ModInf: Exploiting Reified Computational Dependencies for Information Flow Analysis

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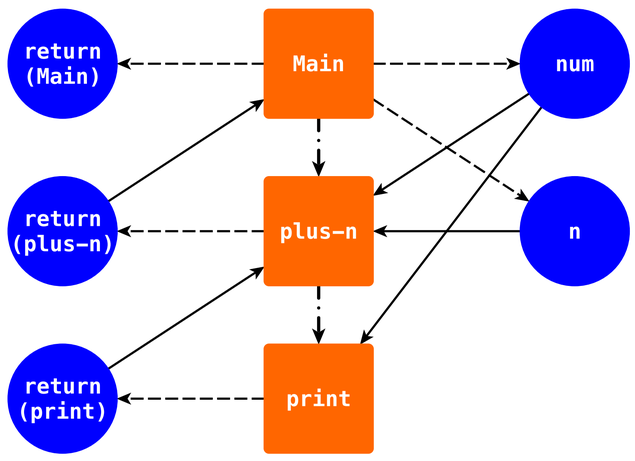
Context

```
(define a #t)
(define a2 (source a))
(define (b x) x)
(define (set-b)
  (set! b (lambda (x) #f)))
(if a2 (set-b))
(define res (b 10))
(sink res)
```

Information flow analysis is used to detect flows of information that decrease the security of an application, e.g., statically using taint analysis.



Modular static analyses divide a program into components that are analysed separately. They scale well and infer inter-component data flow information by design.

Information flow

```
(define x (read))
(define y (read))
(define z (+ x y))
(display z)
```

Explicit information flow: data dependence
"z depends on x and y"

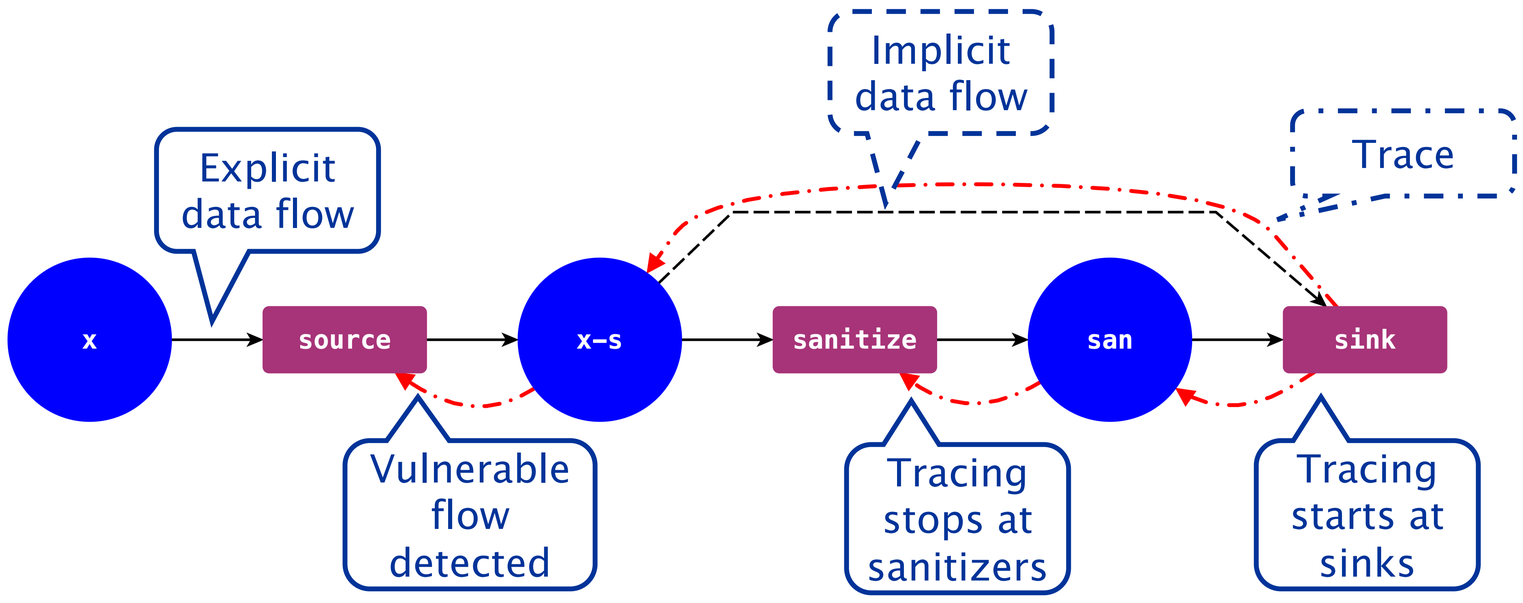
```
(define result #f)
(define input (read))
(if (> input 0)
    (set! result #t))
```

Implicit information flow: control dependence
"result depends on input"

Approach

We extend the *inter*-component data flow information of a modular analysis with *intra*-component flow information, tracked through accesses of the analysis store. We obtain IFC by tracing this flow information instead of by relying on specific lattices or analysis infrastructure. Our approach can handle both explicit and implicit flow information.

```
(define x #t)
(define x-s (source x))
(define san (sanitize x-s))
(if x-s
  (begin
    (sink san)
    (display san))
  #f)
```



Validation

Preliminary validation
- ✓ 9 hand-crafted programs containing complex taint flows
  - Using sources, sinks and sanitizers
  - Containing explicit and implicit information flow
- ✓ Validation using type lattice and no context sensitivity
  - Other lattices and context sensitivities are supported
- ✓ Detected all harmful flows: no false negatives (sound)

Paper link

http://soft.vub.ac.be/Publications/2023/vub-tr-soft-23-04.pdf

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