Структури

Калин Георгиев

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“Пакетиране” на стойности

```
double distance (double x1, double y1, double x2, double y2)
{
  return sqrt ((x1-x2)*(x1-x2) - (y1-y2)*(y1-y2));
}
```

“Пакетиране” на стойности

```
/*???????*/ western (double x1, double y1, double x2, double y2)
{
  if (x1 < x2)
    return /* (x1,y1) */;

   return /* (x2,y2) */;
}
```

Структури

```
struct Point
{
  double x; //field x
  double y; //field y
}
```

- Дефиниране на променливи

```
double a;
int x,y;
Point p1, p2;
```

- Достъп до полета

```
p1.x = 10;
cout << p1.x;
p1.x = p2.x + 5;
```

- Връщане като резултат

```
Point western (Point p1, Point p2)
{
  if (p1.x < p2.x)
    return p1;
  return p2;
}
```

Пример

```
Point western (Point p1, Point p2)
{
  if (p1.x < p2.x)
    return p1;
  return p2;
}

int main ()
{
  Point p1,p2;
  cin >> p1.x >> p1.y >> p2.x >> p2.y;

  Point p3 = western (p1,p2);
  cout << "The western point is ("
       << p3.x
       << ","
       << p3.y
       << ")" << endl;

  //cout << p3 ???
}
```

Пример: Рационални числа

```
sturct Rational
{
   double nom, denom;
};
```

$$\frac{a_{nom}}{a_{denom}} + \frac{b_{nom}}{b_{denom}} = \frac{a_{nom} * b_{denom} + b_{nom} * a_{denom}}{a_{denom}}$$

```
Rational sum (Rational a, Rational b)
{
  Rational result;
  result.nom = a.nom*b.denom + b.nom*a.denom;
  result.denom = a.denom * b.denom;
  return result;
}

Rational multiply (Rational a, Rational b)
{
  Rational result;
  result.nom = a.nom*b.nom;
  result.denom = a.denom*b.denom;
  return result;
}

void print (Rational a)
{
  cout << a.nom << "/" << a.denom;
}
```

Пример: Рационални числа

$$a * b + c$$

```
double an,ad,bn,db,cn,cd;
//...
cout << an*bn*cd + cn*ad*bd;
     << "/"
     << ad*bd*cd;
```

- Алтернативно:

```
Rational a,b,c;
//...
print (sum (multiply (a,b) , c));
```

По-сложни примери

```
struct Date
{
  int day, month, year;
};
struct Person
{
  char name[100];
  Date birthdate;
};
```

```
void readPerson (Person& p)
{
  cout << "Please␣enter␣name:";
  cin.getline (p.name,99);
  cout << "Please␣enter␣day,␣month,"
       << "␣and␣year:";
  cin >> p.birthdate.day
      >> p.birthdate.month
      >> p.birthdate.year;
}
void printPerson (Person p)
{
  cout << "Name:" << p.name
       << "␣birthdate:␣"
       << p.birthdate. day << "/"
       << p.birthdate.month << "/"
       << p.birthdate.year << endl;
}
```

По-сложни примери

```
struct Date
{
  int day, month, year;
};
struct Person
{
  char name[100];
  Date birthdate;
};
```

```
void readPerson (Person& p)
{
  cout << "Please␣enter␣name:";
  cin.getline (p.name,99);
  cout << "Please␣enter␣day,␣month,"
       << "␣and␣year:";
  cin >> p.birthdate.day
      >> p.birthdate.month
      >> p.birthdate.year;
}
void printPerson (Person p)
{
  cout << "Name:" << p.name
       << "␣birthdate:␣"
       << p.birthdate. day << "/"
       << p.birthdate.month << "/"
       << p.birthdate.year << endl;
}
```

Помощна функция

```
bool earlier (Date d1, Date d2)
{
  if (d1.year < d2.year) return true;
  if (d1.year == d2.year &&
      d1.month < d2.month) return true;
  if (d1.year == d2.year &&
      d1.month == d2.month &&
      d1.day < d2.day) return true;

  return false;
}
```

Масив от структури

```
Person findYoungest (Person people[], int n)
{
  int index = 0;
  for (int i = 1; i < n; i++)
    if (earlier (people[i].birthdate,people[index].birthdate))
      index = i;
  return people[index];
}
```

Група от хора

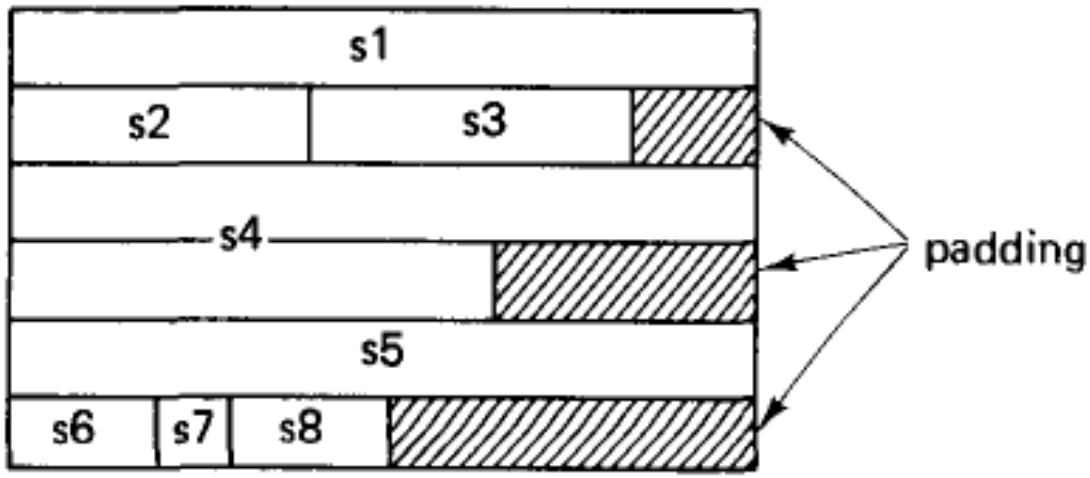
```
Person people[10];
int i;

for (i=0; i<10; i++)
  readPerson (people[i]);

printPerson (findYoungest (people,10));
```

Представяне в паметта

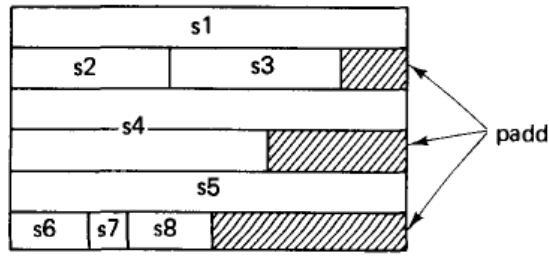
Представяне в паметта



Фигура : Подравняване (padding)[1]

Представяне в паметта

```
struct S {Ta a; Tb b; Tc c;};
S x;
```



- **НЕ МОЖЕМ** да разчитаме, че:

```
sizeof (S) == sizeof (Ta) + sizeof (Tb) + sizeof (Tc)
(long)&x.b == (long)&x + sizeof (Ta);
```

Указатели и функции

Указатели

```
double *pb = &x.b; //double*
*pb = 10;
cout << *pb << x.b;

S arr[10];
pb = &arr[3].b;
*pb = 10;
cout << *pb << arr[3].b;

S* ps = &art[3];
ps->b = 15;
cout << ps->b
     << (*ps).b
     << arr[3].b;
```

```
struct S
{
  int a;
  double b;
  char c;
};
S x;
```

Функции

```
void f (S z)
{
  cout << z.b;
  z.b = 10;
  cout << z.b;}

void g (S& z)
{cout << z.b; z.b = 20;}

void h (S* z)
{z->b = 30;}

S i (S z)
{cout << z.b; z.b = 40; return z;}
```

```
int main ()
{
  S x;
  x.b = 0;

  f(x); cout << x.b;
  g (x); cout << x.b;
  h (&x); cout << x.b;


  cout << i(x).b;
  cout << x.b;
}
```

Библиография

Niklaus Wirth. *"Algorithms + Data Structures = Programs"*,Prentice-Hall Series in Automatic Computation, 1976