

Типове II: Шаблони на функции. Указатели към функции

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Внимание: `-std=c++11`

Предефиниране на типове

Предефиниране на типове

- Използване на “сложен” тип:

```
void doSomething (int myMatrix[10][20])

int main ()
{
    int m[10][20] = {...};
    doSomething (m);
}
```

Предефиниране на типове

- “Полагане” на ново име на тип:

```
using myarr = int[10][20];

void doSomething (myarr myMatrix)

int main ()
{
    myarr m = {...};
    doSomething (m);

    //???
    myarr x[10];
}

void doSomething
    (int myMatrix[10][20])

int main ()
{
    int m[10][20] = {...};
    doSomething (m);
}
```

Тип на указател към функцията

Указател към функция

```
using Comparator =  
    bool (*)(int, int);
```

```
bool compareGt (int a, int b)  
{return a > b;}  
bool compareLt (int a, int b)  
{return a < b;}
```

comparator : int × int → bool

Предаване на функции като параметри

```
using Comparator = bool (*)(int,int);

//int findExtremum (int arr[],
//                  int arrSize,
//                  bool (*pComparator)(int,int));

int findExtremum (int arr[],
                  int arrSize,
                  Comparator pComparator);
{
    int indexMax = 0;
    for (int i = 1; i < arrSize; i++)
        if (pComparator (arr[indexMax],arr[i]))
            indexMax = i;

    return indexMax;
}
```


Шаблони на указатели към функции

Шаблон на указател

```

template <typename T>
using Comparator = bool (*)(T,T);

template <typename T>
int findExtremum (T arr[],
                  int arrSize,
                  Comparator<T> pComparator);
{
    int indexMax = 0;
    for (int i = 1; i < arrSize; i++)
        if (pComparator (arr[indexMax],arr[i]))
            indexMax = i;

    return indexMax;
}

//int findExtremum
//    (int arr[],
//     int arrSize,
//     bool (*pComparator)(int,int));

using Comparator = bool (*)(int,int);

int findExtremum (int arr[],
                  int arrSize,
                  Comparator pComparator);

```

Пример

```
template <typename T>
bool compareGt (T a, T b)
{return a > b;}

bool compareGt (char a, char b)
{return a < b;}
```

```
template <typename T>
bool compareLt (T a, T b)
{return a < b;}
```

```
int main ()
{
    int ia[] = {1,3,5};
    double da[] = {1.7,6.5,3.4,5.8};
    char ca = "abz";
```

```
cout << findExtremum<int> (ia,3,compareGt<int>);
cout << findExtremum<double> (da,4,compareGt<double>);
cout << findExtremum<char> (ca,3,compareGt<char>);
```

```
template <typename T>
using Comparator = bool (*)(T,T);

template <typename T>
int findExtremum (T arr[],
                  int arrSize,
                  Comparator<T> pComparator)
{
    int indexMax = 0;
    for (int i = 1; i < arrSize; i++)
        if (pComparator (arr[indexMax],arr[i]))
            indexMax = i;

    return indexMax;
}
```

Map.Reduce

Задача: еднотипна промяна на всеки елемент на масив

```
void increase (int arr[], int arrsize)
{
    for (int i = 0; i < arrsize; i++)
        arr[i] = arr[i]+1;
}

void multiply (int arr[], int arrsize)
{
    for (int i = 0; i < arrsize; i++)
        arr[i] = arr[i]*2;
}

void increaseEvens (int arr[], int arrsize)
{
    for (int i = 0; i < arrsize; i++)
        if (arr[i] %2 == 0)
            arr[i] = arr[i] + 1;
}
```

Map

$$\text{map} : T \rightarrow T$$

- еднотипна обработка на всеки от елементите на масив

```
template <typename T>
using mapFn = T (*) (T);

template <typename T>
void map (T arr[], int arrsize, mapFn<T> f)
{
    for (int i = 0; i < arrsize; i++)
        arr[i] = f(arr[i]);
}
```

Пример: добавяне на единица

```
int plusOne (int x)
{return x+1;}

int multTwo (int x)
{return x*2;}

int main ()
{
    int arr[] = {1,2,3};
    map<int> (arr,3,plusOne);
    map<int> (arr,3,multTwo);

    printArray<int> (arr,3);
}
```

```
template <typename T>
using mapFn = T (*) (T);

template <typename T>
void map (T arr[], int arrsize, mapFn<T> f)
{
    for (int i = 0; i < arrsize; i++)
        arr[i] = f(arr[i]);
}
```

Пример: добавяне на единица само на четните елементи

```
int evenPlusOne (int x)
{
    if (x%2 == 0)
        return x+1;
    return x;
}
```

```
int main ()
{
    int arr[] = {1,2,3};
    map<int> (arr,3,evenPlusOne);

    printArray (arr,3);
}
```

```
template <typename T>
using mapFn = T (*) (T);

template <typename T>
void map (T arr[], int arrsize, mapFn<T> f)
{
    for (int i = 0; i < arrsize; i++)
        arr[i] = f(arr[i]);
}
```


Задача: намиране на сума, произведение, брой и пр.

```
int sum (int arr[], int arrsize)
{
    int result = arr[0];
    for (int i = 1; i < arrsize; i++)
        result = result + arr[i];
    return result;
}

int prod (int arr[], int arrsize)
{
    int result = arr[0];
    for (int i = 1; i < arrsize; i++)
        result = result * arr[i];
    return result;
}

int countEvens (int arr[], int arrsize)
{
    int result = 0;
    for (int i = 1; i < arrsize; i++)
        if (arr[i] % 2 == 0)
            result = result + 1;
    return result;
}
```

Reduce

$$OP : R \times E \rightarrow R$$

- Сумиране (“акумулиране”, “обединяване”) на всички елементи в един резултат

```
template <typename ResT, typename ElemT>
using reduceFn = ResT (*) (ResT, ElemT);
```

```
template <typename ResT, typename ElemT>
ResT reduce (ElemT arr[],
             int arrsize,
             reduceFn<ResT, ElemT> f,
             ResT init)
```

```
{
    ResT result = init;

    for (int i = 0; i < arrsize; i++)
        result = f (result, arr[i]);

    return result;
}
```

Пример: Събиране и умножение

```
int sum (int accumulated, int x)
{return accumulated + x;}
```

```
int prod (int accumulated, int x)
{return accumulated * x;}
```

```
int main ()
{
    int arr[] = {1,2,3};
    cout << reduce<int,int> (arr,3,sum,0);
    cout << reduce<int,int> (arr,3,prod,1);
}
```

```
template <typename ResT, typename ElemT>
using reduceFn = ResT (*) (ResT, ElemT);

template <typename ResT,typename ElemT>
ResT reduce (ElemT arr[],
             int arrsize,
             reduceFn<ResT,ElemT> f,
             ResT init)
{
    ResT result = init;

    for (int i = 1; i < arrsize; i++)
        result = f (result, arr[i]);

    return result;
}
```

Пример: Събиране само на четните числа

```

int sumEvens (int accumulated, int x)
{
    if (x % 2 == 0)
        return accumulated + x;
    return accumulated;
}

int main ()
{
    int arr[] = {1,2,3};
    cout << reduce<int,int> (arr,3,sumEvens,0);
}

template <typename ResT, typename ElemT>
using reduceFn = ResT (*) (ResT, ElemT);

template <typename ResT,typename ElemT>
ResT reduce (ElemT arr[],
             int arrsize,
             reduceFn<ResT,ElemT> f,
             ResT init)
{
    ResT result = init;

    for (int i = 1; i < arrsize; i++)
        result = f (result,arr[i]);

    return result;
}

```

Пример: Проверка дали има четни числа

```

bool isEven (bool accumulated, int x)
{
    if (x % 2 == 0)
        return true;
    return accumulated;
}

int main ()
{
    int arr[] = {1,2,3};
    cout << reduce<bool,int> (arr,3,isEven,false);
}

template <typename ResT, typename ElemT>
using reduceFn = ResT (*) (ResT, ElemT);

template <typename ResT,typename ElemT>
ResT reduce (ElemT arr[],
             int arrsize,
             reduceFn<ResT,ElemT> f,
             ResT init)
{
    ResT result = init;

    for (int i = 1; i < arrsize; i++)
        result = f (result,arr[i]);

    return result;
}

```

Пример: Брой срещания на символ

```
int countLs (int accumulated, char x)
{
    if (x == 'l')
        return accumulated + 1;
    return accumulated;
}
```

```
int main ()
{
    cout << reduce<int, char> ("Hello_World!", 12, countLs, 0);
}
```

```
template <typename ResT, typename ElemT>
using reduceFn = ResT (*) (ResT, ElemT);
```

```
template <typename ResT, typename ElemT>
ResT reduce (ElemT arr[],
             int arrsize,
             reduceFn<ResT, ElemT> f,
             ResT init)
{
    ResT result = init;

    for (int i = 1; i < arrsize; i++)
        result = f (result, arr[i]);

    return result;
}
```

Благодаря за вниманието!