \left(-0.0000275468 + \left(-9.32211 \times 10^{-6} + (0.00100018 + (-0.00118684 + (-0.0113514 - 0.00936587\,(-0.98 + x))\,(-1.58 + x))\,(-1.1 + x))\,(-0.74 + x)\right)\,(-1.82 + x)\right)\,(-1.46 + x)\right)\,(-0.62 + x)\right)\,(-1.7 + x)\right)\,(-0.86 + x)\right)\,(-1.22 + x)\right)\,(-0.5 + x)\right)\,(-1.94 + x)$$

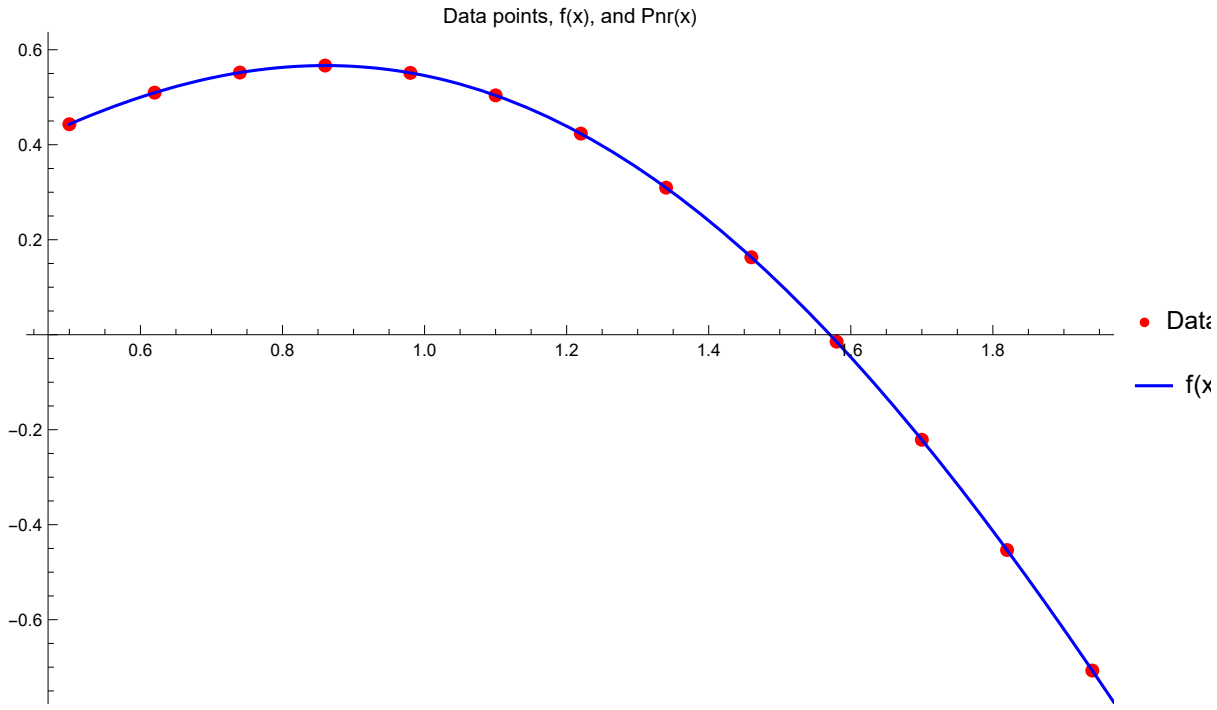
In[225]:=
```
Np[x_] = Simplify[Np[x]]
```
упростить

Out[225]=
$$0.00225165 + 1.01222\,x - 0.181547\,x^2 + 0.650965\,x^3 - 3.71915\,x^4 + 7.47051\,x^5 - 9.93623\,x^6 + 9.18074\,x^7 - 5.89562\,x^8 + 2.58661\,x^9 - 0.740318\,x^{10} + 0.124641\,x^{11} - 0.00936587\,x^{12}$$

In[226]:=

```
Show[ListPlot[data2, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Np[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[226]=



In[227]:=

```
(*8 степень*)
```

In[228]:=

```
Np[x_] = InterpolatingPolynomial[data3, x]
```

Out[228]=

$$-0.707094 + (-0.798801 + (-1.07137 + (-0.0389509 + (0.110247 + (-0.492197 + (0.176252 + (-6.57771 + 19.9814 (-1.04 + x)) (-1.58 + x)) (-0.68 + x)) (-1.76 + x)) (-0.86 + x)) (-1.22 + x)) (-0.5 + x)) (-1.94 + x)$$

In[229]:=

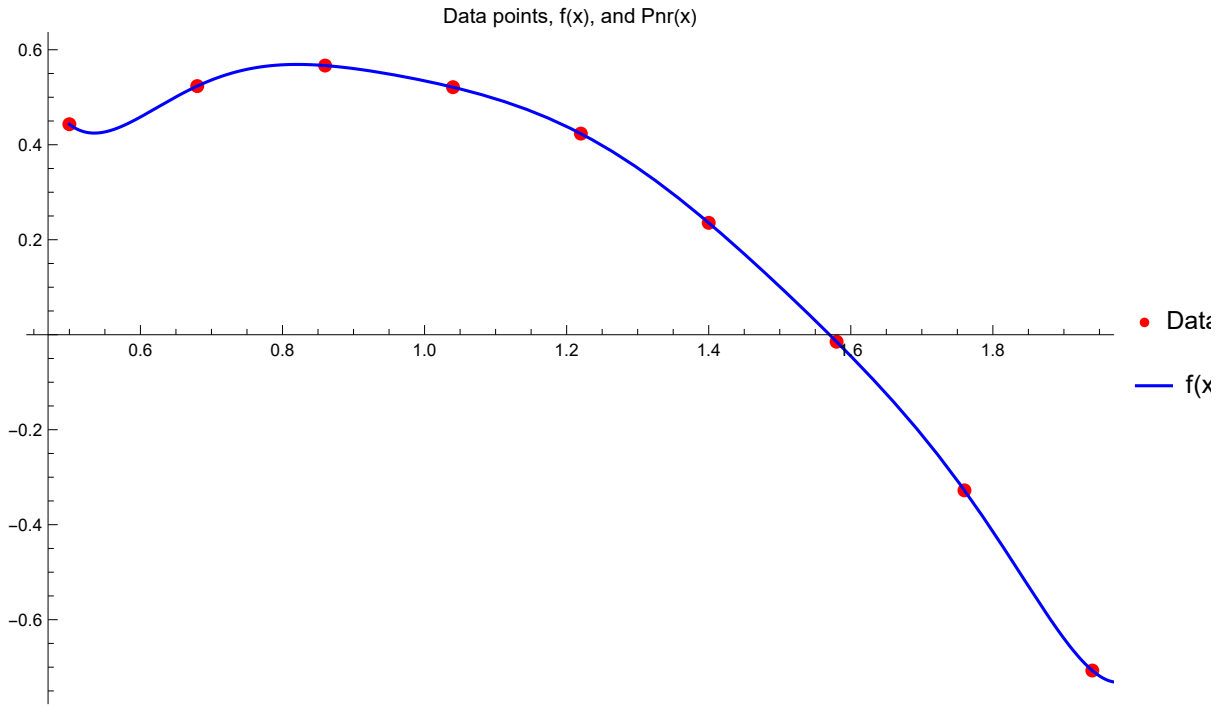
```
Np[x_] = Simplify[Np[x]]
```

Out[229]=

$$53.7079 - 420.646\,x + 1399.23\,x^2 - 2570.33\,x^3 + 2863.52\,x^4 - 1986.52\,x^5 + 839.587\,x^6 - 197.999\,x^7 + 19.9814\,x^8$$

In[230]:=
```
Show[ListPlot[data3, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Np[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[230]=



In[231]:=
```
(*5 степень*)
```

In[232]:=
```
Np[x_] = InterpolatingPolynomial[data4, x]
```

Out[232]=
$$-0.823971 + (-0.844767 + (-1.05116 + (0.134733 + (0.318164 - 0.294136\,(-0.8 + x))\,(-1.7 + x))\,(-1.1 + x))\,(-0.5 + x))\,(-2. + x)$$

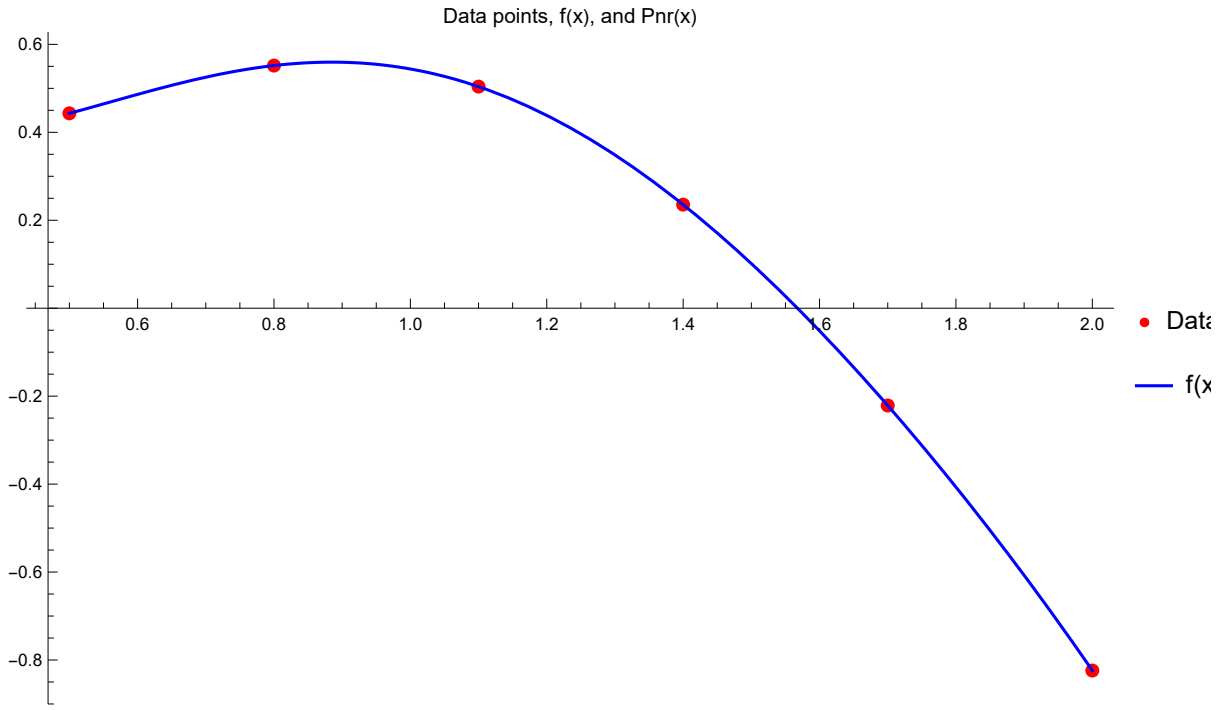
In[233]:=
```
Np[x_] = Simplify[Np[x]]
```

Out[233]=
$$0.70119 - 2.39886\,x + 6.12524\,x^2 - 5.70179\,x^3 + 2.11239\,x^4 - 0.294136\,x^5$$

In[234]:=

```
Show[ListPlot[data4, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Np[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[234]=



In[235]:=

```
Np[x_] = InterpolatingPolynomial[data1, x]
```

Out[235]=

$$-0.823971 + \left(-0.844767 + \left(-1.04789 + \left(0.161598 + \left(0.206975 + \left(-0.197966 + \left(-0.857129 + \left(-3.59592 + \left(4.43746 + \left(17.7616 + \left(22.7457 + \left(-16.9772 + \left(116.681 + \left(830.838 + \left(-253.823 + \left(4063.81 + \left(46\,639.3 + \left(-8401.71 + \left(275\,128. + \left(303\,399. + \left(3.1789 \times 10^{6} + \left(4.35099 \times 10^{6} + \left(1.64007 \times 10^{8} + \left(-3.8305 \times 10^{8} + \left(2.32781 \times 10^{9} - 2.8047 \times 10^{10} (-1.16 + x)\right)(-1.52 + x)\right)(-0.98 + x)\right)(-1.4 + x)\right)(-0.86 + x)\right)(-1.64 + x)\right)(-1.1 + x)\right)(-1.76 + x)\right)(-0.68 + x)\right)(-1.34 + x)\right)(-0.8 + x)\right)(-1.82 + x)\right)(-1.58 + x)\right)(-0.62 + x)\right)(-1.04 + x)\right)(-1.94 + x)\right)(-1.46 + x)\right)(-0.56 + x)\right)(-0.92 + x)\right)(-1.88 + x)\right)(-0.74 + x)\right)(-1.7 + x)\right)(-1.22 + x)\right)(-0.5 + x)\right)(-2. + x)$$

In[236]:=

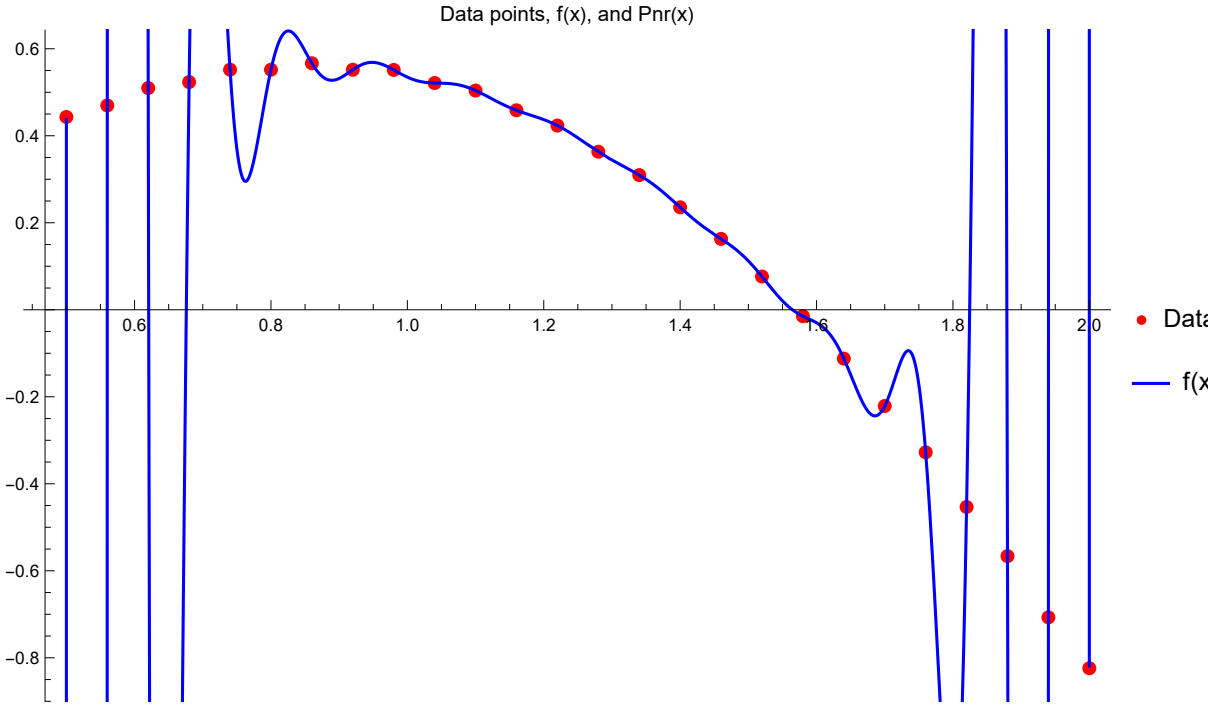
In[237]:=

In[238]:=

In[239]:=

```
Show[ListPlot[data1, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Np[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[239]=



In[240]:=

```
(*Чем выше степень многочлена, тем точнее график функции,
однако из-за специфичной таблицы значений функций и аргументов для
  многочлена 25 степени приближенный график построить не получается*)
```

In[241]:=

```
(*Задание 2*)
```

In[242]:=

```
(*n=25*)
Sp1 = Interpolation[data1, Method → "Spline"]
```

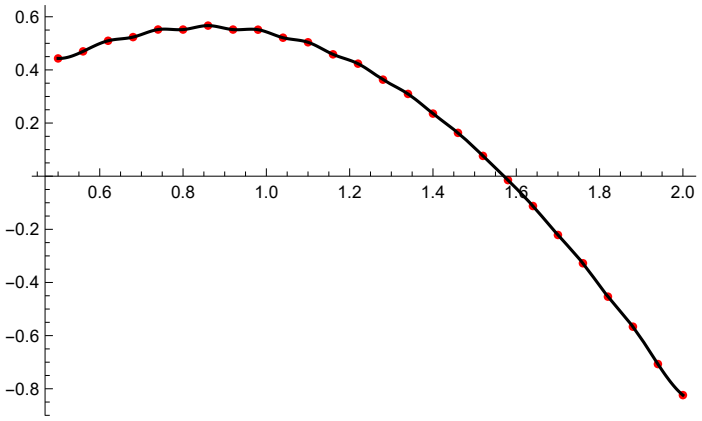
Out[242]=

```
InterpolatingFunction[ Domain: {{0.5, 2.}}
                       Output: scalar ]
```

In[243]:=

```
Show[ListPlot[data1, PlotStyle → Red, ImageSize → Medium],
 Plot[Sp1[x], {x, a, 2}, PlotStyle → Black]]
```

Out[243]=



In[244]:=

```
(*n=12*)
Sp2 = Interpolation[data2, Method → "Spline"]
```

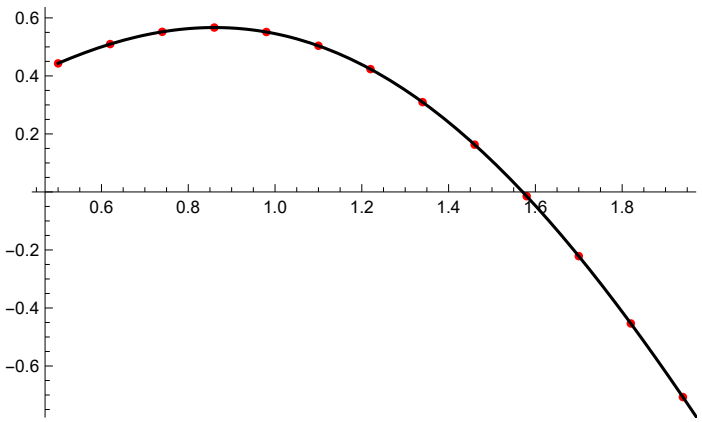
Out[244]=

```
InterpolatingFunction[ Domain: {{0.5, 1.94}}
                       Output: scalar ]
```

In[245]:=

```
Show[ListPlot[data2, PlotStyle → Red, ImageSize → Medium],
 Plot[Sp2[x], {x, a, 2}, PlotStyle → Black]]
```

Out[245]=



In[246]:=

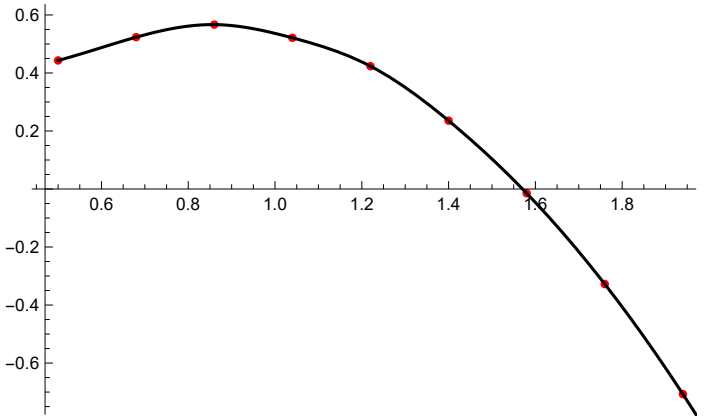
```
(*n=8*)
Sp3 = Interpolation[data3, Method → "Spline"]
```

Out[246]=

```
InterpolatingFunction[ Domain: {{0.5, 1.94}}
                       Output: scalar ]
```

In[247]:=
```
Show[ListPlot[data3, PlotStyle → Red, ImageSize → Medium],
 Plot[Sp3[x], {x, a, 2}, PlotStyle → Black]]
```
пок… диаграмма разброс… стиль графика кра… размер изоб… средний
график функции стиль графика чёрный

Out[247]=



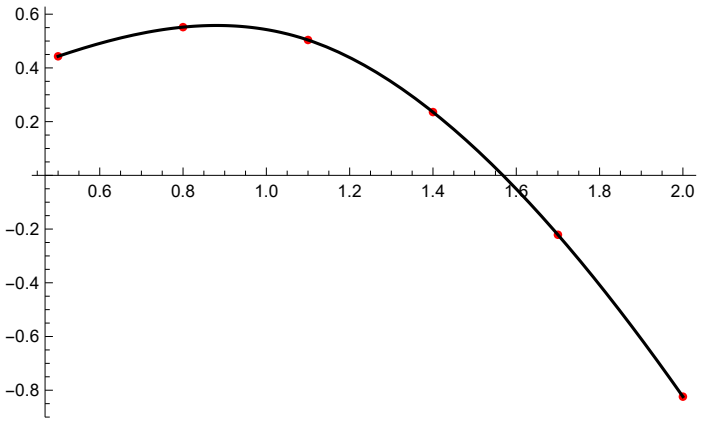
In[248]:=
```
(*n=5*)
Sp4 = Interpolation[data4, Method → "Spline"]
```
интерполировать метод

Out[248]=

InterpolatingFunction [Domain: {{0.5, 2.}} Output: scalar]

In[249]:=
```
Show[ListPlot[data4, PlotStyle → Red, ImageSize → Medium],
 Plot[Sp4[x], {x, a, 2}, PlotStyle → Black]]
```
пок… диаграмма разброс… стиль графика кра… размер изоб… средний
график функции стиль графика чёрный

Out[249]=



In[250]:=
```
(*Задание 3*)
```

In[251]:=
```
a11 = 26;
```

In[252]:=

$$a12 = \sum_{i=1}^{26} data[[i, 1]]$$

Out[252]=

32.5

In[253]:=

$$a21 = a12$$

Out[253]=

32.5

In[254]:=

$$a22 = \sum_{i=1}^{26} (data[[i, 1]])^2$$

Out[254]=

45.89

In[255]:=

$$b1 = \sum_{i=1}^{26} data[[i, 2]]$$

Out[255]=

4.54802

In[256]:=

$$b2 = \sum_{i=1}^{26} (data[[i, 1]] * data[[i, 2]])$$

Out[256]=

1.18087

In[257]:=

$$A = \begin{pmatrix} a11 & a12 \\ a21 & a22 \end{pmatrix}$$

Out[257]=

{{26, 32.5}, {32.5, 45.89}}

In[258]:=

$$B = \begin{pmatrix} b1 \\ b2 \end{pmatrix}$$

Out[258]=

{{4.54802}, {1.18087}}

In[259]:=

```
coeffs = LinearSolve[A, B]
```

решить линейные урав

Out[259]=

{{1.24429}, {-0.855492}}

In[260]:=

```
Q1[x_] = coeffs[[2]] * x + coeffs[[1]]
```

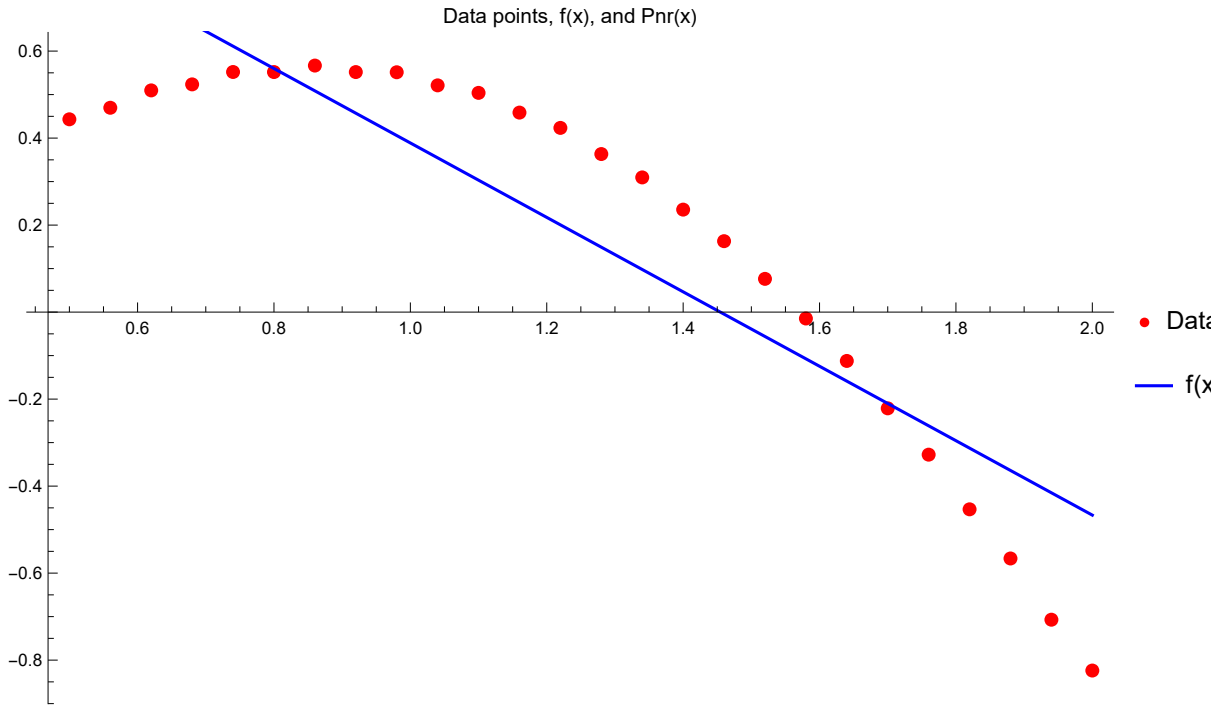
Out[260]=

{1.24429 - 0.855492 x}

In[261]:=

```
Show[ListPlot[data, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Q1[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[261]=



In[262]:=

$$\sum_{i=1}^{26} (\text{Abs}[Q1[a + h * i] - \text{data}[[i, 2]]])^2$$

Out[262]=

{1.01453}

In[263]:=

```
a13 = a22;
```

In[264]:=

$$a23 = \sum_{i=1}^{26} \text{data}[[i, 1]]^3$$

Out[264]=

70.525

In[265]:=

```
a31 = a22
```

Out[265]=

45.89

In[266]:=

```
a32 = a23
```

Out[266]=

70.525

In[267]:=

$$a33 = \sum_{i=1}^{26} data[[i, 1]]^4$$

Out[267]=

114.751

In[268]:=

$$b3 = \sum_{i=1}^{26} \left(data[[i, 1]]^2 * data[[i, 2]]\right)$$

Out[268]=

-4.12869

In[269]:=

```
Clear[A]
```

очистить

In[270]:=

```
Clear[B]
```

очистить

In[271]:=

$$A = \begin{pmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{pmatrix}$$

Out[271]=

{{26, 32.5, 45.89}, {32.5, 45.89, 70.525}, {45.89, 70.525, 114.751}}

In[272]:=

$$B = \begin{pmatrix} b1 \\ b2 \\ b3 \end{pmatrix}$$

Out[272]=

{{4.54802}, {1.18087}, {-4.12869}}

In[273]:=

```
Clear[coeffs]
```

очистить

In[274]:=

```
coeffs = LinearSolve[A, B]
```

решить линейные уравı

Out[274]=

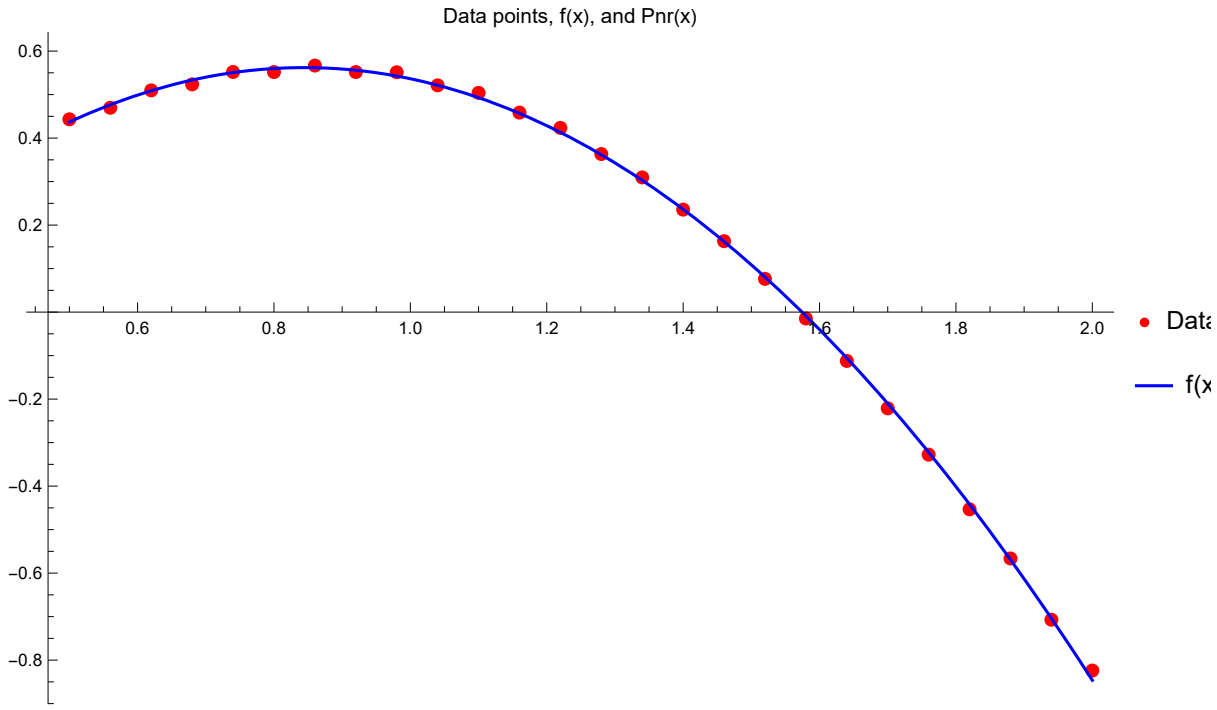
{{-0.190028}, {1.78112}, {-1.05464}}

In[275]:=

```
Q2[x_] = coeffs[[3]] * x^2 + coeffs[[2]] * x + coeffs[[1]];
```

In[276]:=
```
Show[ListPlot[data, PlotStyle → Red, PlotLegends → {"Data points"}],
 Plot[Q2[x], {x, 0.5, 2}, PlotStyle → Blue, PlotLegends → {"f(x)"}],
 PlotLabel → "Data points, f(x), and Pnr(x)", ImageSize → Large]
```

Out[276]=



In[277]:=

In[278]:=

In[279]:=
```
∑_{i=1}^{26} (Abs[Q2[a + h * i] - data[[i, 2]]])^2
```

Out[279]=
```
{0.164896}
```

In[280]:=
```
(*Задание 4*)
(*Метод левых прямоугольников*)
```

In[281]:=
```
int1p1 = h * ∑_{i=1}^{18} data[[i, 2]]
```

Out[281]=
```
0.466482
```

In[282]:=

$$\text{int1p2} = h * \sum_{i=19}^{25} \text{data}[[i, 2]]$$

Out[282]=

$$-0.144162$$

In[283]:=

```
int1 = int1p1 + Abs[int1p2]
```

абсолютное зна

Out[283]=

$$0.610644$$

In[284]:=

```
(*Метод правых прямоугольников*)
```

$$\text{int2p1} = h * \sum_{i=2}^{18} \text{data}[[i, 2]]$$

$$\text{int2p2} = h * \sum_{i=19}^{26} \text{data}[[i, 2]]$$

Out[284]=

$$0.439891$$

Out[285]=

$$-0.193601$$

In[286]:=

```
int2 = int2p1 + Abs[int2p2]
```

абсолютное зна

Out[286]=

$$0.633492$$

In[287]:=

```
(*Метод средних прямоугольников*)
```

In[288]:=

```
(*для 25 точек, для последнего прямоугольника нет второй половины*)
```

In[289]:=

$$\text{int3p1} = 2 * h * \sum_{i=1}^{9} \text{data}[[2 * i, 2]]$$

Out[289]=

$$0.450224$$

In[290]:=

$$\text{int3p2} = 2 * h * \sum_{i=10}^{12} \text{data}[[2 * i, 2]]$$

Out[290]=

$$-0.12076$$

In[291]:=
```
int3p3 =
 h * data[[25, 2]] (*для последнего отрезка с помощью формулу левых прямоугольников*)
```
Out[291]=
```
-0.0424256
```

In[292]:=
```
int3 = int3p1 + Abs[int3p2] + Abs[int3p3]
```
абсолютное зн… абсолютное зна

Out[292]=
```
0.61341
```

In[293]:=

In[294]:=
```
(*Метод трапеций*)
```

In[295]:=
$$\text{int4p1} = h * \sum_{i=1}^{17} \left(\frac{\text{data}[[i, 2]] + \text{data}[[i + 1, 2]]}{2} \right)$$
$$\text{int4p2} = h * \sum_{i=19}^{25} \left(\frac{\text{data}[[i, 2]] + \text{data}[[i + 1, 2]]}{2} \right)$$

Out[295]=
```
0.450894
```

Out[296]=
```
-0.168441
```

In[297]:=
```
int4 = int4p1 + Abs[int4p2]
```
абсолютное зна

Out[297]=
```
0.619335
```

In[298]:=
```
(*метод парабол(Симпсона)для 25 точек, т.к. отрезков должно быть четное кол-во*)
```

In[299]:=
$$\text{int5p1} = \frac{h}{3} * \left(\text{data}[[1, 2]] + \text{data}[[17, 2]] + 4 * \left(\sum_{i=1}^{8} \text{data}[[2 * i, 2]] \right) + 2 * \left(\sum_{i=1}^{7} \text{data}[[2 * i + 1, 2]] \right) \right)$$

Out[299]=
```
0.442826
```

In[300]:=
$$\text{int5p2} = \frac{h}{3} * \left(\text{data}[[19, 2]] + \text{data}[[25, 2]] + 4 * \left(\sum_{i=10}^{12} \text{data}[[2 * i, 2]] \right) + 2 * \left(\sum_{i=10}^{11} \text{data}[[2 * i + 1, 2]] \right) \right)$$

Out[300]=
```
-0.121926
```

In[301]:=
```
int5p3 = h * data[[18, 2]];
 int5p4 = h * data[[25, 2]];
```

In[303]:=
```
(*Пришлось использовать формулу левых прямоугольников,
т.к. разделил отрезок интегрирования на 2 части,
а для метода Симпсона кол-во точек на отрезке должно быть нечетным*)
```

In[304]:=

In[305]:=
```
int5 = int5p1 + Abs[int5p2] + int5p3 + Abs[int5p4];
```
абсолютное значение абсолютное знач

In[306]:=
```
int5
```
Out[306]=
```
0.611762
```

In[307]:=
```
(*Задание 5*)
```

In[308]:=
```
(*первые производные первого порядка точности*)
```

In[309]:=
```
poryadok1 = N[Table[{i, (data[[i + 1, 2]] - data[[i, 2]])/h}, {i, 1, 25}]]
```
таблица значений

Out[309]=
```
{{1., 0.442317}, {2., 0.66555}, {3., 0.230183}, {4., 0.474483}, {5., -0.00231667},
 {6., 0.248583}, {7., -0.248767}, {8., -0.00733333}, {9., -0.502283}, {10., -0.28765},
 {11., -0.755717}, {12., -0.586033}, {13., -1.0019}, {14., -0.895533}, {15., -1.23367},
 {16., -1.2088}, {17., -1.44401}, {18., -1.51821}, {19., -1.62637}, {20., -1.81595},
 {21., -1.77465}, {22., -2.09425}, {23., -1.88338}, {24., -2.34552}, {25., -1.94795}}
```

In[310]:=
```
(*первые проивзодные второго порядка точности*)
```

In[311]:=
```
poryadok2 = N[Table[{i, (data[[i + 1, 2]] - data[[i - 1, 2]])/(2 * h)}, {i, 2, 25}]]
```
таблица значений

Out[311]=
```
{{2., 0.553933}, {3., 0.447867}, {4., 0.352333}, {5., 0.236083},
 {6., 0.123133}, {7., -0.0000916667}, {8., -0.12805}, {9., -0.254808},
 {10., -0.394967}, {11., -0.521683}, {12., -0.670875}, {13., -0.793967},
 {14., -0.948717}, {15., -1.0646}, {16., -1.22123}, {17., -1.32641},
 {18., -1.48111}, {19., -1.57229}, {20., -1.72116}, {21., -1.7953},
 {22., -1.93445}, {23., -1.98882}, {24., -2.11445}, {25., -2.14673}}
```

In[312]:=
```
(*вторые производные второго порядка точности*)
```

In[313]:=

```
second1 = N[Table[{i, (data[[i + 1, 2]] - 2 data[[i, 2]] + data[[i - 1, 2]])/h^2}, {i, 2, 25}]]
```

таблица значений

Out[313]=

```
{{2., 3.72056}, {3., -7.25611}, {4., 4.07167}, {5., -7.94667}, {6., 4.18167},
 {7., -8.28917}, {8., 4.02389}, {9., -8.24917}, {10., 3.57722}, {11., -7.80111},
 {12., 2.82806}, {13., -6.93111}, {14., 1.77278}, {15., -5.63556}, {16., 0.414444},
 {17., -3.92017}, {18., -1.23661}, {19., -1.80267}, {20., -3.15972},
 {21., 0.688333}, {22., -5.32667}, {23., 3.51444}, {24., -7.70222}, {25., 6.62611}}
```

In[314]:=

```
(*вторые производные первого порядка точности*)
```

In[315]:=

```
second2 = N[Table[{i, (poryadok1[[i + 1, 2]] - poryadok1[[i, 2]])/h}, {i, 1, 24}]]
```

таблица значений

Out[315]=

```
{{1., 3.72056}, {2., -7.25611}, {3., 4.07167}, {4., -7.94667}, {5., 4.18167},
 {6., -8.28917}, {7., 4.02389}, {8., -8.24917}, {9., 3.57722}, {10., -7.80111},
 {11., 2.82806}, {12., -6.93111}, {13., 1.77278}, {14., -5.63556}, {15., 0.414444},
 {16., -3.92017}, {17., -1.23661}, {18., -1.80267}, {19., -3.15972},
 {20., 0.688333}, {21., -5.32667}, {22., 3.51444}, {23., -7.70222}, {24., 6.62611}}
```