Lab: Control-Dependence and Reachability

(Week 3)

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Quiz-1 + Lab-Exercise-1 + Assignment-1

- A set of quizzes on WebCMS (5 points)
  - LLVM compiler and its intermediate representation
  - Code graphs (including ICFG and PAG)
- Lab-Exercise-1 (5 points)
  - Implement a graph traversal on a general graph
- Assignment-1 (20 points)
  - **Control-flow**: Implement a context-sensitive graph traversal on a CodeGraph (i.e., ICFG) and print **feasible** paths from a source node to a sink node on the graph
  - **Data-flow**: Implement Andersen's inclusion-based constraint solving for points-to analysis
  - Implement a taint checker using control-flow analysis and data-flow analysis.

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  - **Data-flow**: Implement Andersen's inclusion-based constraint solving for points-to analysis
  - Implement a taint checker using control-flow analysis and data-flow analysis.
  - **Specification and code template**: `https://github.com/SVF-tools/Software-Security-Analysis/wiki/Assignment-1`
  - **SVF APIs for control- and data-flow analysis** `https://github.com/SVF-tools/Software-Security-Analysis/wiki/SVF-CPP-API`

Context-Sensitive Control-Dependence

Algorithm 1: 1 Context sensitive control-flow reachability

Input : curNode : ICFGNode snk : ICFGNode path : vector⟨ICFGNode⟩
callstack : vector⟨SVFInstruction⟩ visited : set⟨ICFGNode, callstack⟩;

```
1  dfs(curNode, dst)
2    pair = ⟨curNode, callstack⟩;
3    if pair ∈ visited then
4  |     return;
5    visited.insert(pair);
6    path.push_back(curNode);
7    if src == snk then
8  |   printICFGPath(path);
9    foreach edge ∈ curNode.getOutEdges() do
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12   |  else if edge.isCallCFGEdge() then
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21   |  |  else if callstack == ∅ then
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23   visited.erase(pair);
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```
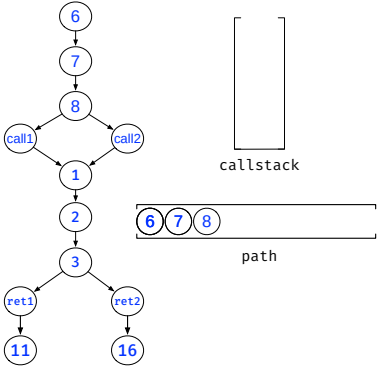

Context-Sensitive Control-Dependence

Obtaining a path from node 6 to node 11 on ICFG



Algorithm 2: 1 Context sensitive control-flow reachability

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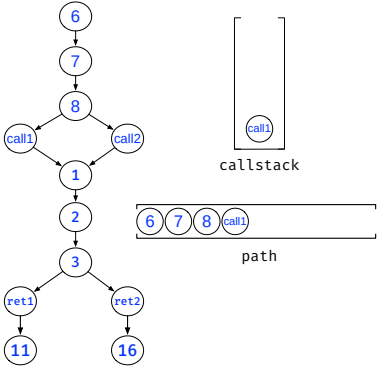

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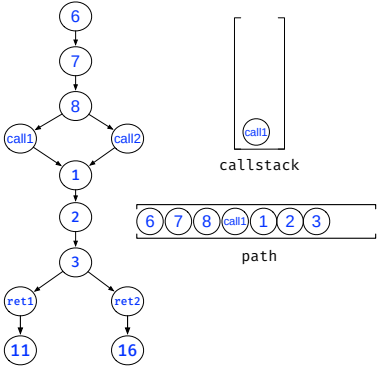

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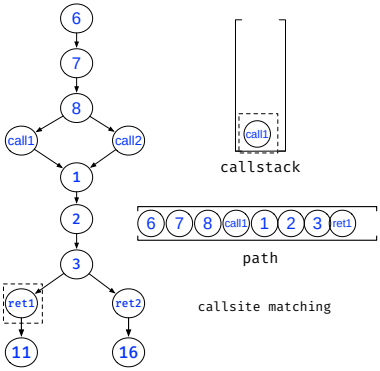

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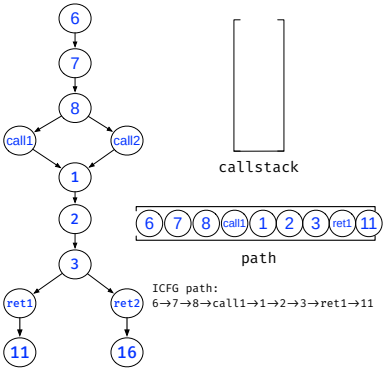

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Context-Sensitive Control-Dependence

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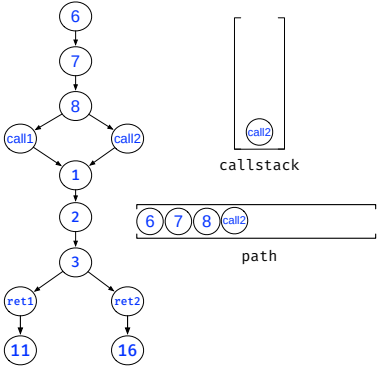

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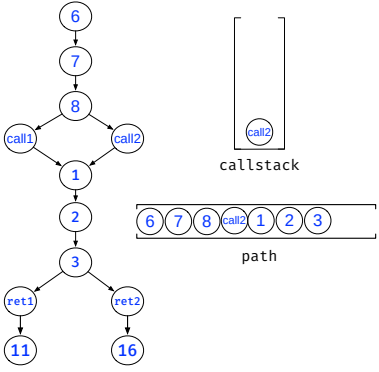

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Context-Sensitive Control-Dependence

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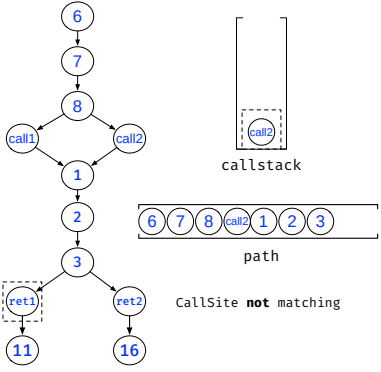

Algorithm 9: 1 Context sensitive control-flow reachability

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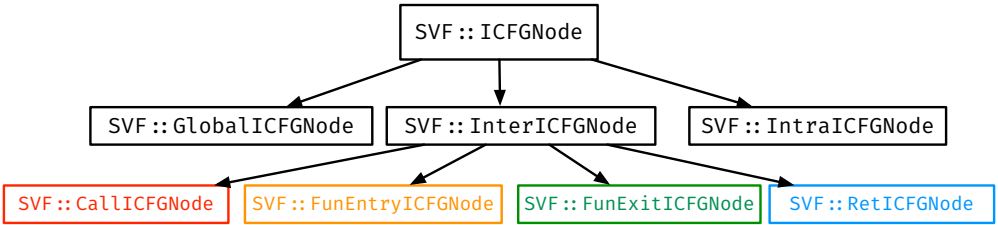
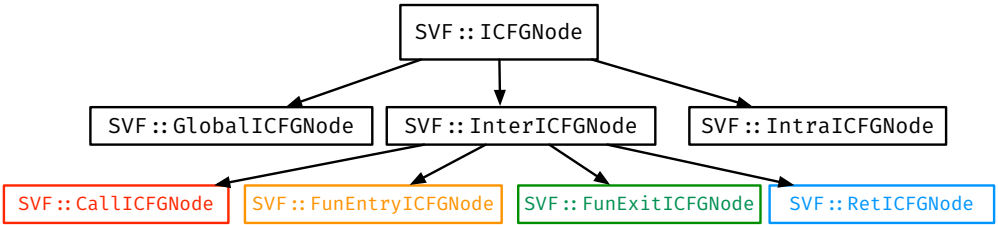
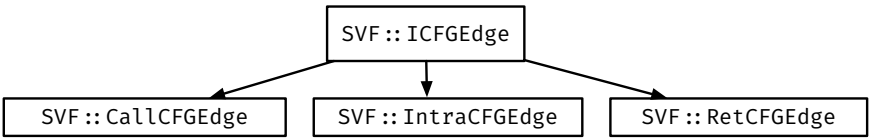
ICFG Node and Edge Classes



https://github.com/SVF-tools/SVF/blob/master/include/Graphs/ICFGNode.h

ICFG Node and Edge Classes





https://github.com/SVF-tools/SVF/blob/master/include/Graphs/ICFGEdge.h

`cast` and `dyn_cast`

- C++ Inheritance: see slides in Week 2.
- Casting a **parent** class pointer to pointer of a **Child** type:
  - `SVFUtil::cast`
    - Casts a pointer or reference to an instance of a specified class. This cast fails and aborts the program if the object or reference is not the specified class at runtime.
  - `SVFUtil::dyn_cast`
    - "Checked cast" operation. Checks to see if the operand is of the specified type, and if so, returns a pointer to it (this operator does not work with references). If the operand is not of the correct type, a null pointer is returned.
    - Works very much like the dynamic_cast<> operator in C++, and should be used in the same circumstances.
- Example: accessing the attributes of the child class via casting.
  - `RetBlockNode* retNode = SVFUtil::cast<RetBlockNode>(ICFGNode);`
  - `CallCFGEdge* callEdge = SVFUtil::dyn_cast<CallCFGEdge>(ICFGEdge);`