Assignment 3

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Assignment 3: Quiz + A Coding Task

- A quiz (10 points)
  - Data dependence
  - Constraint graph
  - Andersen's points-to analysis

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- A quiz (10 points)
  - Data dependence
  - Constraint graph
  - Andersen's points-to analysis
- One coding task (15 points)
  - **Goal**: implement Andersen's pointer analysis by solving the constraint graph of a program.
  - **Specification and code template**: `https://github.com/SVF-tools/Teaching-Software-Analysis/wiki/Assignment-3`
  - **SVF CPP API** `https://github.com/SVF-tools/Teaching-Software-Analysis/wiki/SVF-CPP-API`

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
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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)
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%0 = load i8** %p, align 8
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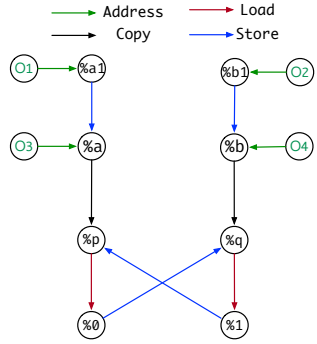


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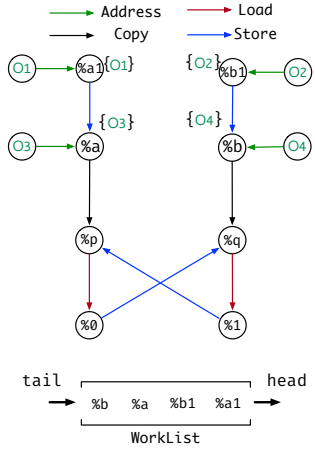


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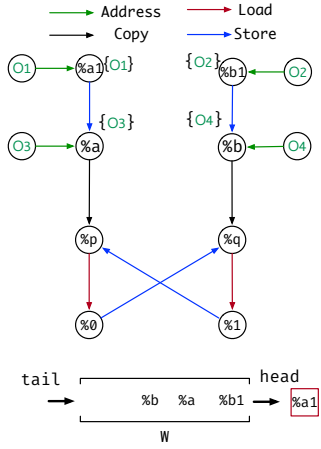


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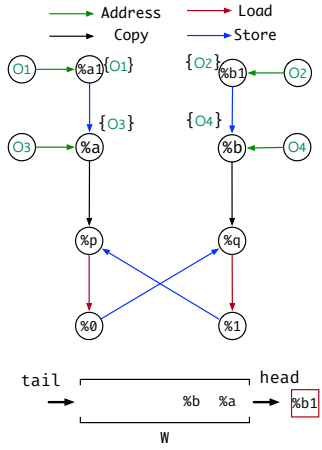


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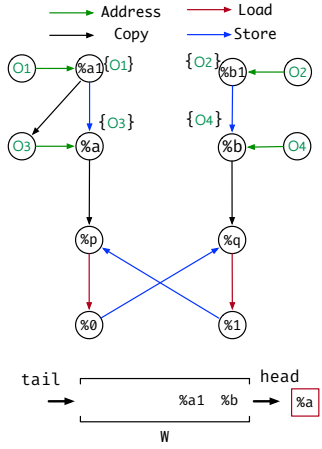


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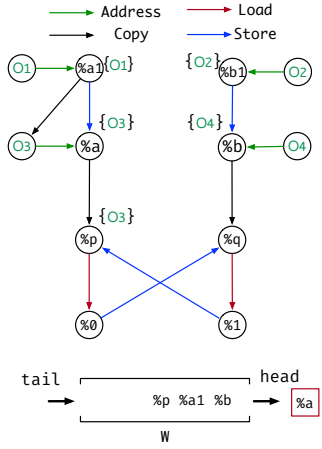


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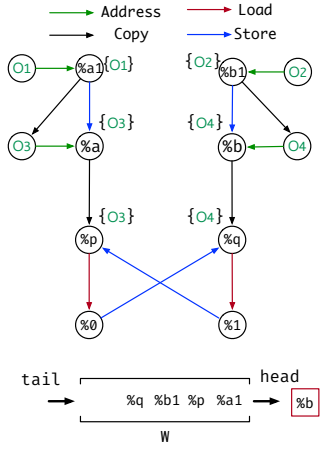


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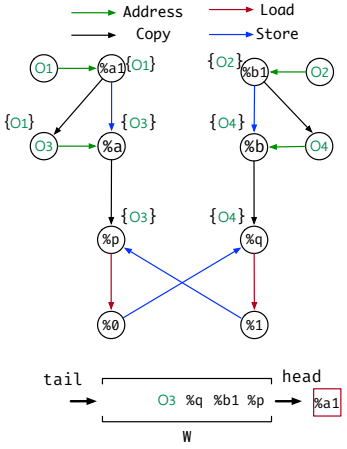


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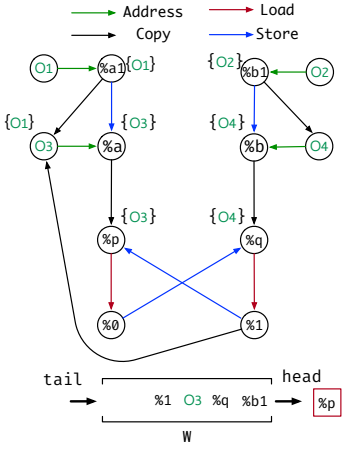


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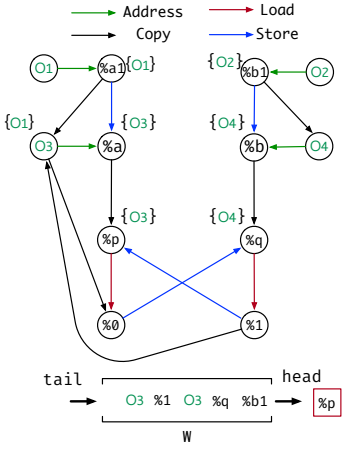


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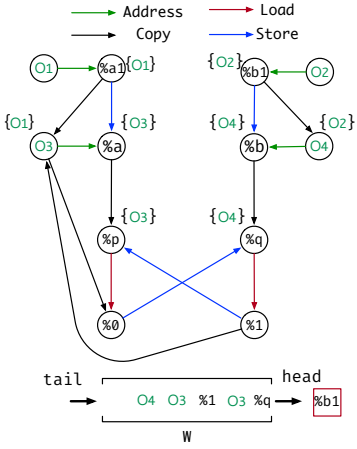


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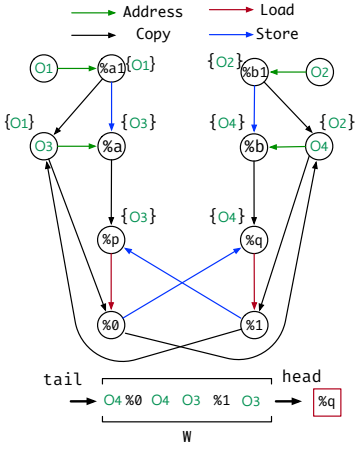
18         pushIntoWorklist(x)
```

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
}
```




```
G = < V,E >  // Constraint Graph
V: a set of nodes in graph
E: a set of edges in graph
WorkList: a vector of nodes
foreach o --Address--> p do          // Address rule
    pts(p) = {o}
    pushIntoWorklist(p)
while WorkList ≠ ∅ do
  p ← popFromWorklist()
  foreach o ∈ pts(p) do
    foreach q --Store--> p do        // Store rule
      if q --Copy--> o ∉ E then
        E ← E ∪ {q --Copy--> o}// Add copy edge
        pushIntoWorklist(q)
    foreach p --Load--> r do         // Load rule
      if o --Copy--> r ∉ E then
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Andersen's Pointer Analysis

Algorithm

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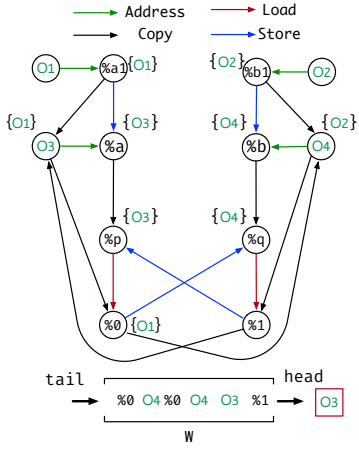
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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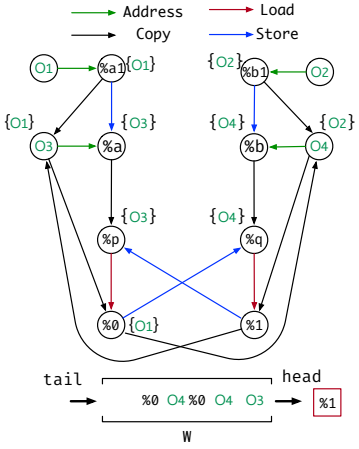
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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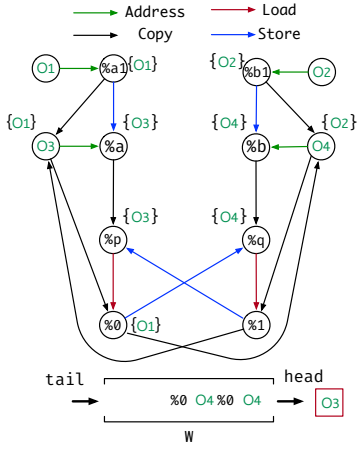
%b = alloca i8*, align 8        // O4
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q,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

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16         pts(x) ← pts(x) ∪ pts(p)
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```

Andersen's Pointer Analysis

Algorithm

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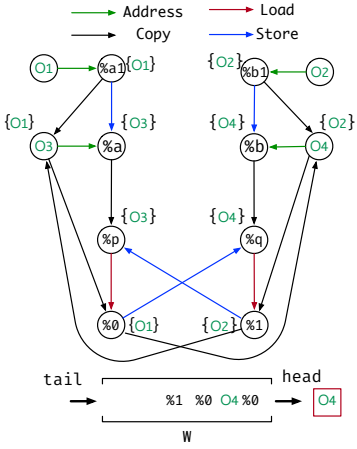
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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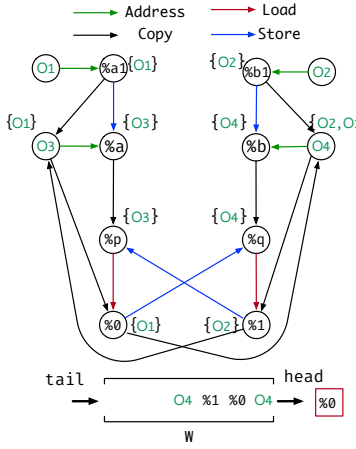
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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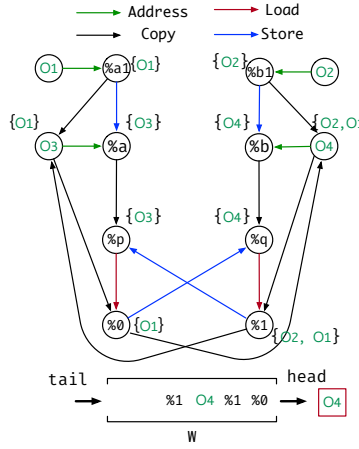
store i8* %a1, i8** %a, align 8
store i8* %b1, i8** %b, align 8
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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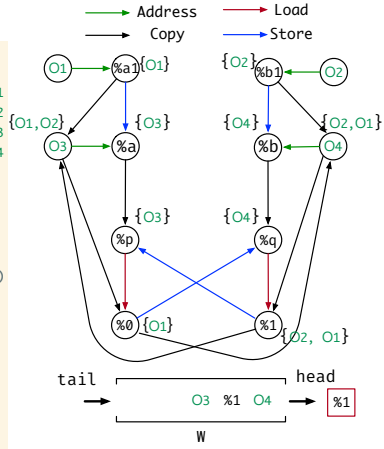
call void @swap(i8** %a, i8** %b)
ret i32 0
}
define void @swap(i8** %p, i8** %q)
#0 {
entry:
%0 = load i8** %p, align 8
%1 = load i8** %q, align 8
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

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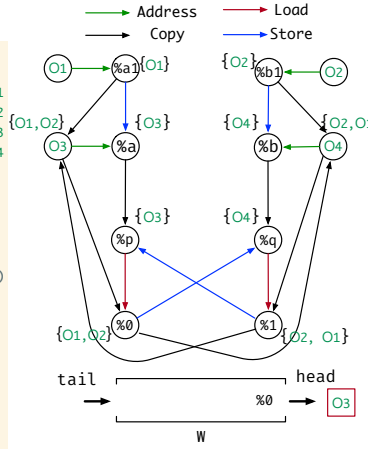
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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Andersen's Pointer Analysis

Algorithm

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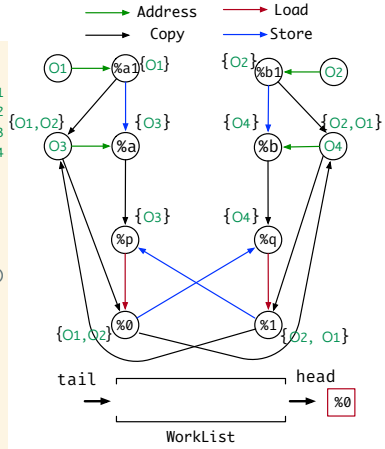
store i8* %1, i8** %p, align 8
store i8* %0, i8** %q, align 8
ret void
}
```

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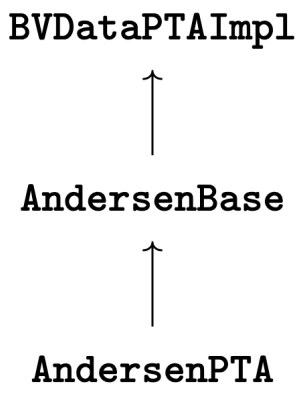
Assignment Structure

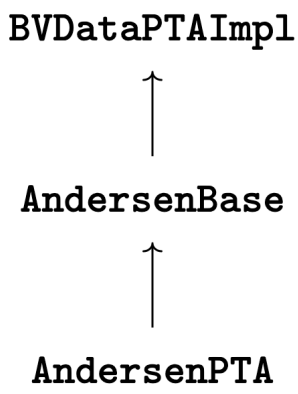
- You will be working on `AndersenPTA`'s `solveWorklist` method.

Assignment Structure



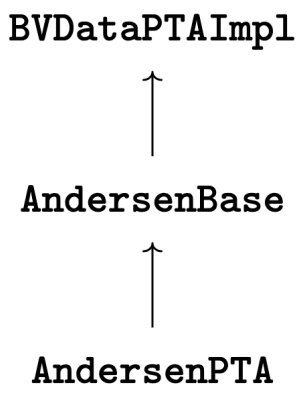
- You will be working on `AndersenPTA`'s `solveWorklist` method.
- Constraint graph is the field `consCG`.

Assignment Structure



- You will be working on `AndersenPTA`'s `solveWorklist` method.
- Constraint graph is the field `consCG`.
- Address edge processing is done for you.

Assignment Structure



- You will be working on `AndersenPTA`'s `solveWorklist` method.
- Constraint graph is the field `consCG`.
- Address edge processing is done for you.
- Note in the API there is a `getDirectInEdges`/`getDirectOutEdges` but no `getCopyIn/OutEdges`. This is intentional, use the `Direct` variant.
- You will reuse this assignment for assignment 4, make sure it is clean. :)