Generating Fast Sequential Code from Concurrent Programs

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Motivation

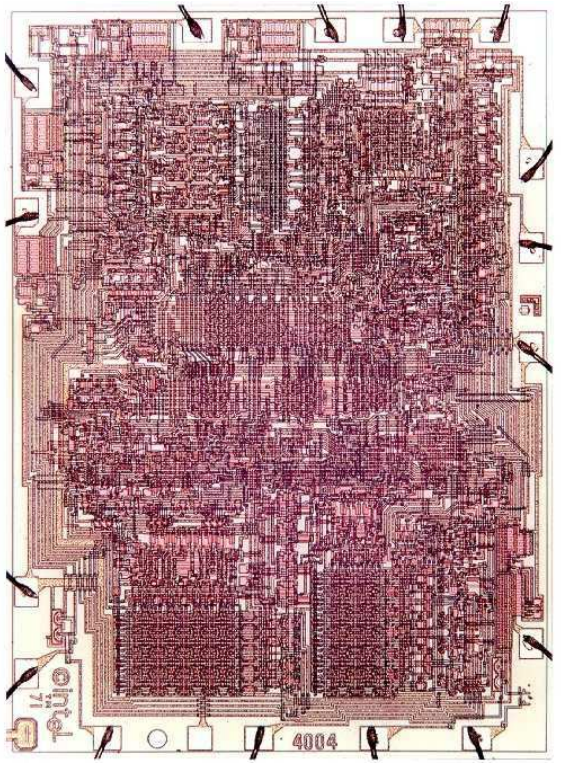
- Dynamic vs. Static Scheduling

	Dynamic	Static
Flexibility	high	low
Overhead	run time	compile time
Behavior	unpredictable	predictable

- Embedded system requirement:
  low run-time cost, quick response, predictable
  $\Rightarrow$ Static scheduling

Motivation Cont.

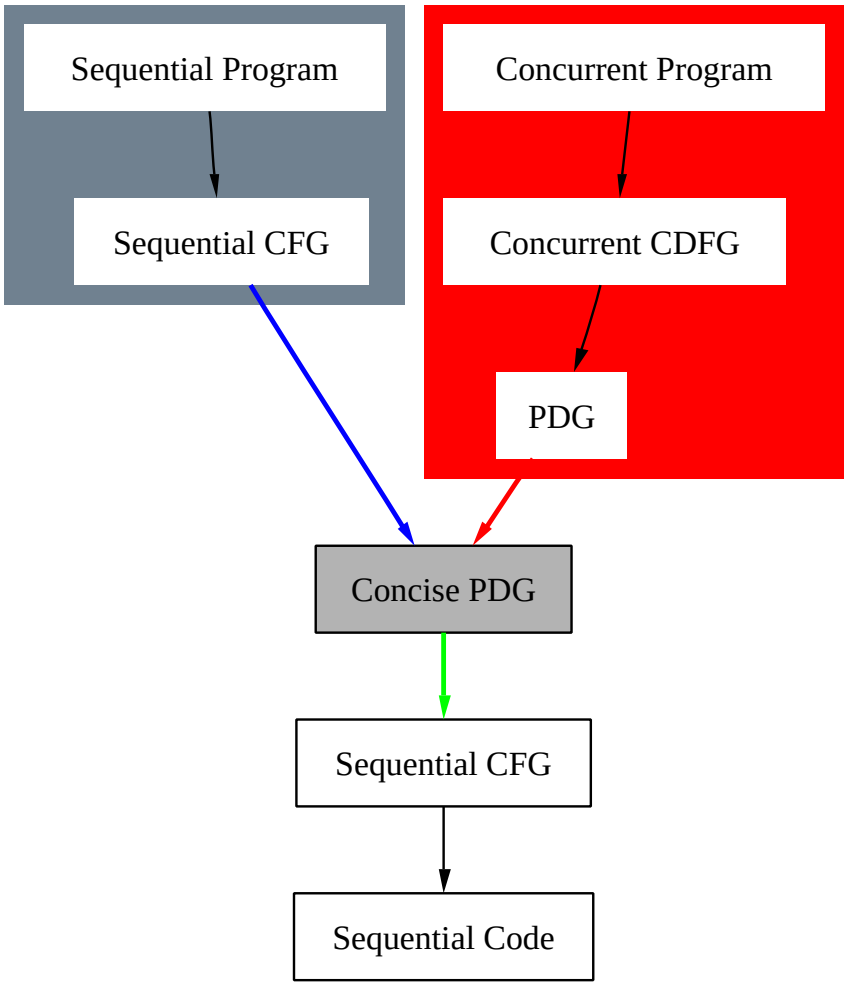
- Hardware Implemention and Simulation



$\Rightarrow$ Simulation is required;

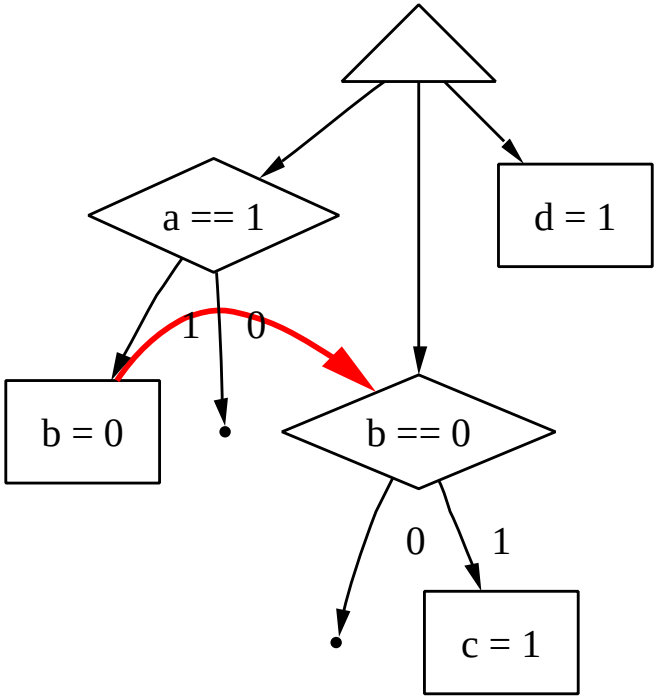
Speed is never fast enough

Overview

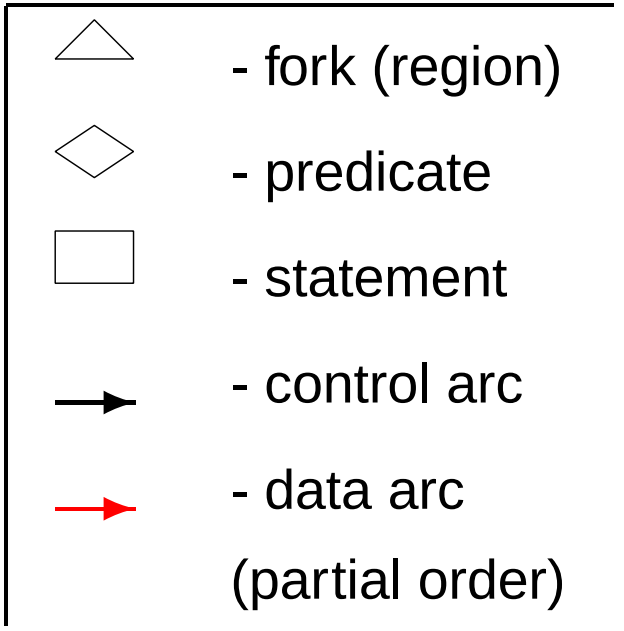


- Ferrante, Mace & Simons, 1984: Using PDG
- Cytron et al., 1991: Generating PDG
- Simons & Ferrante, 1993: External Edge
- Our approach: Natural Concurrent Programs

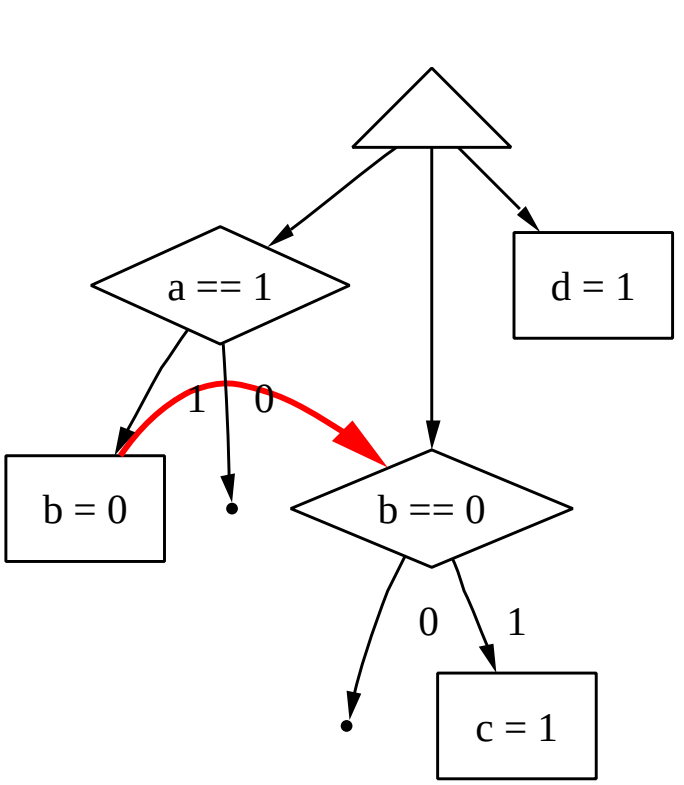
PDG - Program Dependence Graph

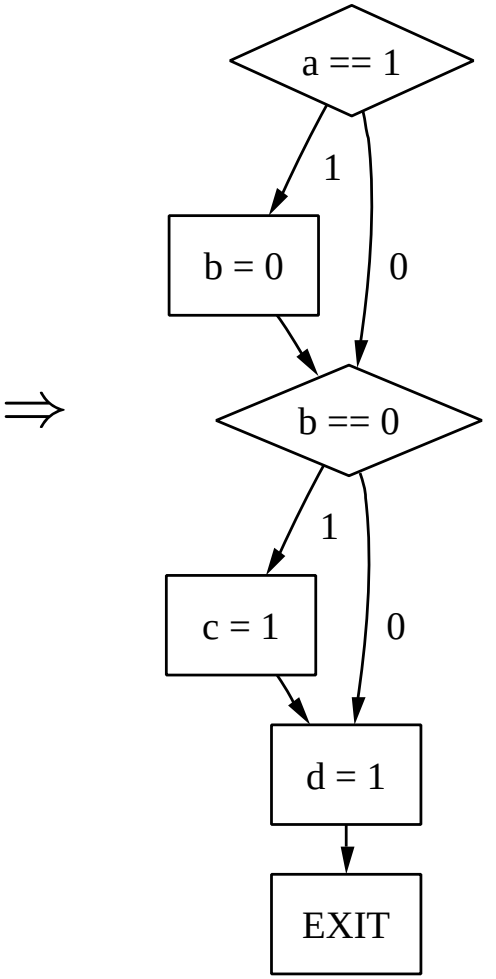



```
if (a == 1)
  b = 0;
d = 1;
if (b == 0)
  c = 1;
```



From PDG to SCFG: Trivial?

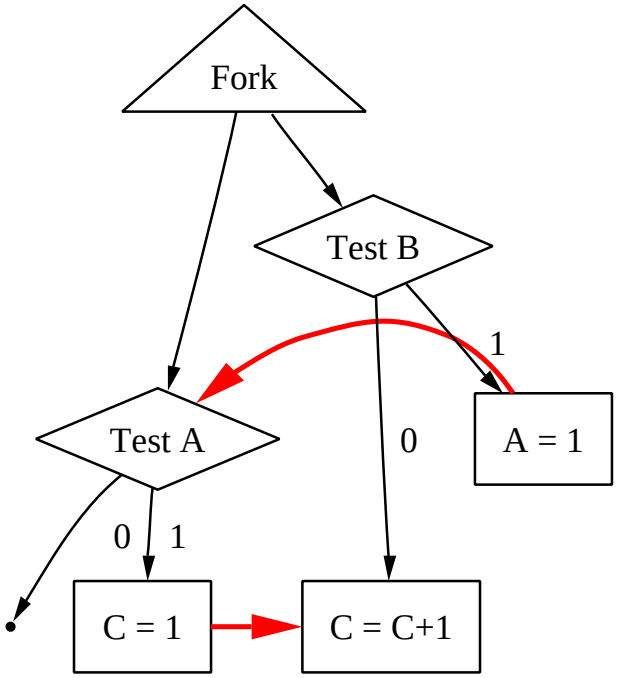


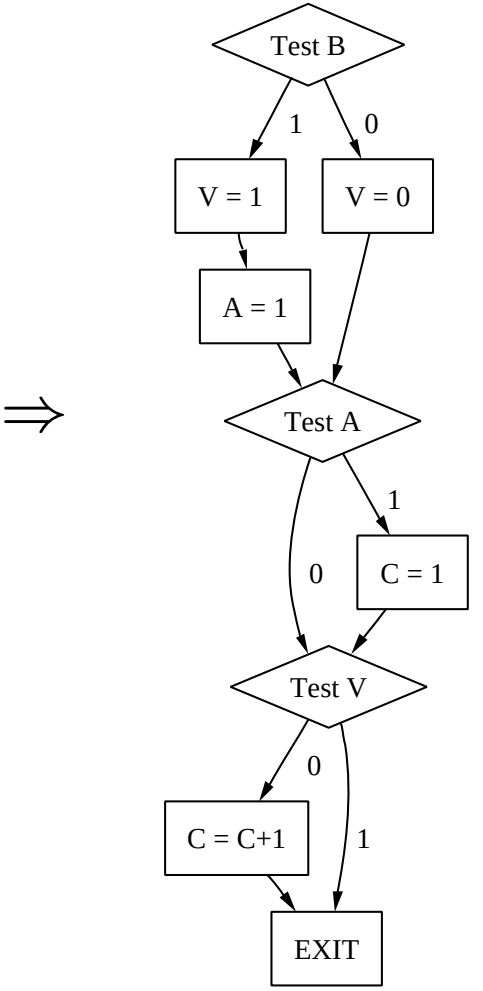


Make it sequential directly

Execute one by one

From PDG to SCFG: Non-trivial

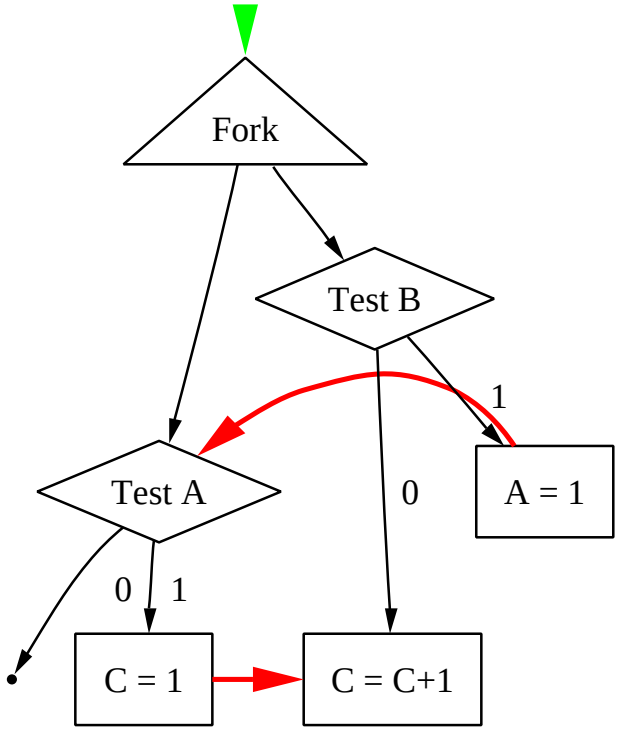




No way to be sequential unless

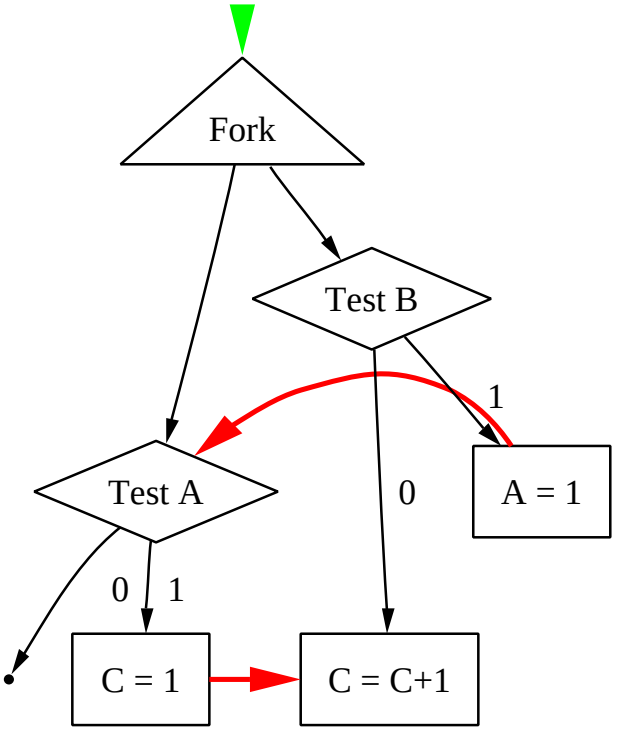
to add guard variable or copy

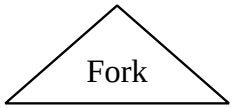
An Example: Reconstructing PDG 0



orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	-	-	-	-	-	-

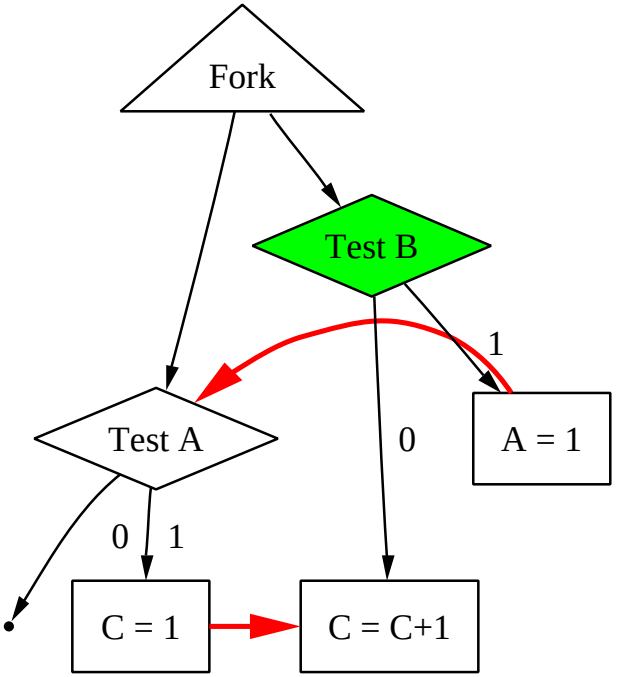
An Example: Reconstructing PDG 1

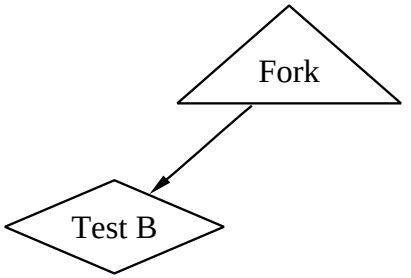




orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	-	-	-	-	-

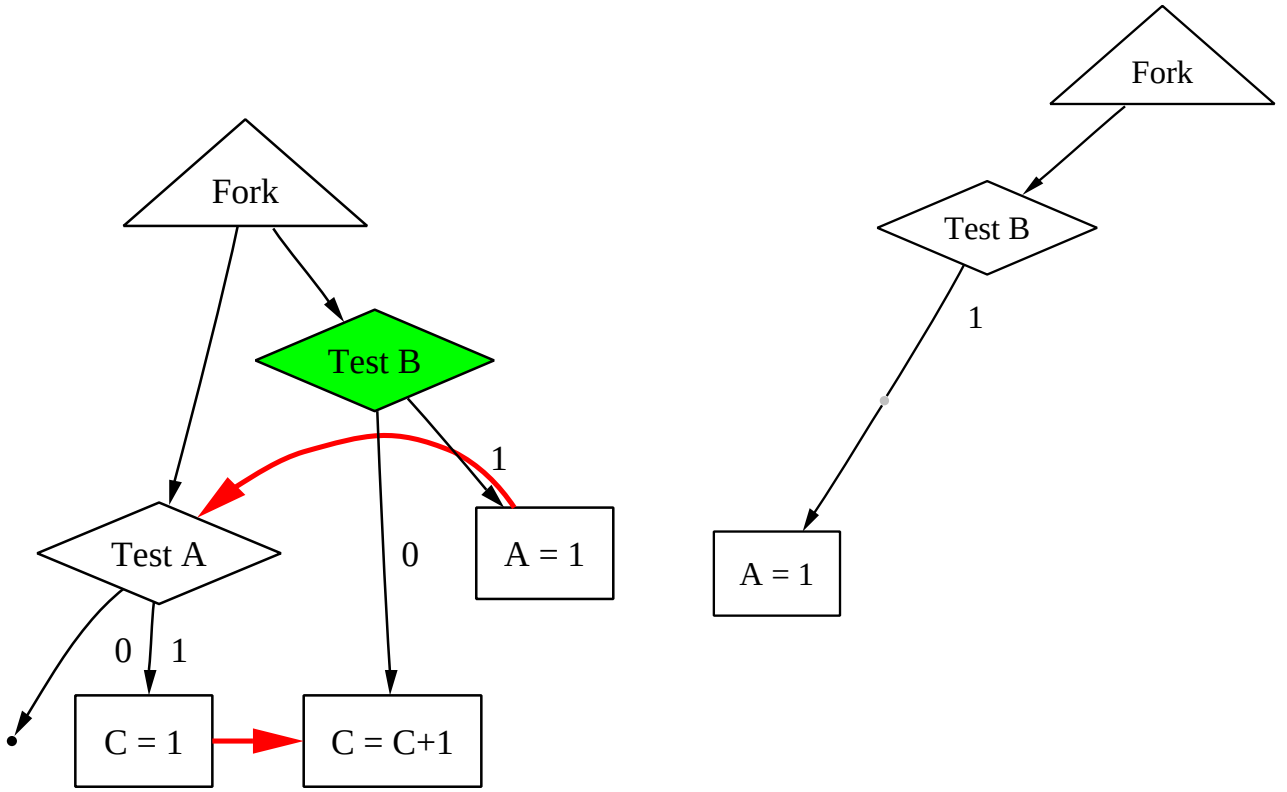
An Example: Reconstructing PDG 2





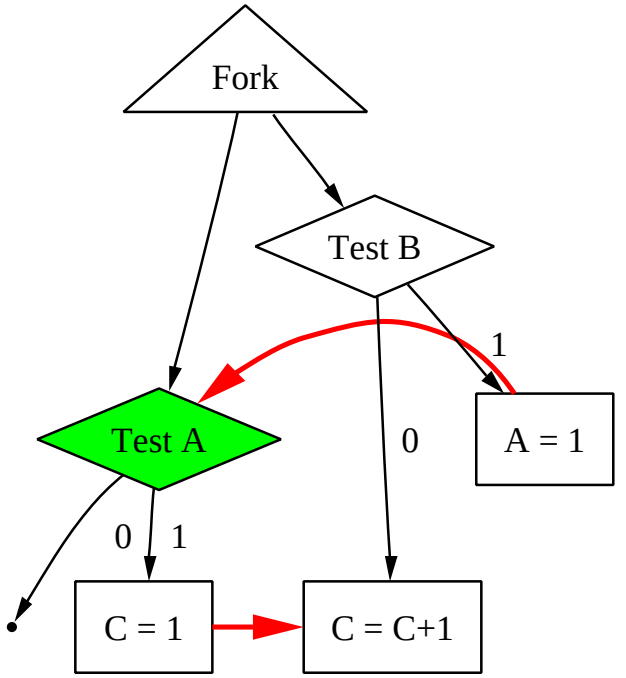
orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test B	-	-	-	-

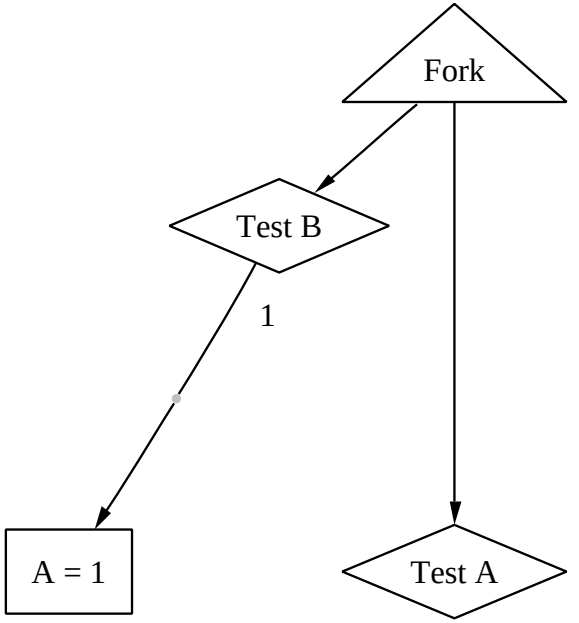
An Example: Reconstructing PDG 3



orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test B	A = 1	-	-	-

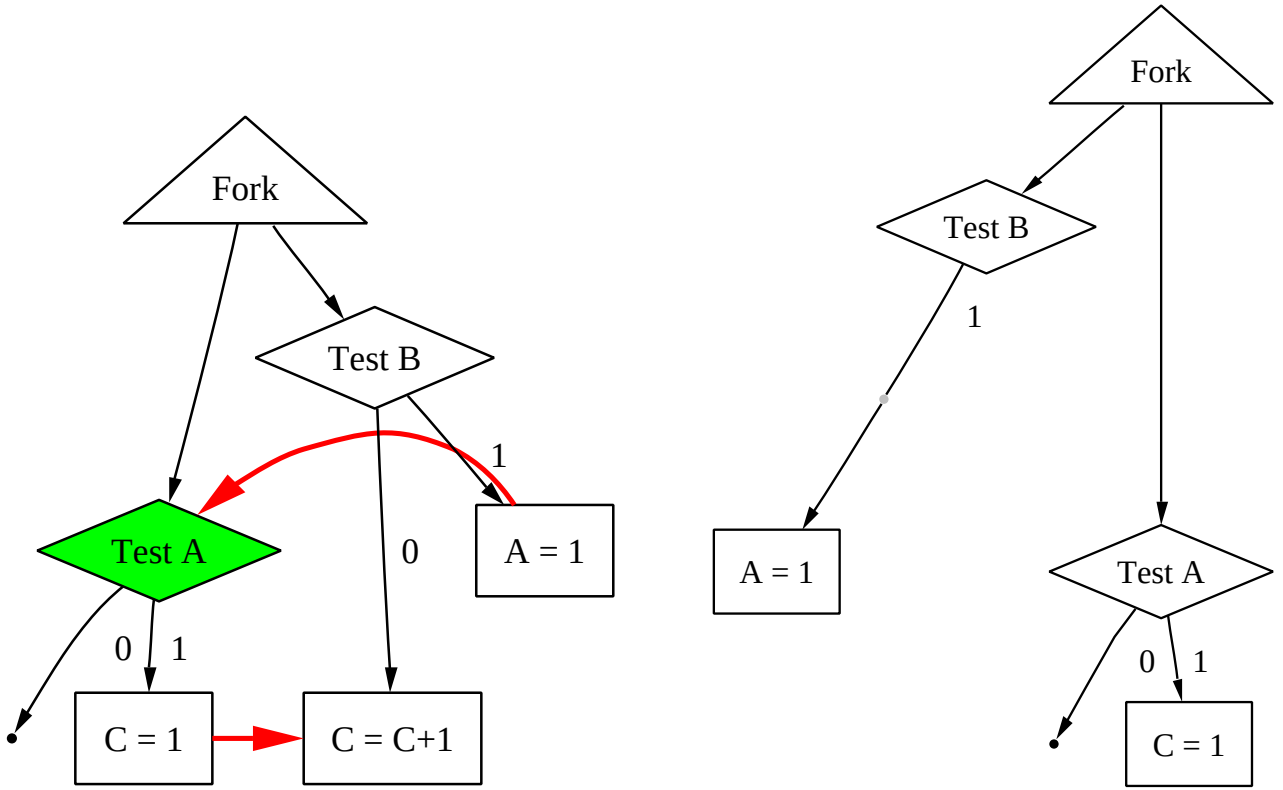
An Example: Reconstructing PDG 4





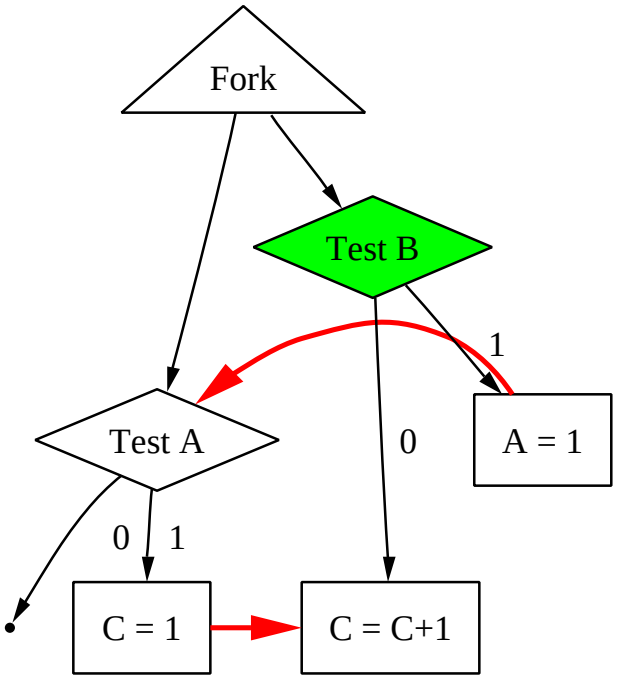
orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test B	A = 1	Test A	-	-

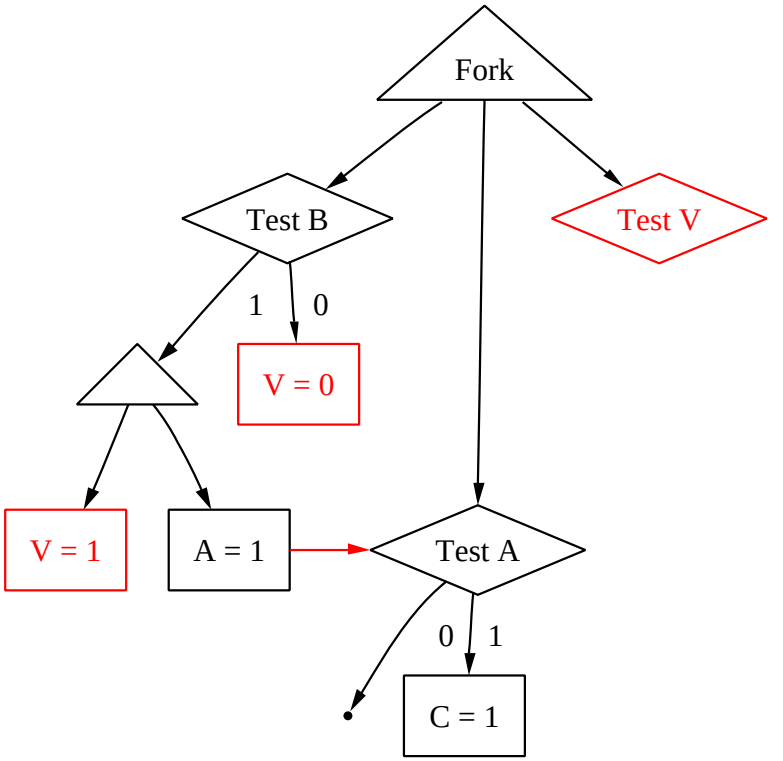
An Example: Reconstructing PDG 5



orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test B	A = 1	Test A	C = 1	-

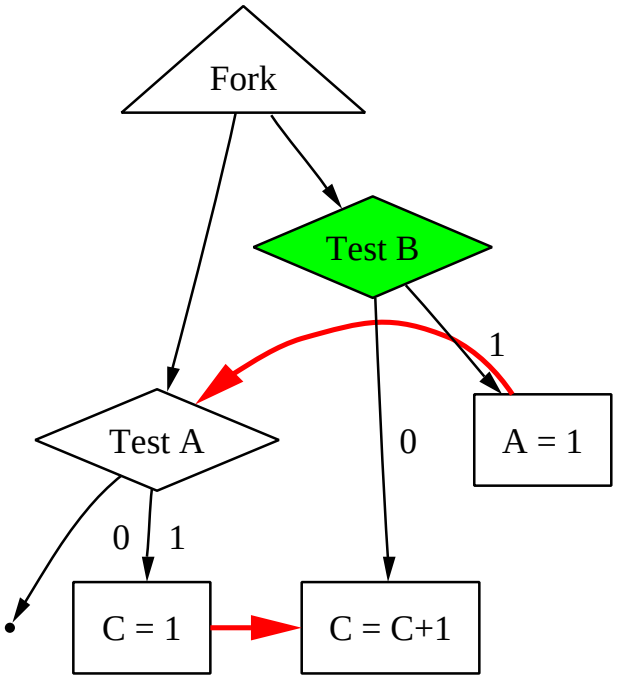
An Example: Reconstructing PDG 6

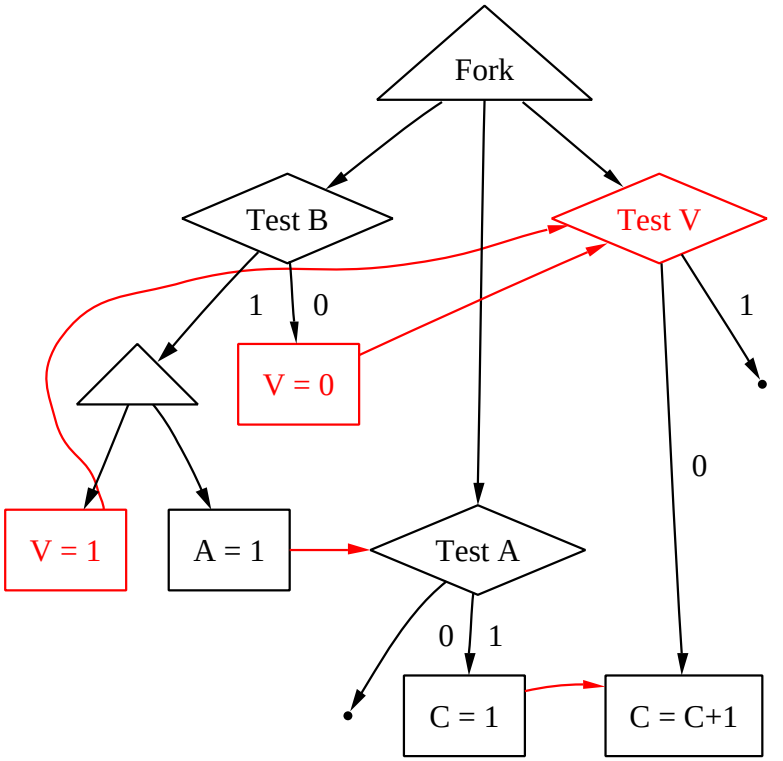




orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test V	A = 1	Test A	C = 1	

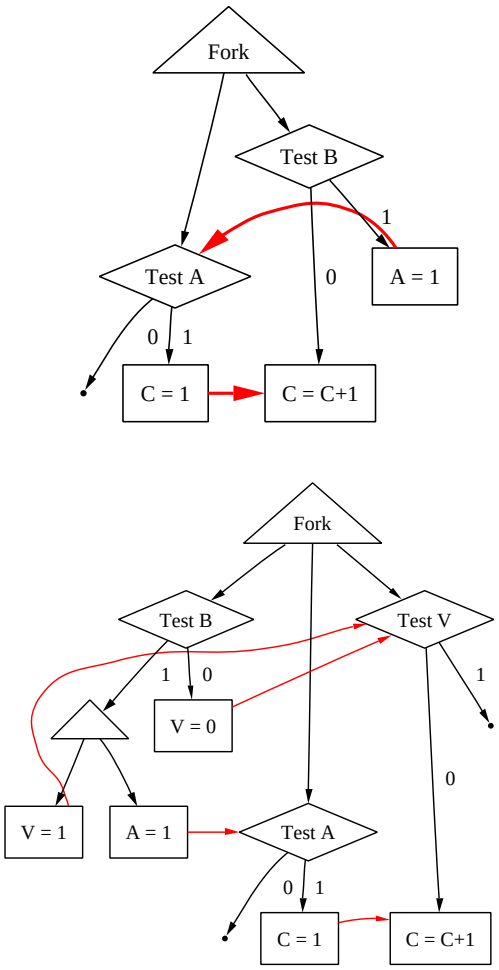
An Example: Reconstructing PDG 6

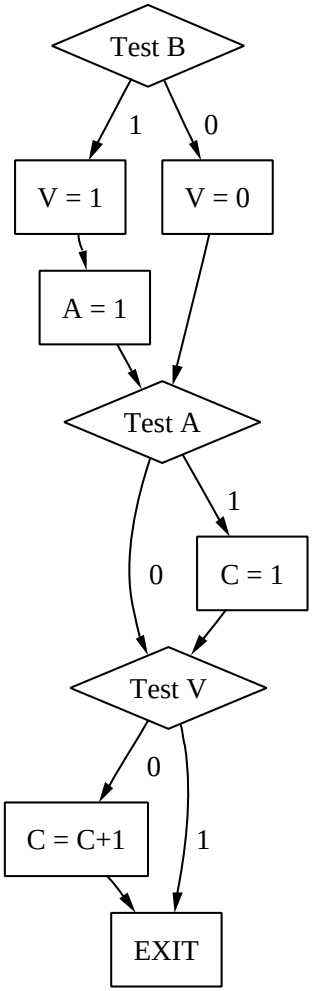




orig	Fork	Test B	A = 1	Test A	C = 1	C = C+1
copy	Fork	Test V	A = 1	Test A	C = 1	C = C+1

An Example: Whole process

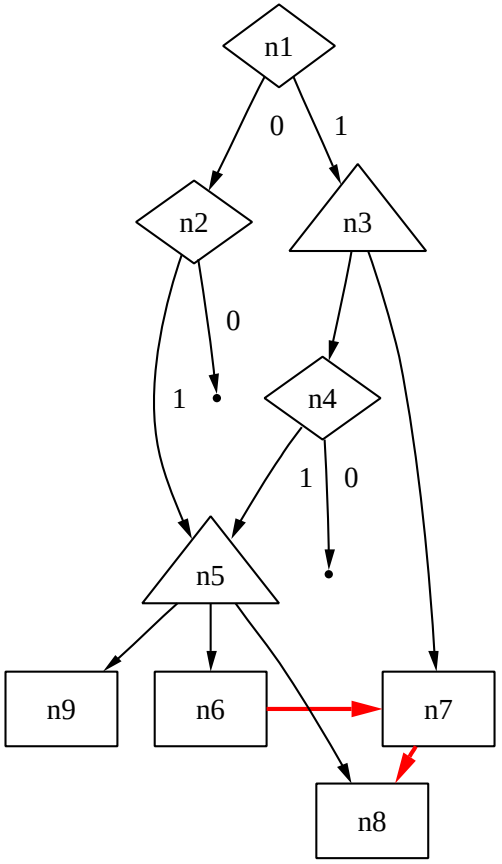


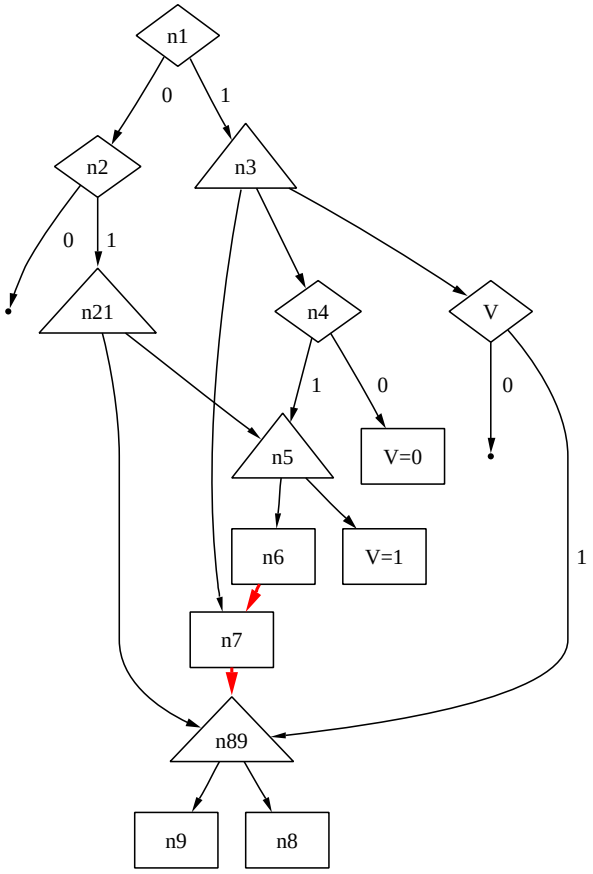



```
if (B){
  V = 1;
  A = 1;
}
else
  V = 0;
if (A)
  C = 1;
if (V)
  {}
else
  C = C + 1;
```

More complex situations:

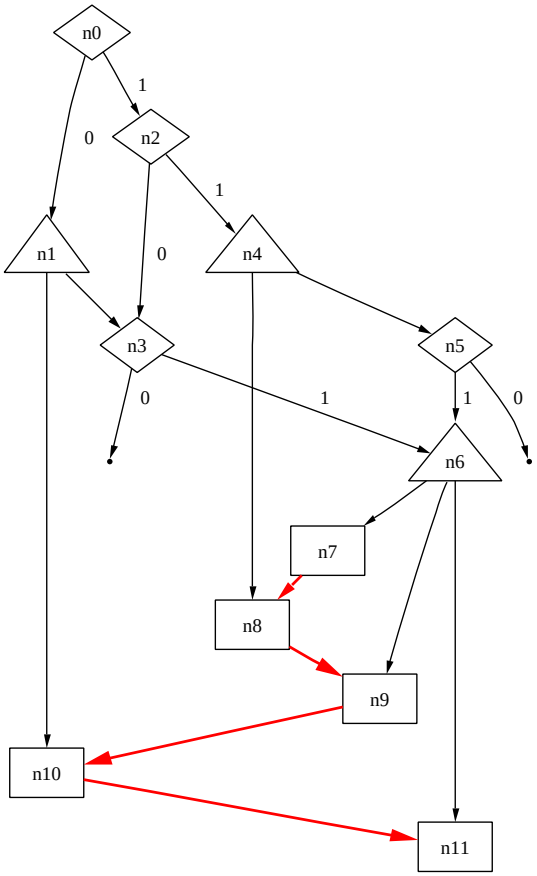
converge control flow

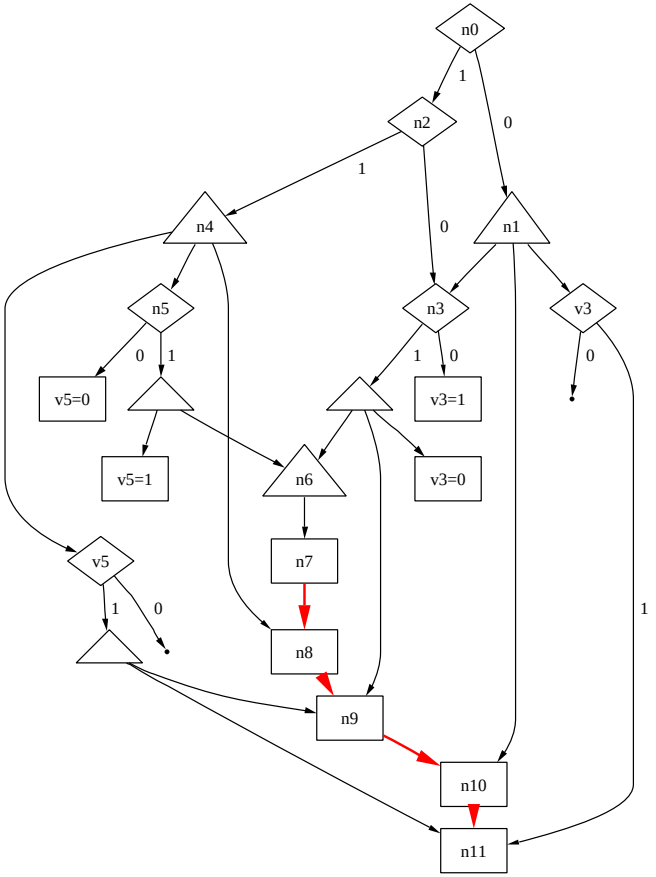




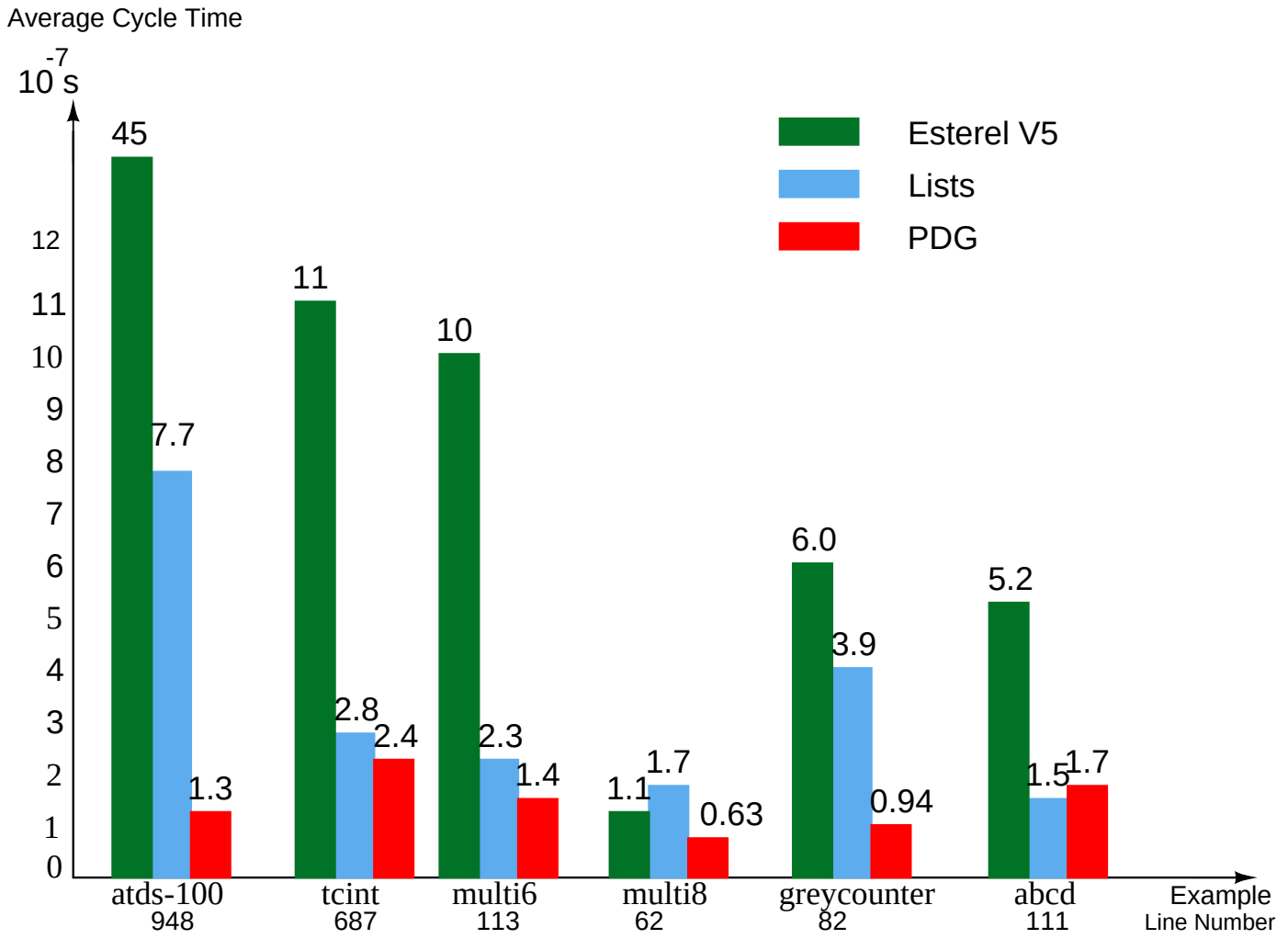
More complex situations:

more forks & more data flow





Experimental Results



Generated C code for examples running on 2.5 GHz Pentium 4, Linux

Conclusion

- A technique to generate fast sequential code from PDG for concurrent programs;
- Useful for embedded software and simulation.
- Speed improvement

Acknowlegement

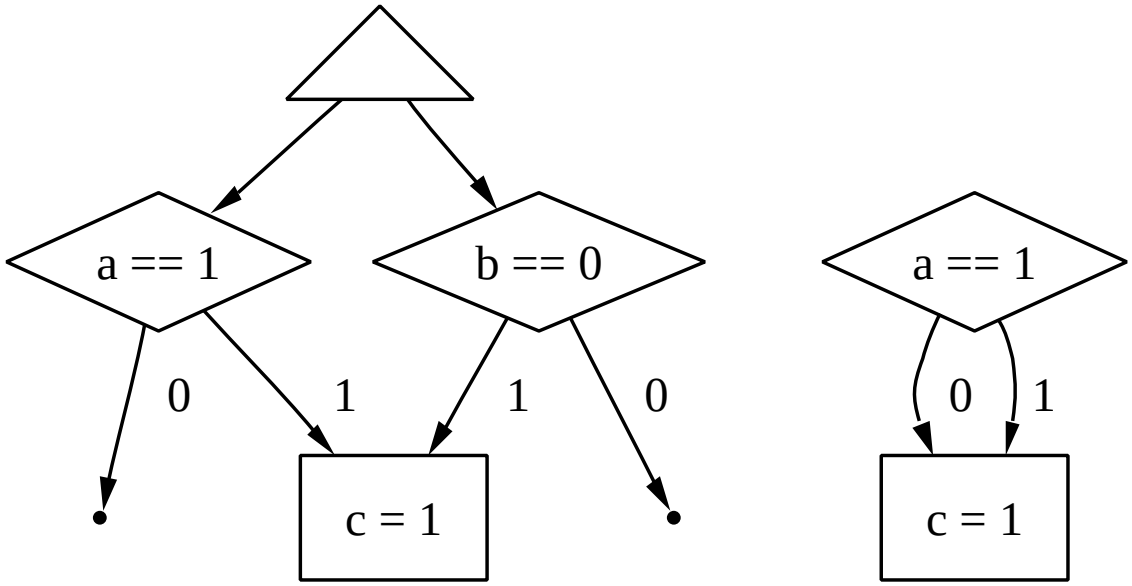
Prof. Edwards (Advisor)

Cristian Soviani (Partner)

Thank you all!

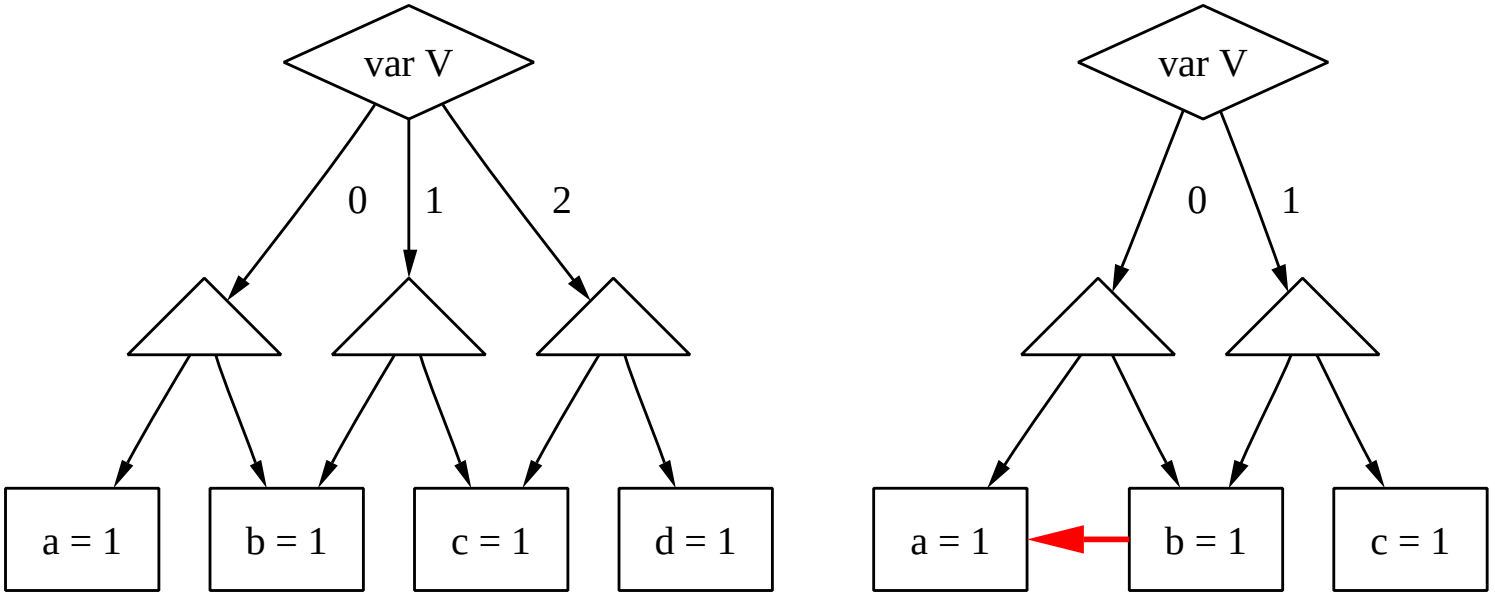
Questions & Answers

Illegal PDG



- Predicate least common ancestor rule
- No post-dominance rule

Non-concise PDG



- Conflict between control/control flows
- Conflict between control/data flows

Algorithm Complexity