函数与泛函编程

In [1]:

```
(* 前缀、中缀和后缀： *)
f[x]
f@x
f[x, y]
x~f~y
f[g[x]]
f@g[x]
f@g@x
x // g // f
```

Out[2]:

```
f[x]
f[x]
f[x, y]
f[x, y]
f[g[x]]
f[g[x]]
f[g[x]]
f[g[x]]
```

函数的属性:

In [10]:

```
(* Orderless：交换性 *)
SetAttributes[f, Orderless];
f[x, y, z] == f[y, z, x]
```

Out[12]:

```
True
```

In [13]:

```
(* Flat：结合性 *)
SetAttributes[f, Flat];
f[x, f[y, z]] == f[f[x, y], z] == f[x, y, z]
```

Out[15]:

```
True
```

In [16]:

```
(* OneIdentity:同一性 *)
SetAttributes[f, OneIdentity];
MatchQ[a, f[x_ : 0, y_]]
```

Out[18]:

```
True
```

In [19]:

```
(* Listable *)
SetAttributes[f, Listable];
f[{1, 2, 3}]
```

Out[21]:

```
{f[1], f[2], f[3]}
```

匿名函数用法

In [22]:

```
(* 自定义排序函数： *)
listlist = {{1, 3}, {1, 2}, {4, 3}, {5, 1}, {2, 6}, {2, 3}};
Sort[listlist]
Sort[listlist, #1[[2]] <= #2[[2]] &]
Sort[listlist, (#1[[1]] > #2[[
      1]]) || (#1[[1]] == #2[[1]] && #1[[2]] < #2[[2]]) &]
```

Out[24]:

```
{{1, 2}, {1, 3}, {2, 3}, {2, 6}, {4, 3}, {5, 1}}
{{5, 1}, {1, 2}, {1, 3}, {4, 3}, {2, 3}, {2, 6}}
{{5, 1}, {4, 3}, {2, 3}, {2, 6}, {1, 2}, {1, 3}}
```

In [27]:

```
(* 自定义筛选函数： *)
S = Normal@Series[Cos[x]/(x^4 Tan[x]), {x, 0, 5}]
Plus @@ Cases[S, a_. x^d_ /; d < 0]
Select[S, (# /. {a_. x^d_ :> d}) < 0 &]
Select[S, MatchQ[#, a_. x^d_ /; d < 0] &]
```

Out[28]:

$$\frac{1}{x^5}-\frac{5}{6x^3}+\frac{67}{360x}-\frac{19x}{3024}+\frac{247x^3}{604800}+\frac{89x^5}{4790016}$$

$$\frac{1}{x^5}-\frac{5}{6x^3}+\frac{67}{360x}$$

$$\frac{1}{x^5}-\frac{5}{6x^3}+\frac{67}{360x}$$

$$\frac{1}{x^5}-\frac{5}{6x^3}+\frac{67}{360x}$$

In [32]:

```
(* 带下标的函数： *)
p = Plus @@ ((g @@ #)[u[0]] Times @@ u /@ # & /@ Partitions[#]) &;
p[5]
```

Out[34]:

```
5 u[0]
```

In [4]:

```
(* 函数的函数： *)
f = Function[x, Function[y, x + y]];
f[2]
f[2][2]
```

Out[6]:

```
Function[y$, 2 + y$]
4
```

泛函操作：

In [35]:

```
Map[f, {a, b, c}]
f /@ {a, b, c}
```

Out[35]:

```
{f[a], f[b], f[c]}
{f[a], f[b], f[c]}
```

In [37]:

```
L = {a, b, c, d};
MapIndexed[
 Print["The position of ", #1, " in the List ", L, " is ", First[#2],
   "."] &, L]
```

```
The position of a in the List {a, b, c, d} is 1.
The position of b in the List {a, b, c, d} is 2.
The position of c in the List {a, b, c, d} is 3.
The position of d in the List {a, b, c, d} is 4.
```

Out[38]:

```
{Null, Null, Null, Null}
```

In [44]:

```
MapThread[f, {{a, b, c}, {p, q, r}, {u, v, w}, {x, y, z}}]
f @@@ Transpose[{{a, b, c}, {p, q, r}, {u, v, w}, {x, y, z}}]
```

Out[44]:

```
ClearAll
{f[a, u, x, Plus @@ ((g @@ #1) [u[0]] Times @@ u /@ #1 &) /@ Partitions[#1] &], f[b, q, v, y], f[c, r, w, z]}
{f[a, u, x, Plus @@ ((g @@ #1) [u[0]] Times @@ u /@ #1 &) /@ Partitions[#1] &], f[b, q, v, y], f[c, r, w, z]}
```

In [47]:

```
Scan[Print["Hey! I'm ", #] &, {a, b, c}]
```

```
Hey! I'm a
Hey! I'm b
Hey! I'm c
```

In [48]:

```
Apply[f, {a, b, c}]
f @@ {a, b, c}
```

Out[48]:

```
f[a, b, c]
f[a, b, c]
```

In [50]:

```
list = {g[1, 2], h[3, 4], u[x, y]};
f @@ # & /@ list
f @@@ list
```

Out[51]:

```
{f[1, 2], f[3, 4], f[x, y]}
{f[1, 2], f[3, 4], f[x, y]}
```

In [53]:

```
Through[(f + g + h)[x, y]]
```

Out[53]:

```
f[x, y] + g[x, y] + h[x, y]
```

函数迭代:

In [54]:

```
Nest[f, x, 3]
NestList[f, x, 3]
ord[f_] := Max[Cases[f, u[i_] :> i, Infinity]]
dx[f_] := Expand@Sum[D[f, u[i]] u[i + 1], {i, 0, ord[f]}]
dx[f_, n_] := Nest[dx, f, n]

dx[f[u[0]], 4]
```

Out[54]:

```
f[x]
{x, f[x], f[x], f[x]}
u[4] f'[u[0]] + 3 u[2]^2 f''[u[0]] + 4 u[1] u[3] f''[u[0]] + 6 u[1]^2 u[2] f^(3)[u[0]] + u[1]^4 f^(4)[u[0]]
```

In [60]:

```
(* 函数不动点： *)
f[x_] := N[(x + 3/x)/2, 1000]
FixedPoint[f, 1]
FixedPointList[f, 1] // MatrixForm
```

Out[62]:

```
1.732050807568877293527446341505872366942805253810380628055806979451933016908800037081146186757248575675626141415406703029969945094998952478811655512094373648528093231902305582067974820101084674923265015312343266903322886650672254668921837971227047131660367861588019049986537379859389467650347506576050756618348129606100947602187190325083145829523959832997789824508288714463832917347224163984587855397667958063818353666110843173780894378316102088305524901670023520711144288695990956365797087168498072899493296484283020786408603988738697537582317317831395992983007838702877053913369563312103707264019249106768231199288375641141422016742752102372994270831059898459475987664288897796147837958390228854852903576033852808064381972344661059689722872865264153822664698420021195484155278441181286534507035191650016689294415480846071277143999762926834629577438361895110127148638746976545982451788550975379013880664961911962222957110555242923723192197738262561631468842032853716682938649611917049738836395495938
```

条件迭代:

In [64]:

```
NestWhile[#^2 &, 2, (# < 10^10) &]
NestWhileList[#^2 &, 2, (# < 10^10) &]

f[x_] := N[(x + 3/x)/2, 20]
NestWhile[f, 1, Unequal, 2]
NestWhileList[Mod[3 #, 57] &, 1, Unequal, All]
```

Out[64]:

```
18446744073709551616
{2, 4, 16, 256, 65536, 4294967296, 18446744073709551616}
1.7320508075688772935
{1, 3, 9, 27, 24, 15, 45, 21, 6, 18, 54, 48, 30, 33, 42, 12, 36, 51, 3
9, 3}
```

折叠运算:

In [ ]:

```
Fold[f, x, {a, b, c}]
FoldList[f, x, {a, b, c}]
```