```
(*  Elemente der Programmierung 2,  WQ FS 2013 *)

(*  Funktionen mit optionalen Parametern *)

potReihe[f_, x_: x, xo_: 0, order_: 6] := Series[f, {x, xo, order}]

potReihe[Sin[x], x]
```

$$x - \frac{x^3}{6} + \frac{x^5}{120} + O[x]^7$$

```
potReihe[Sin[x], x, Pi, 3]
```

$$-(x-\pi) + \frac{1}{6}(x-\pi)^3 + O[x-\pi]^4$$

```
(* 'bessere' Programmierung ist aber,
Standardwerte als Optionen zu formulieren *)

Clear[potReihe]

Options[potReihe] := {val → x, value → 0, order → 6};

potReihe[f_, Opts___?OptionQ] :=
 Series[f, {var, value, order} /. {Opts} /. Options[potReihe] ]

potReihe[Sin[y], var -> y, order → 7]
```

$$y - \frac{y^3}{6} + \frac{y^5}{120} - \frac{y^7}{5040} + O[y]^8$$

```
(* kleine Programmierbeispiele fuer Berechnung der Zahl Pi *)

ClearAll[archi]

archi[s_, c_, n_] := Module[{x = c, y = s, t, j = 0},
  While[j < n, j = j + 1;
   x = Sqrt[(1 + x) / 2]; y = y / x;  t = y / x;
   Print["n= ", j, "  S= ",  N[y, 13], "   < Pi=",
    N[Pi, 13], "  <   T=", N[t, 13]]]; Return[N[{y, t}, 13]]]

c = 0
s = 2
archi[s, c, 20]
0

2
```

```
n= 1  S= 2.828427124746   < Pi=3.141592653590  <   T=4.000000000000
n= 2  S= 3.061467458921   < Pi=3.141592653590  <   T=3.313708498985
n= 3  S= 3.121445152258   < Pi=3.141592653590  <   T=3.182597878075
n= 4  S= 3.136548490546   < Pi=3.141592653590  <   T=3.151724907429
n= 5  S= 3.140331156955   < Pi=3.141592653590  <   T=3.144118385246
n= 6  S= 3.141277250933   < Pi=3.141592653590  <   T=3.142223629942
n= 7  S= 3.141513801144   < Pi=3.141592653590  <   T=3.141750369169
n= 8  S= 3.141572940367   < Pi=3.141592653590  <   T=3.141632080703
n= 9  S= 3.141587725277   < Pi=3.141592653590  <   T=3.141602510257
n= 10  S= 3.141591421511   < Pi=3.141592653590  <   T=3.141595117750
n= 11  S= 3.141592345570   < Pi=3.141592653590  <   T=3.141593269629
n= 12  S= 3.141592576585   < Pi=3.141592653590  <   T=3.141592807600
n= 13  S= 3.141592634339   < Pi=3.141592653590  <   T=3.141592692092
n= 14  S= 3.141592648777   < Pi=3.141592653590  <   T=3.141592663215
n= 15  S= 3.141592652387   < Pi=3.141592653590  <   T=3.141592655996
n= 16  S= 3.141592653289   < Pi=3.141592653590  <   T=3.141592654191
n= 17  S= 3.141592653515   < Pi=3.141592653590  <   T=3.141592653740
n= 18  S= 3.141592653571   < Pi=3.141592653590  <   T=3.141592653627
n= 19  S= 3.141592653585   < Pi=3.141592653590  <   T=3.141592653599
n= 20  S= 3.141592653589   < Pi=3.141592653590  <   T=3.141592653592
{3.141592653589, 3.141592653592}
```

```
(* relativer Fehler *)
N[Abs[%7[[1]] - Pi] / Pi]
N[Abs[%7[[2]] - Pi] / Pi]
```

3.73931×10^{-13}

7.48102×10^{-13}

```
(* next mit Ansatz von Vieta *)

ClearAll[vv, vieta, vietaPi]

vv[x_] := Sqrt[2. + x];
vieta[x_, n_] := Nest[vv, x, n - 1];
vieta[x_, 1] := x;
vietaPi[n_] := 2.^(n + 1) / Product[vieta[Sqrt[2.], m], {m, 1, n}];

(* Arbeit von Nest *)
vieta[x, 4]
```

$$\sqrt{2. + \sqrt{2. + \sqrt{2. + x}}}$$

```
(* Pi in 10.Naeherung *)
viPi10 = vietaPi[10]
N[viPi10 - Pi]
```

3.14159

-1.23208×10^{-6}

```
(* relativer Fehler *)
N[Abs[viPi10 - Pi] / Pi]
```

3.92183×10^{-7}

```
(*  Pi mit Leibniz'scher Summenformel *)

leibPi[n_] := N[4 Sum[(-1)^(m + 1) / (2 m - 1), {m, 1, n}]]

lei200 = leibPi[200]
```

3.13659

```
(* relativer Fehler *)
N[Abs[lei200 - Pi] / Pi]
```

0.00159154

```
(* Versuch je 2 +- Terme zusammenzufassen: Bringt nichts *)

leibPi2[n_] := N[8 Sum[1 / (4 m^2 - 1), {m, 1, n / 2}]]

lei2mit200 = leibPi[200]
```

3.13659

```
(* relativer Fehler *)
N[Abs[lei200 - Pi] / Pi]
```

0.00159154

```
(*  Volle symbolische Rechnung *)
leibnizPi = 4 Sum[(-1)^(m + 1) / (2 m - 1), {m, 1, Infinity}]
```

π

```
(*  Zufallsexperiment *)

randomPi[n_] := Module[{p, i = 0, m = 0},
  While[i ≤ n, i = i + 1; m = m + 1 - Floor[Random[]^2 + Random[]^2]];
  Return[p = 4. m / n]]

randomPi[10 000]
```

3.1312

```
(*  also sehr 'schlecht',
in anderen Faellen wird der Zufall aber (verbessert) genutzt *)

(*  Modernere Naeherungsrechnung: BBP- Reihe, 1995 *)
```

```
bbp[n_] :=
 N[ Sum[1 / 16^m (4 / (8 m + 1) - 2 / (8 m + 4) - 1 / (8 m + 5 ) - 1 / (8 m + 6)), {m, 0, n}]]
bbp5 = bbp[5]
bbp10 = bbp[10]
```

```
3.14159
```

```
3.14159
```

```
(* relativer Fehler *)
N[Abs[bbp5 - Pi] / Pi]
```

$$1.15135 \times 10^{-10}$$

```
N[Abs[bbp10 - Pi] / Pi]
```

```
0.
```

```
(* kleines
 Programmierbeispiel: Euklidischer Algorithmus fuer GGT zweier Zahlen *)
euklid[a0_Integer, b0_Integer] := Module[{a = a0, b = b0, q, r},
  While[b ≠ 0, r = Mod[a, b]; q = (a - r) / b;
   Print[a, "=", q, "*", b, "+", r]; {a, b} = {b, r}]; Print["GGT = ", a]]
euklid[12, 7]
```

```
12=1*7+5
7=1*5+2
5=2*2+1
2=2*1+0
GGT = 1
```

```
euklid[330, 44]
```

```
330=7*44+22
44=2*22+0
GGT = 22
```

```
GCD[330, 44]
```

```
22
```