

Assignment 3

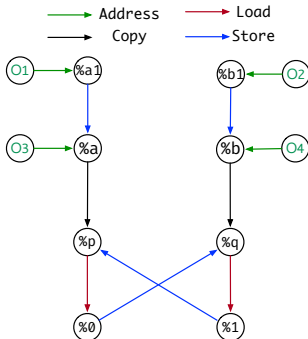
Yulei Sui

University of Technology Sydney, Australia

Andersen's Pointer Analysis

Algorithm

```
define i32 @main() #0 {
entry:
%a1 = alloca i8, align 1      // O1
%b1 = alloca i8, align 1      // O2
%a = alloca i8*, align 8      // O3
%b = alloca i8*, align 8      // O4
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```



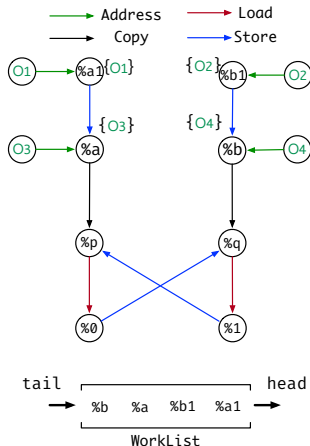
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G = < V, E > // Constraint Graph
V: a set of nodes in graph
E: a set of edges in graph
WorkList: a vector of nodes

1 foreach address p = &o do // Address rule
2   pts(p) = {o}
3   pushIntoWorklist(p)
4 while WorkList ≠ ∅ do
5   p ← popFromWorklist()
6   foreach o ∈ pts(p) do
7     foreach store *p = q do // Store rule
8       if q → o ∉ E then
9         E ← E ∪ {q → o} // Add copy edge
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  ret i32 0  
}  
  
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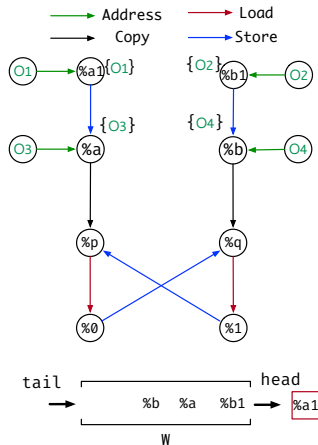


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  ret void  
}
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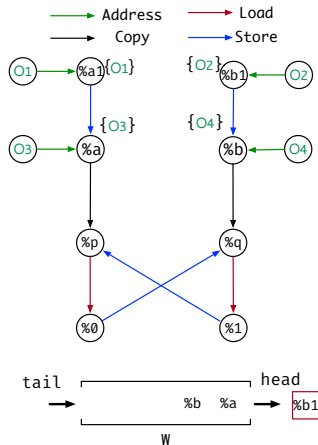


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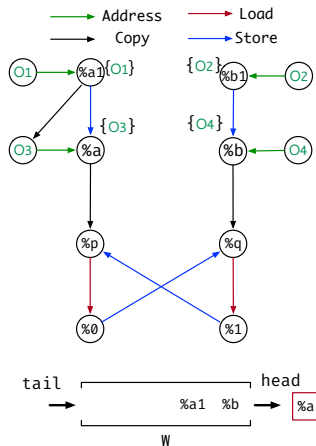


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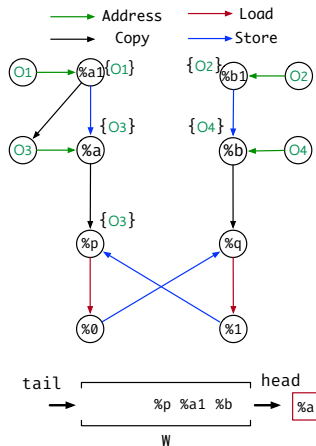


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```

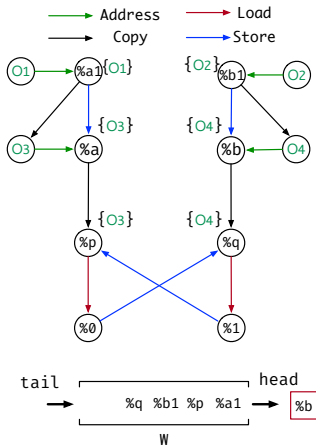


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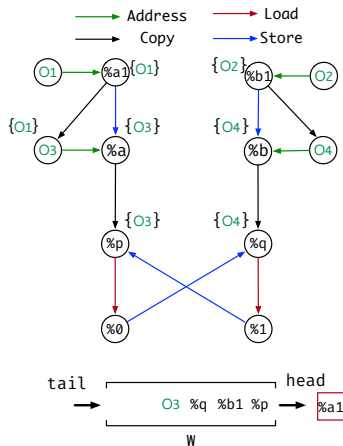


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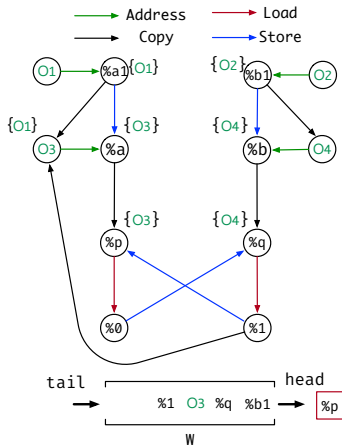


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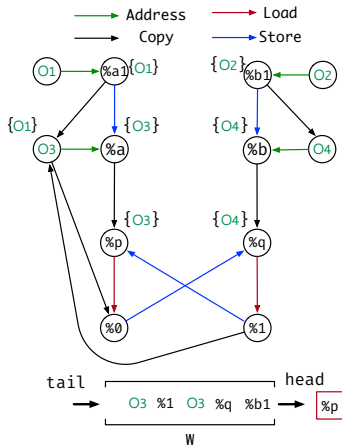
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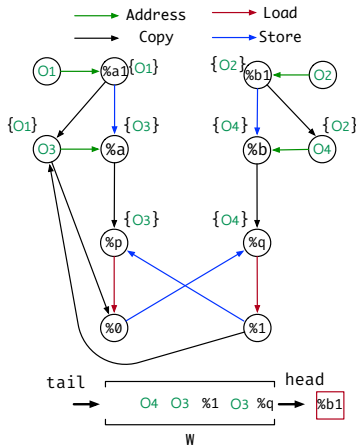
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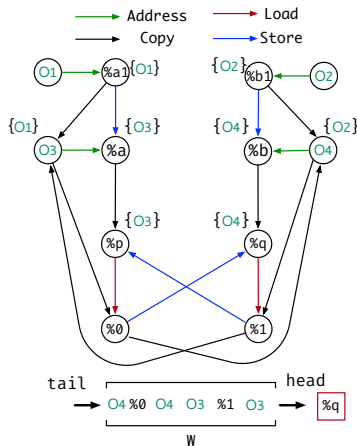


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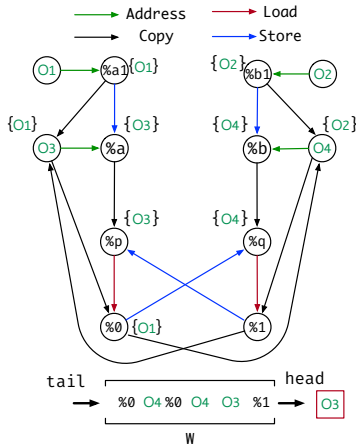


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12        if o → r ∉ E then  
13          E ← E ∪ {o → r} // Add copy edge  
14          pushIntoWorklist(o)  
15      foreach p → x ∈ E do // Copy rule  
16        pts(x) ← pts(x) ∪ pts(p)  
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```

Andersen's Pointer Analysis

Algorithm

```
define i32 @main() #0 {  
  entry:  
  %a1 = alloca i8, align 1      // O1  
  %b1 = alloca i8, align 1      // O2  
  %a = alloca i8*, align 8      // O3  
  %b = alloca i8*, align 8      // O4  
  store i8* %a1, i8** %a, align 8  
  store i8* %b1, i8** %b, align 8  
  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
define void @swap(i8** %p, i8** %q)  
#0 {  
  entry:  
  %0 = load i8** %p, align 8  
  %1 = load i8** %q, align 8  
  store i8* %1, i8** %p, align 8  
  store i8* %0, i8** %q, align 8  
  ret void  
}
```



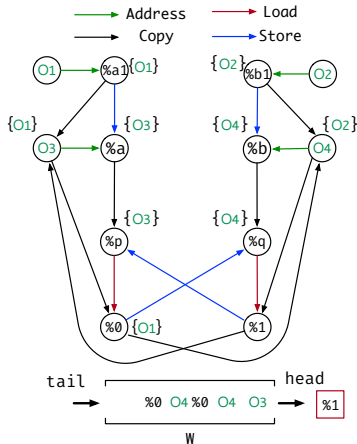
```
G = < V, E > // Constraint Graph  
V: a set of nodes in graph  
E: a set of edges in graph  
WorkList: a vector of nodes  
1 foreach address p = &o do // Address rule  
2   pts(p) = {o}  
3   pushIntoWorklist(p)  
4 while WorkList ≠ ∅ do  
5   p ← popFromWorklist()  
6   foreach o ∈ pts(p) do  
7     foreach store *p = q do // Store rule  
8       if q → o ∉ E then  
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Andersen's Pointer Analysis

Algorithm

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%a1 = alloca i8, align 1           // O1
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%a = alloca i8*, align 8           // O3
%b = alloca i8*, align 8           // O4
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}

define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```



```

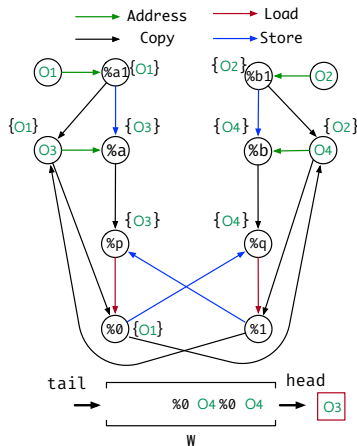
G = < V, E > // Constraint Graph
V: a set of nodes in graph
E: a set of edges in graph
WorkList: a vector of nodes

1 foreach address p = &o do // Address rule
2   pts(p) = {o}
3   pushIntoWorklist(p)
4 while WorkList ≠ ∅ do
5   p ← popFromWorklist()
6   foreach o ∈ pts(p) do
7     foreach store *p = q do // Store rule
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Andersen's Pointer Analysis

Algorithm

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%a1 = alloca i8, align 1           // O1
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%b = alloca i8*, align 8           // O4
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```



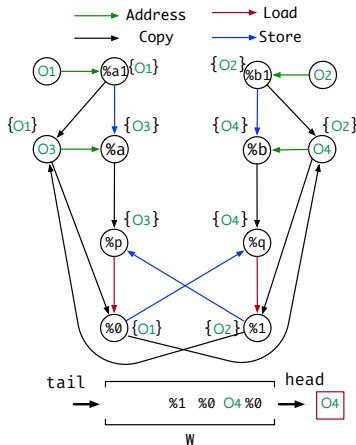
```
G = < V, E > // Constraint Graph
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WorkList: a vector of nodes

1 foreach address p = &o do // Address rule
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3   pushIntoWorklist(p)
4 while WorkList ≠ ∅ do
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6   foreach o ∈ pts(p) do
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Andersen's Pointer Analysis

Algorithm

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  %a = alloca i8*, align 8      // O3  
  %b = alloca i8*, align 8      // O4  
  store i8* %a1, i8** %a, align 8  
  store i8* %b1, i8** %b, align 8  
  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
define void @swap(i8** %p, i8** %q)  
#0 {  
  entry:  
  %0 = load i8** %p, align 8  
  %1 = load i8** %q, align 8  
  store i8* %1, i8** %p, align 8  
  store i8* %0, i8** %q, align 8  
  ret void  
}
```

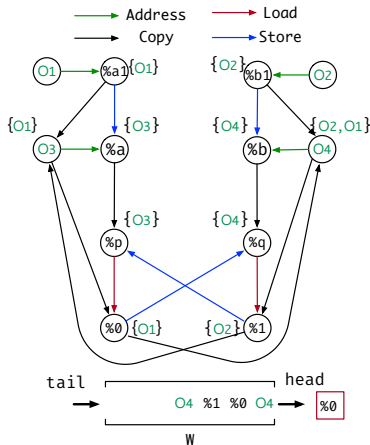


```
G = < V, E > // Constraint Graph  
V: a set of nodes in graph  
E: a set of edges in graph  
WorkList: a vector of nodes  
1 foreach address p = &o do // Address rule  
2   pts(p) = {o}  
3   pushIntoWorklist(p)  
4 while WorkList ≠ ∅ do  
5   p ← popFromWorklist()  
6   foreach o ∈ pts(p) do  
7     foreach store *p = q do // Store rule  
8       if q → o ∉ E then  
9         E ← E ∪ {q → o} // Add copy edge  
10        pushIntoWorklist(q)  
11      foreach load r = *p do // Load rule  
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Andersen's Pointer Analysis

Algorithm

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  %a = alloca i8*, align 8      // O3  
  %b = alloca i8*, align 8      // O4  
  store i8* %a1, i8** %a, align 8  
  store i8* %b1, i8** %b, align 8  
  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
define void @swap(i8** %p, i8** %q)  
#0 {  
  entry:  
  %0 = load i8** %p, align 8  
  %1 = load i8** %q, align 8  
  store i8* %1, i8** %p, align 8  
  store i8* %0, i8** %q, align 8  
  ret void  
}
```

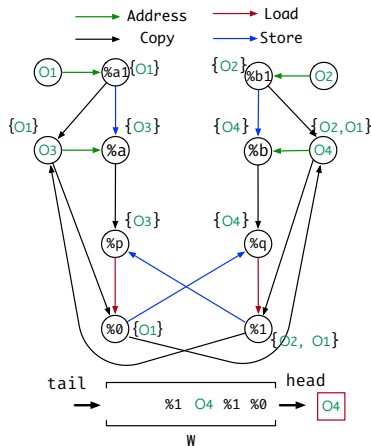


```
G = < V, E > // Constraint Graph  
V: a set of nodes in graph  
E: a set of edges in graph  
WorkList: a vector of nodes  
1 foreach address p = &o do // Address rule  
2   pts(p) = {o}  
3   pushIntoWorklist(p)  
4 while WorkList !=  $\emptyset$  do  
5   p  $\leftarrow$  popFromWorklist()  
6   foreach o  $\in$  pts(p) do  
7     foreach store *p = q do // Store rule  
8       if q  $\rightarrow$  o  $\notin$  E then  
9         E  $\leftarrow$  E  $\cup$  {q  $\rightarrow$  o} // Add copy edge  
10        pushIntoWorklist(q)  
11      foreach load r = *p do // Load rule  
12        if o  $\rightarrow$  r  $\notin$  E then  
13          E  $\leftarrow$  E  $\cup$  {o  $\rightarrow$  r} // Add copy edge  
14          pushIntoWorklist(o)  
15      foreach p  $\rightarrow$  x  $\in$  E do // Copy rule  
16        pts(x)  $\leftarrow$  pts(x)  $\cup$  pts(p)  
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```

Andersen's Pointer Analysis

Algorithm

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define i32 @main() #0 {
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%a1 = alloca i8, align 1      // O1
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%a = alloca i8*, align 8      // O3
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store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```



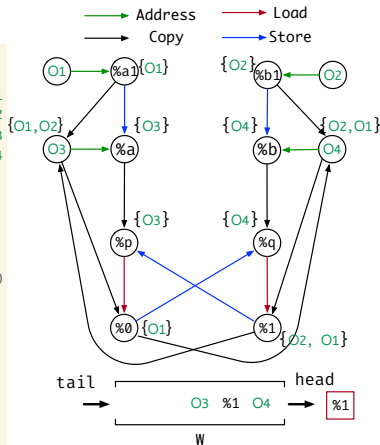
```
G = < V, E > // Constraint Graph
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WorkList: a vector of nodes

1 foreach address p = &o do // Address rule
2   pts(p) = {o}
3   pushIntoWorklist(p)
4 while WorkList ≠ ∅ do
5   p ← popFromWorklist()
6   foreach o ∈ pts(p) do
7     foreach store *p = q do // Store rule
8       if q → o ∉ E then
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Andersen's Pointer Analysis

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  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
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  store i8* %1, i8** %p, align 8  
  store i8* %0, i8** %q, align 8  
  ret void  
}
```

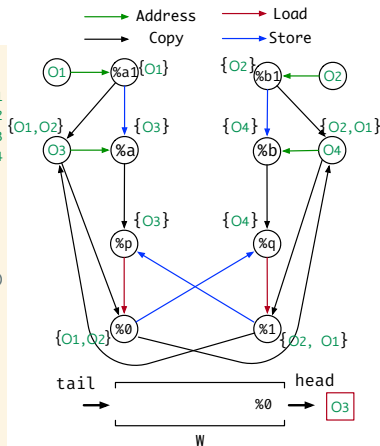


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Andersen's Pointer Analysis

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store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
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entry:
%0 = load i8** %p, align 8
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store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

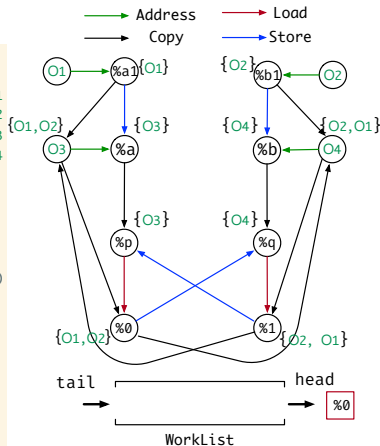


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  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
define void @swap(i8** %p, i8** %q)  
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