

# Assignment 3

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# Assignment 3: Data-Dependence

## Andersen's points-to analysis

- You will be using what you have learned about Andersen's pointer analysis.
- **Goal:** implement Andersen's pointer analysis by solving the constraint graph of a program.

# Assignment 3: Data-Dependence

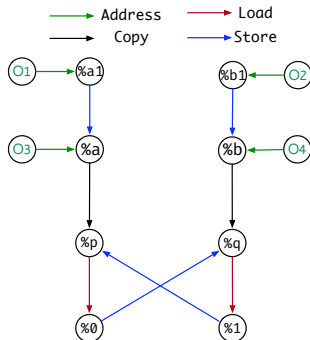
## Andersen's points-to analysis

- You will be using what you have learned about Andersen's pointer analysis.
- **Goal:** implement Andersen's pointer analysis by solving the constraint graph of a program.
- **Specification and code template:**  
<https://github.com/SVF-tools/SVF-Teaching/wiki/Assignment-3>
- **SVF CPP API**  
<https://github.com/SVF-tools/SVF-Teaching/wiki/SVF-CPP-API>

# 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
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store i8* %a1, i8** %a, align 8
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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
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ret void
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E: a set of edges in graph
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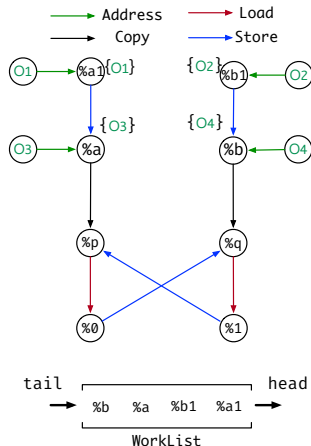
1 foreach address p = &o do // Address rule
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4 while WorkList ≠ ∅ do
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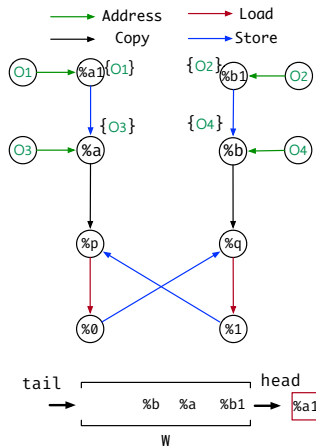
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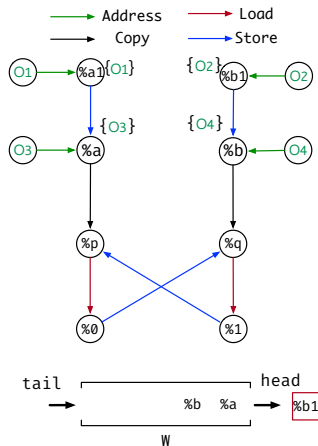
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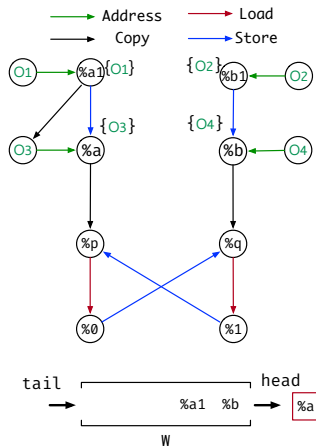
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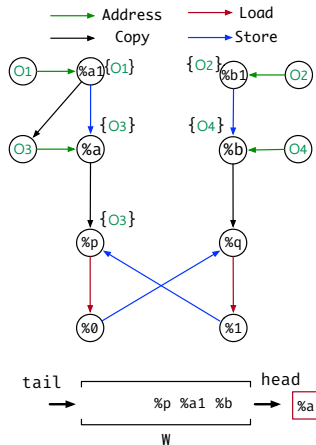
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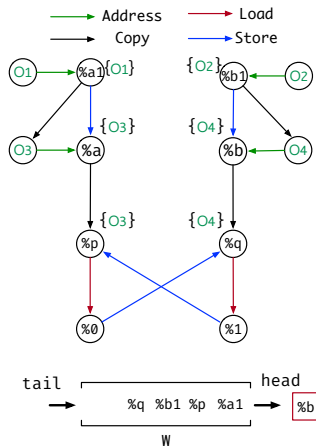
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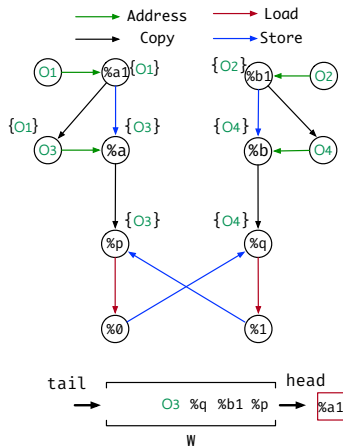
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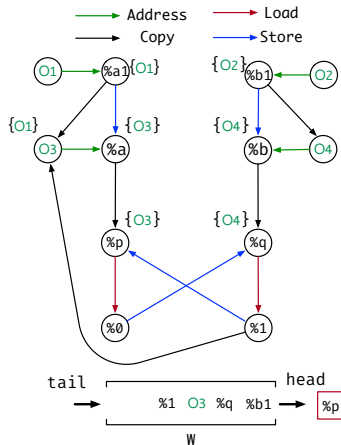


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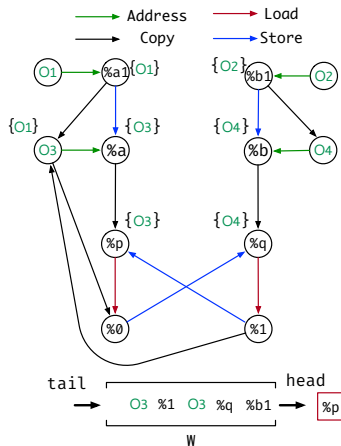


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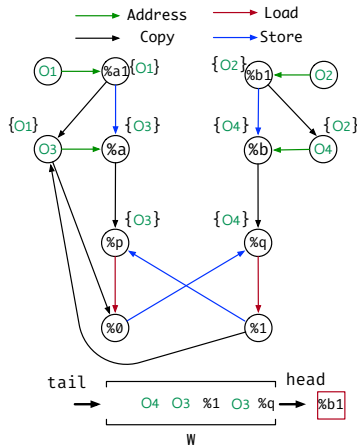


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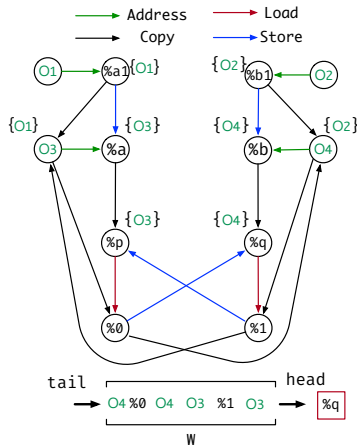
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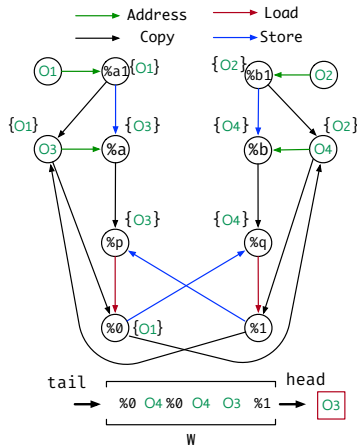


```
G = < V, E > // Constraint Graph  
V: a set of nodes in graph  
E: a set of edges in graph  
WorkList: a vector of nodes  
  
1 foreach address p = &o do // Address rule  
2   pts(p) = {o}  
3   pushIntoWorklist(p)  
4 while WorkList ≠ ∅ do  
5   p ← popFromWorklist()  
6   foreach o ∈ pts(p) do  
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)  
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14          pushIntoWorklist(o)  
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16        pts(x) ← pts(x) ∪ pts(p)  
17        if pts(x) changed then  
18          pushIntoWorklist(x)
```

# 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  
}
```



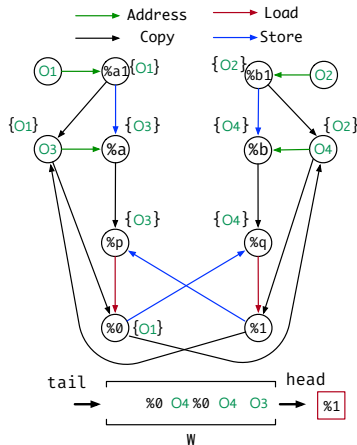
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G = < V, E > // Constraint Graph  
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17    if pts(x) changed then  
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```



# Andersen's Pointer Analysis

## Algorithm

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define i32 @main() #0 {  
  entry:  
  %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  
}
```



---

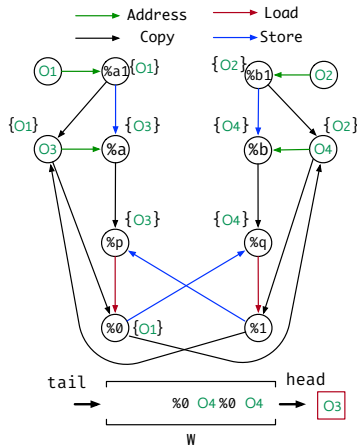
```
G = < V, E > // Constraint Graph  
V: a set of nodes in graph  
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1 foreach address p = &o do // Address rule  
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7     foreach store *p = q do // Store rule  
8       if q → o ∉ E then  
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```

---

# Andersen's Pointer Analysis

## Algorithm

```
define i32 @main() #0 {  
  entry:  
  %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  
}
```



---

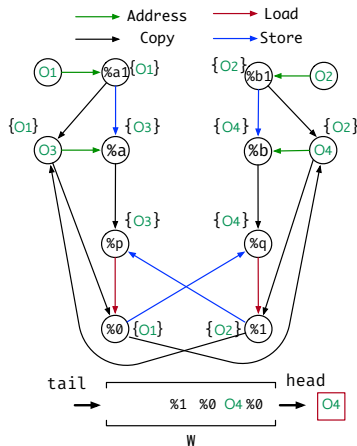
```
G = < V, E > // Constraint Graph  
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WorkList: a vector of nodes  
  
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---

# Andersen's Pointer Analysis

## Algorithm

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define i32 @main() #0 {  
  entry:  
  %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  
}
```

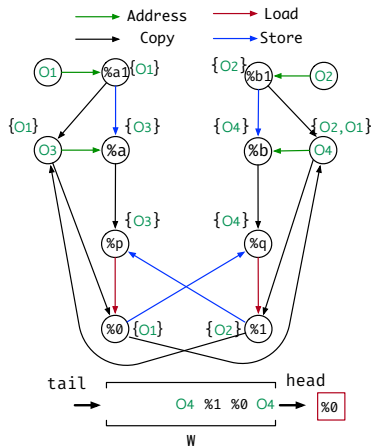


```
G = < V, E > // Constraint Graph  
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WorkList: a vector of nodes  
1 foreach address p = &o do // Address rule  
2   pts(p) = {o}  
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6   foreach o ∈ pts(p) do  
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# Andersen's Pointer Analysis

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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  
}
```

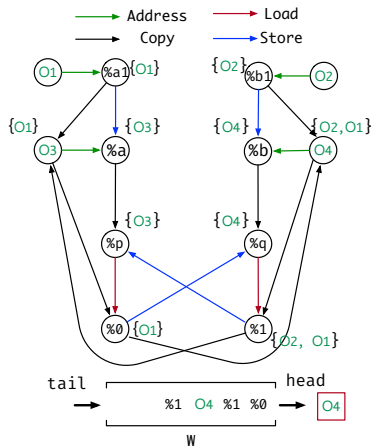


```
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# Andersen's Pointer Analysis

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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  
}
```

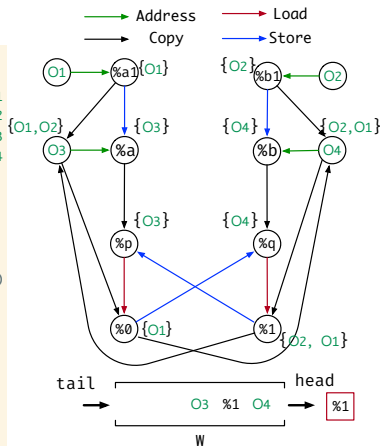


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  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
  
define void @swap(i8** %p, i8** %q)  
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  %0 = load i8** %p, align 8  
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  store i8* %1,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

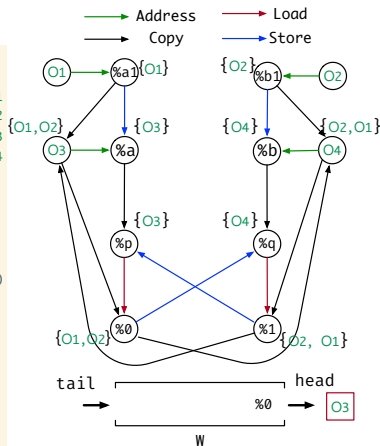


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  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
  
define void @swap(i8** %p, i8** %q)  
#0 {  
  entry:  
  %0 = load i8** %p, align 8  
  %1 = load i8** %q, align 8  
  store i8* %1, i8** %p, align 8  
  store i8* %0, i8** %q, align 8  
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



---

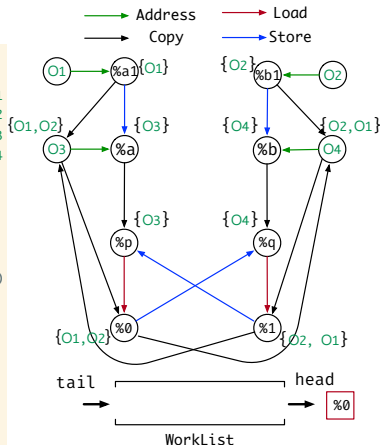
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  store i8* %b1, i8** %b, align 8  
  call void @swap(i8** %a, i8** %b)  
  ret i32 0  
}  
define void @swap(i8** %p, i8** %q)  
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  entry:  
  %0 = load i8** %p, align 8  
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}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



---

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