

# CS6013 - Modern Compilers: Theory and Practice

## Alias analysis

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## Alias/Points to analysis

- May and must analysis.
- Flow sensitive and insensitive analysis.
- Abstract representation of Stack ( $\rho$ ) and Heap ( $\sigma$ ).
- Rules for updating  $\rho$  and  $\sigma$  – for each statement in miniLR.
- Lattice (subset based).
- Meet operations for may and must analysis.



## Opening remarks

What have we done so far?

- Compiler overview.
- Scanning and parsing.
- JavaCC, visitors and JTB
- Semantic Analysis - specification, execution, attribute grammars.
- Type checking, Intermediate Representation, Intermediate code generation.
- Control flow analysis, interval analysis, structural analysis
- Data flow analysis, intra-procedural and inter-procedural constant propagation.
- Loop Optimizations.
- Call Graphs, Inter procedural constant propagation.

Announcement:

- Assignment 4 – one week to go.

Today: Alias analysis examples.



## Example 1

```
i: m = new X(); // Ri
j: n = new X(); // Rj
k: p = m;
l: p = n;
a: q = p;
b: n = m;
```

Flow insensitive:

```
p -> {Ri, Rj}
q -> {Ri, Rj}
n -> {Ri, Rj}
```



## Example 2

```
1) h: a = new Object(); // Rh
2) i: b = new Object(); // Ri
3) j: c = new Object(); // Rj
4) a = b;
5) b = c;
6) c = a;
```

Flow insensitive (part):	Flow insensitive (fully):
a -> {Rh, Ri}	a -> {Ri, Rj, Rh}
b -> {Ri, Rj}	b -> {Ri, Rj, Rh}
c -> {Ri, Rj, Rh}	c -> {Ri, Rj, Rh}



## Example 3

```
p = new A(); // R1
p.f = new Y(); // R2
if (cond) {
    q = new X(); // R3
    q.f = new Z(); // R4
    r1 = q;
} else {
    q = new X(); // R5
    q.f = new Z(); // R6
    r2 = q;
}
p.f = new Y(); // R7
q.f = new Z(); // R8
```



## Example 4

```
insert (int m) {
    prev = lst
    while (lst != null) {
        prev = lst;
        lst = lst.next;
    }
    prev.next = new node(m);
    lst = prev;
}
```



## Example 5

```
node insert (int [] a) {

    if (a.length == 0) return null;
    if (a.length == 1) return new node(a[0]);
    List lst = new node(a[0]); // R1
    for (int i=1; i <a.length; ++i) {
        lst.next = new node(a[i]); // R2
        lst = lst.next;
    }
    return lst;
}
```



## Example 6

```
node insert(node p, int m)
{
  node q;
  q = p;
  while (q != null){
    if (q.val == m)
      return q;
    if (q.next == null) {
      q.next = new node(m); // R2
    }
    q = q.next
  }
  q = new node(m); // R1
  return q;
}
```



## Example 7

```
node find(node p, int m)
{
  node q;
  q = p;
  while (q != null){
    if (q.val == m)
      return q;
    q = q.next
  }
  return null;
}
```



## Closing remarks

What have we done today?

- Flow sensitive intra-procedural alias analysis

To read

- Muchnick - Ch 10, Dragon book - 12.4

Next:

- Register Allocation

