Domination-Based Scoping and Static Single Assignment Languages

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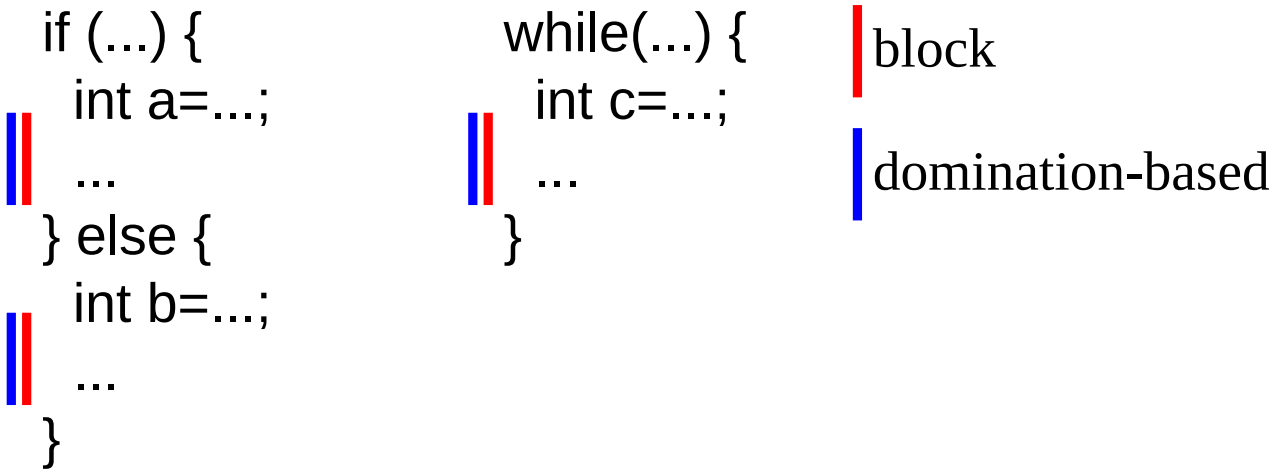
Domination-based Scoping

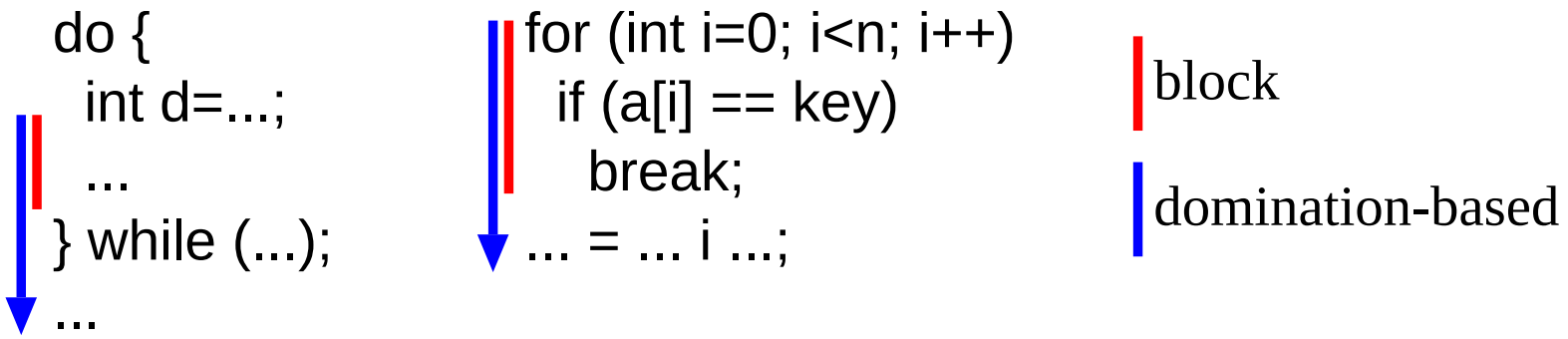
- Frequent Mistake: Uninitialized Variables
- Initialize variables on definition
- Visible only where initialized
- Visible everywhere where initialized
- $\Rightarrow$ in scope where initialization dominates
- Can differ from block scoping
  ... depending on control structure

Domination-based scope same as block scope

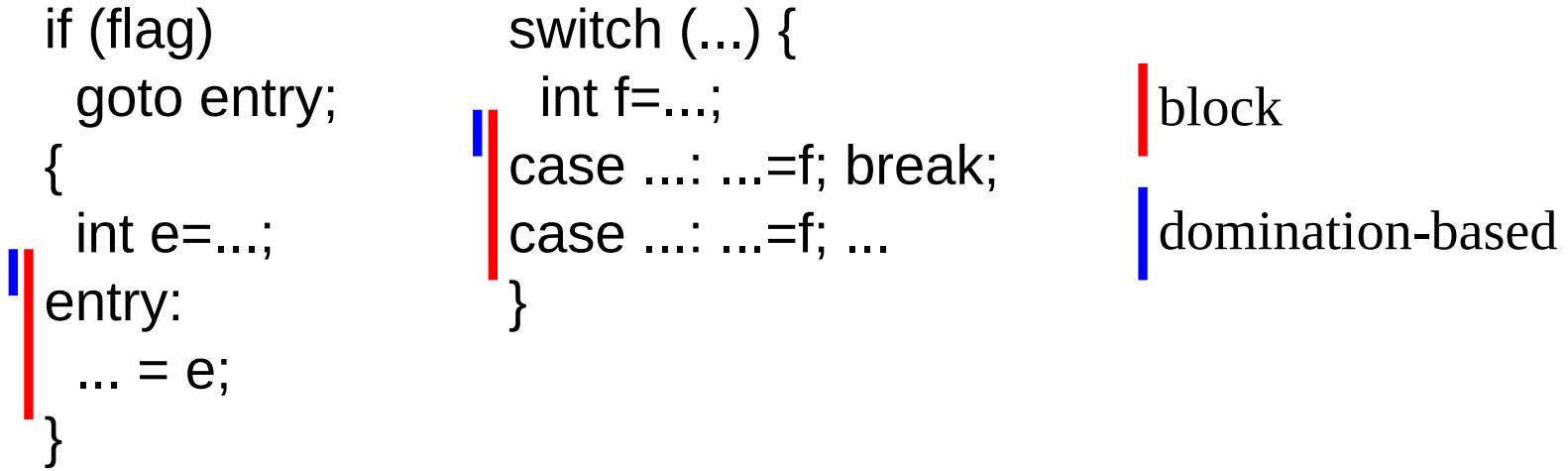


Explains why block scoping works

Domination-based scope larger than block scope



Domination-based scope smaller than block scope



Experiences

- Implemented in Gforth since 1994
- No problems reported by users
- Occasionally useful

Pros and Cons

– Block scoping is well-known and accepted

\+ If the language supports jumps into blocks

Static Single Assignment Programming

- Each variable has only one assignment (=definition).
- Facilitates understanding the data flow.
- Also for imperative languages.
- Initialization on definition helps a lot, but
- ... what about control flow joins?

ϕ-functions in programming language: confusing

```
unsigned fib(unsigned n)
{
  for (;;) {
    unsigned a=phi(0,b);
    unsigned b=phi(1,a+b);
    unsigned i=phi(n,i-1);
    if (i==0)
      break;
  }
  return a;
}
```

Stack-based languages (Gforth)

```
: fib { n -- n2 }
    0 1 n BEGIN { a b i }
        i 0 <> WHILE
        b  a b +  i 1-
    REPEAT
    a ;
```

Algol-family language without ϕ-functions

```
func fib(n)
  0,1,n -> start -> a,b,i;
     if i=0 then
       exit;
     b, a+b, i-1 ->
  repeat
  a ->
end;
```

Conditional and compound updates

```
x=0;
a={1,2,3};
...
if ...
  x=1;
a[x]=4;
...
... x, a;
... x, a;
```

Experiences

- Works well in Gforth
- Algol-family language implemented in compiler course
- Grammar: statement/sequence/block tradition does not work
- SSA for conditional and compound updates?
- Different declaration syntax for SSA and SMA variables?

Conclusion

- Domination-based scoping
  - ensures that variables are initialized
  - useful for languages with jumps into blocks
  - helps understanding the interaction of scoping and control flow
- Static Single Assignment Programming
  - Makes programs easier to understand
  - Syntax for Algol-family languages interesting
- Paper: `http://www.complang.tuwien.ac.at/papers/ertl07kps.ps.gz`

Expertise

- Code generation:
  Instruction Selection
  Instruction Scheduling
  Register Allocation

- Implementation of efficient interpreters