

Распараллеливающее преобразование циклов «retiming»

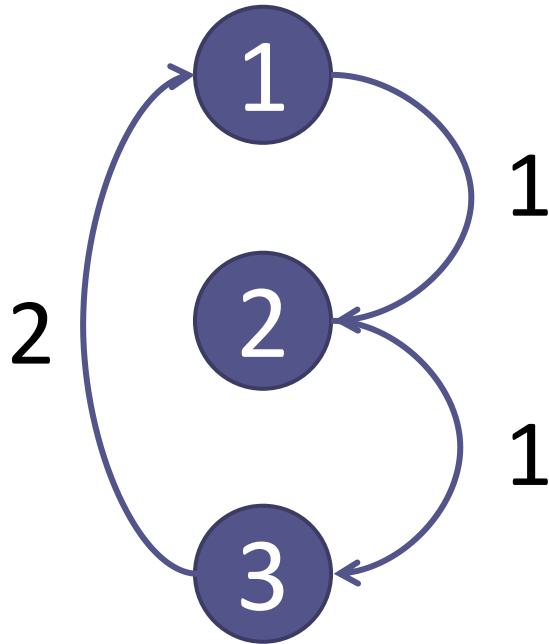
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компьютерных наук им. И. И. Воровича
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ИСТОЧНИК

- Duo Liu, Zili Shao, Meng Wang, Minyi Guo and Jingling Xue. Optimal Loop Parallelization for Maximizing Iteration-Level Parallelism. [International Conference on Compilers, Architecture, and Synthesis for Embedded Systems \(CASES'09\), Grenoble, 2009](#)

```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```

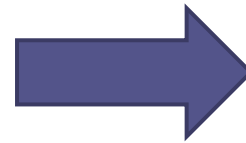
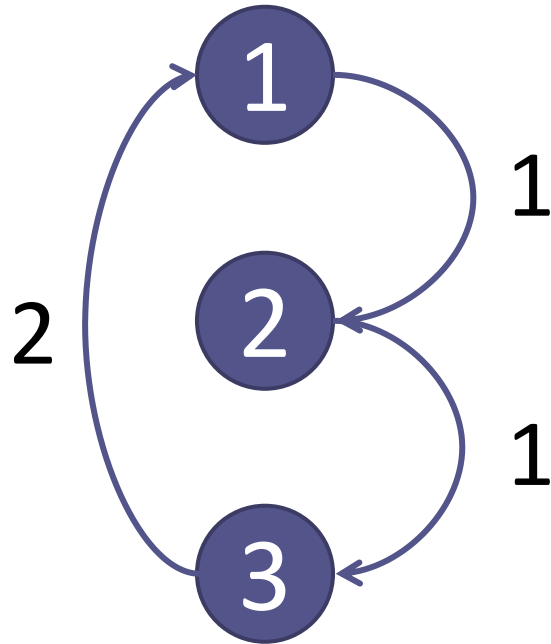
```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```



```

for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}

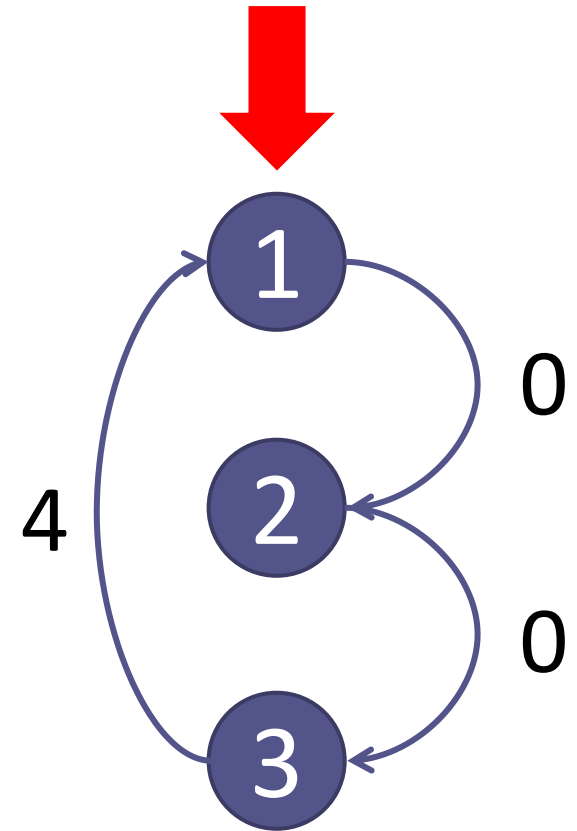
```



```

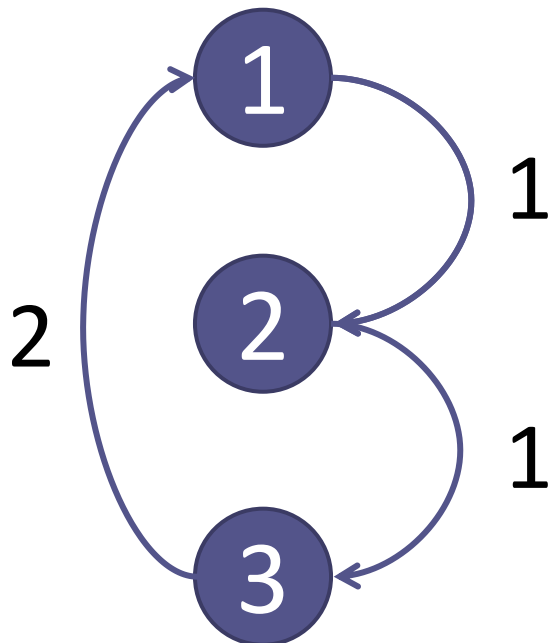
/*Результирующий код*/

```

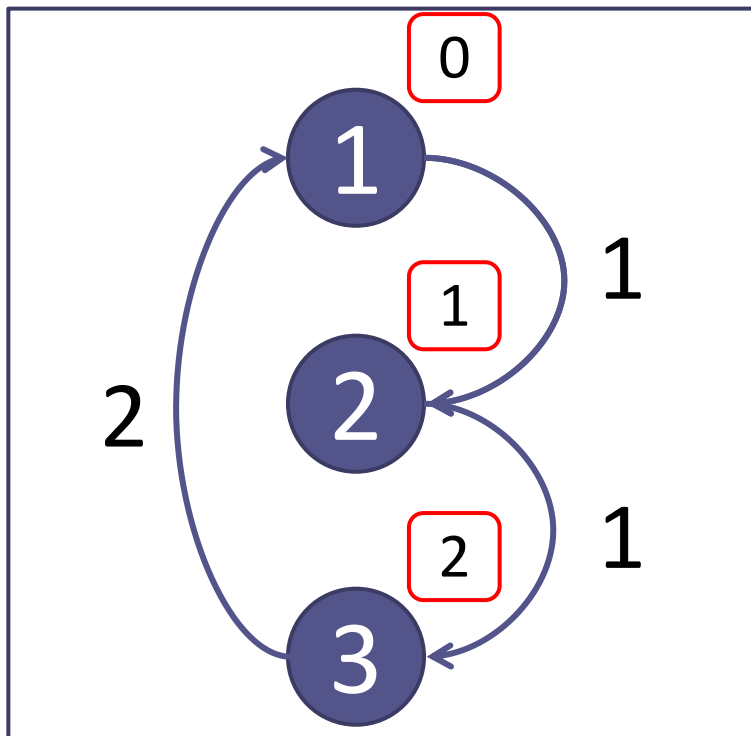


```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```

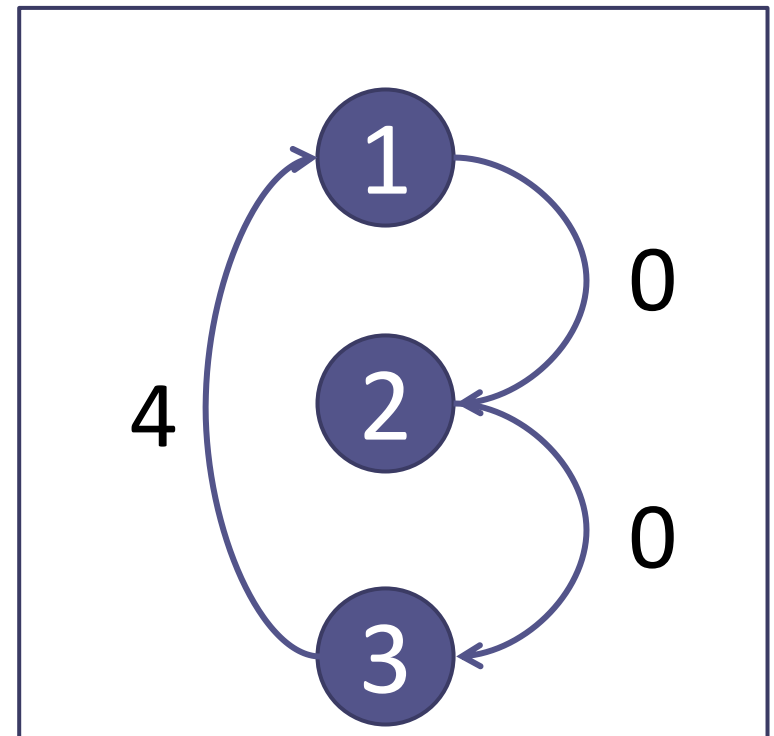
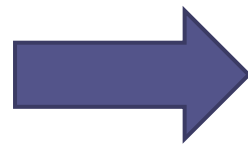
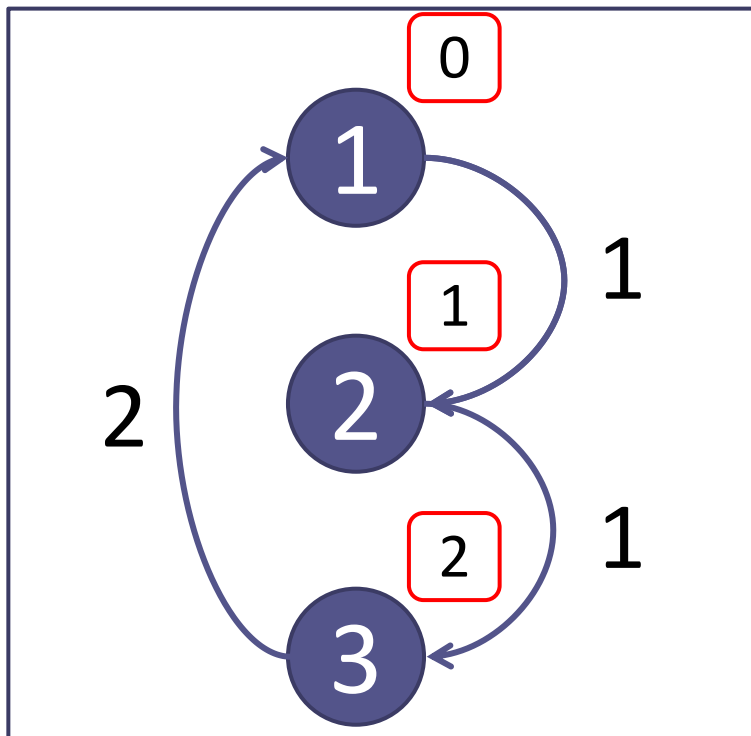
```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```



```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```



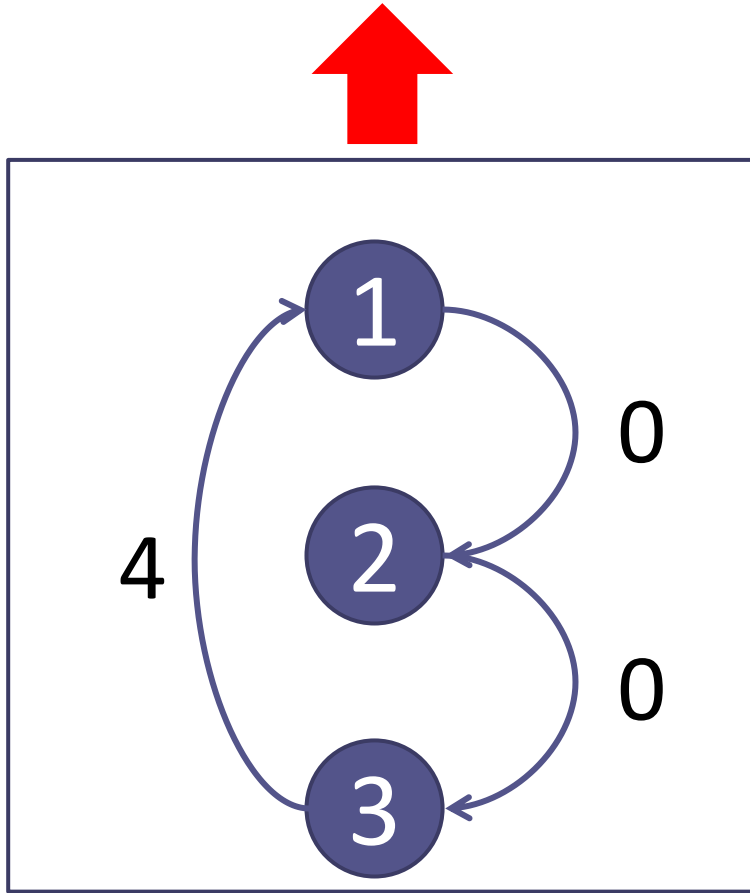
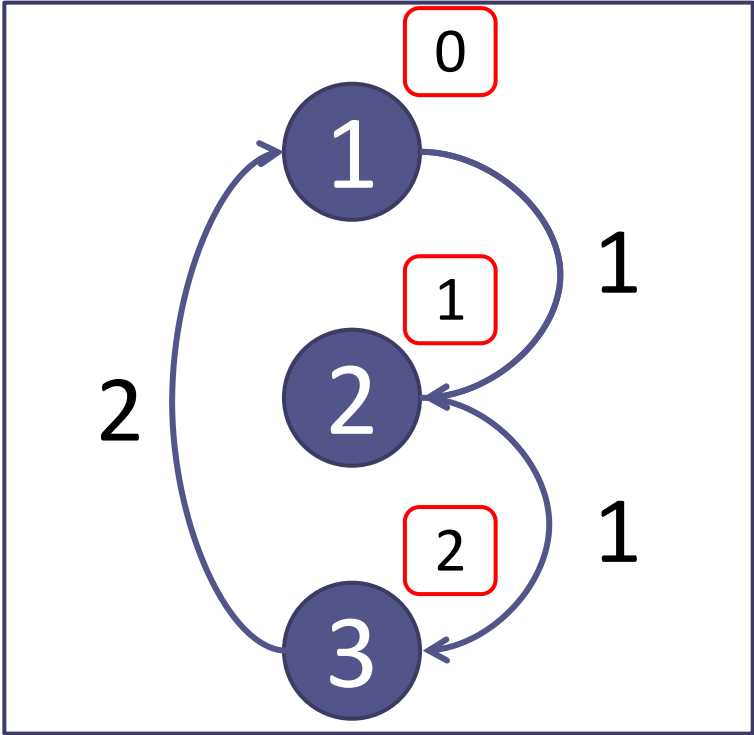

```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```



```
for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}
```



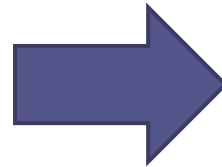
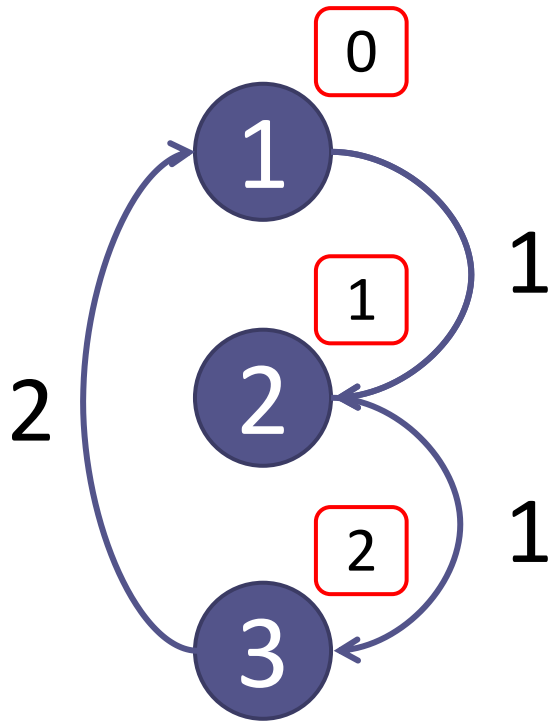
```
/*Результирующий код*/
```



```

for (int i=0; i<1000; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+1] = ...a[i]... ;
    c[i+2] = ...b[i]... ;
}

```



```
c[2] = ...b[0]... ;
```

```
b[1] = ...a[0]... ;
```

```
c[3] = ...b[1]... ;
```

```

for (int i=0; i<1000-2; ++i)
{
    a[i+1] = ...c[i]... ;
    b[i+2] = ...a[i+1]... ;
    c[i+4] = ...b[i+2]... ;
}

```

```

a[999] = ...c[998]... ;
b[1000] = ...a[999]... ;

```

```
a[1000] = ...c[999]... ;
```

Схема реализации преобразования



Экономия регистров

Исходный цикл

.L13:

```

movl    (%rdx,%rax,4), %r10d
imull   8(%rcx,%rax,4), %r10d
movl    %r10d, 4(%rdi,%rax,4)

movl    (%rdi,%rax,4), %r10d
addl   4(%r8,%rax,4), %r10d
movl    %r10d, 4(%rsi,%rax,4)

movl    (%rsi,%rax,4), %r10d
subl   (%r9,%rax,4), %r10d
movl    %r10d, 8(%rdx,%rax,4)

addq   $1, %rax
cmpl   %eax, %r11d
jg     .L13

```

Преобразованный цикл

.L13:

```

movl    (%rdx,%rax,4), %r10d
imull   8(%rcx,%rax,4), %r10d
movl    %r10d, 4(%rdi,%rax,4)

addl   8(%r8,%rax,4), %r10d
movl    %r10d, 8(%rsi,%rax,4)

subl   8(%r9,%rax,4), %r10d
movl    %r10d, 16(%rdx,%rax,4)

addq   $1, %rax
cmpl   %eax, %r11d
jg     .L13

```

Экономия памяти

Целевая архитектура

Спасибо за внимание!