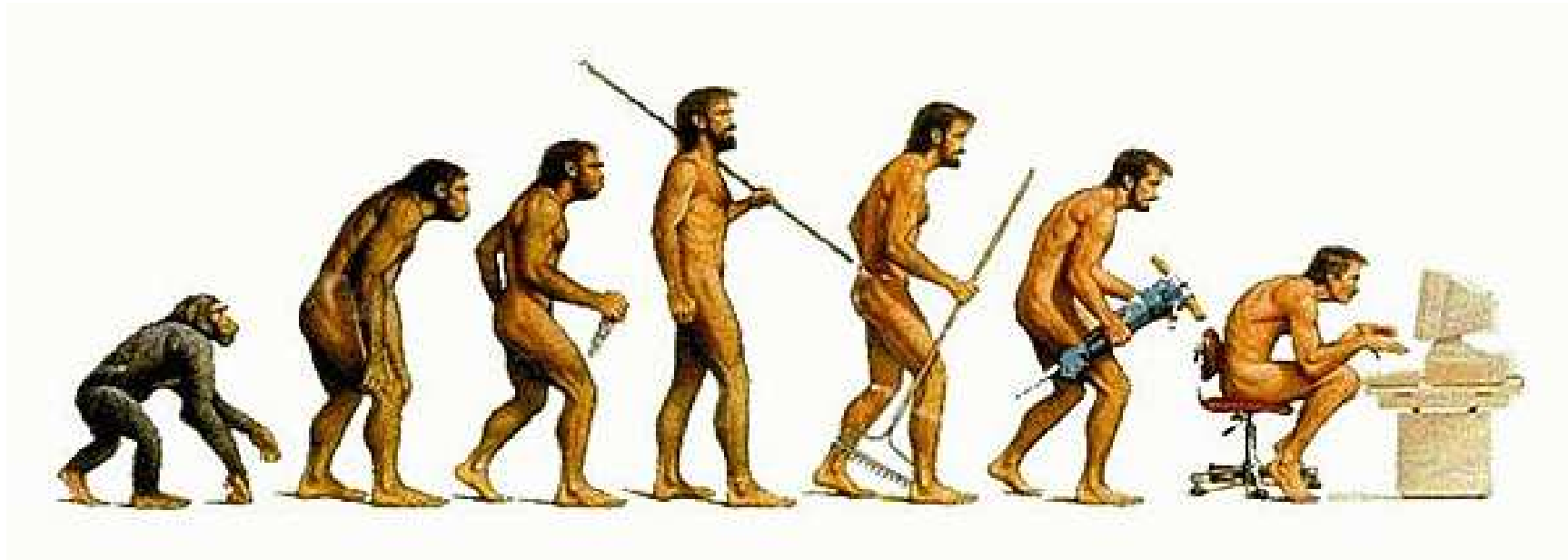

A Determinizing Compiler

Nalini Vasudevan Stephen A. Edwards

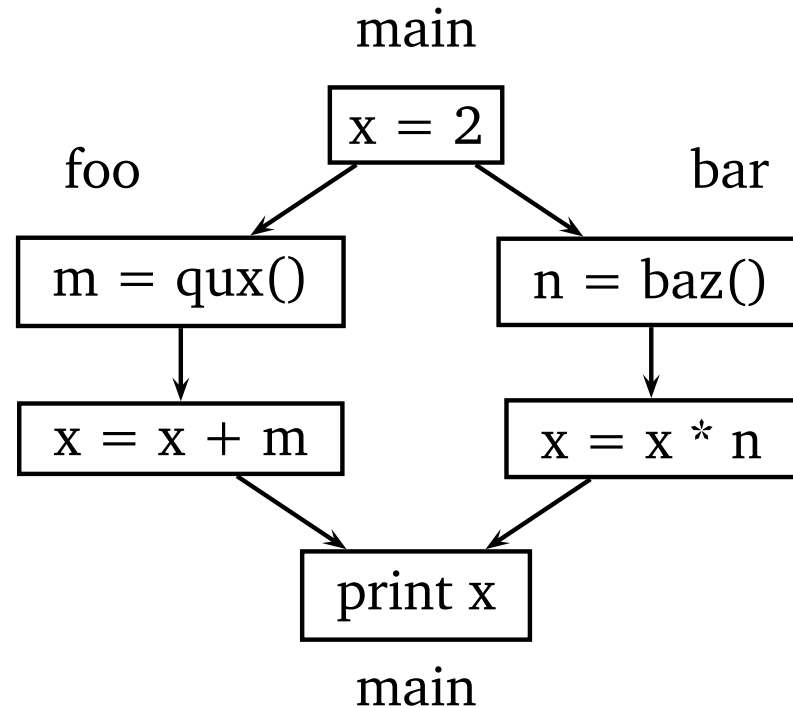
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	Library		Performance		Non-	
Parallel	Support	Parallel		Data	Determinism	
Computers		Languages		Races		Hard-to-debug

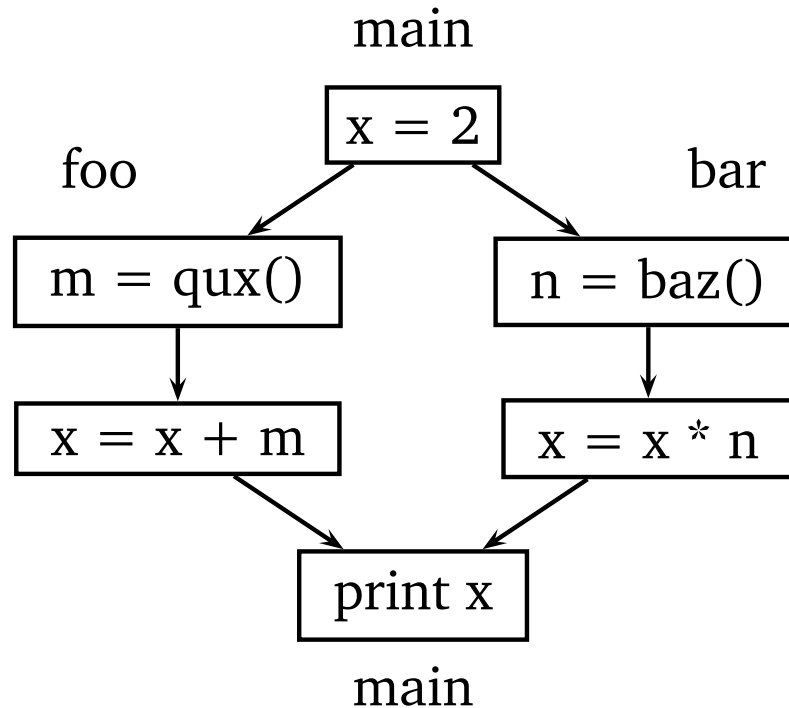
An Example

```
int x;
foo(){
    int m;
    m = qux();
    x = x + m;
}
bar(){
    int n;
    n = baz();
    x = x * n;
}
main() {
    x = 2;
    thread_create(foo);
    thread_create(bar);
    thread_join(foo);
    thread_join(bar);
    print(x);
}
```



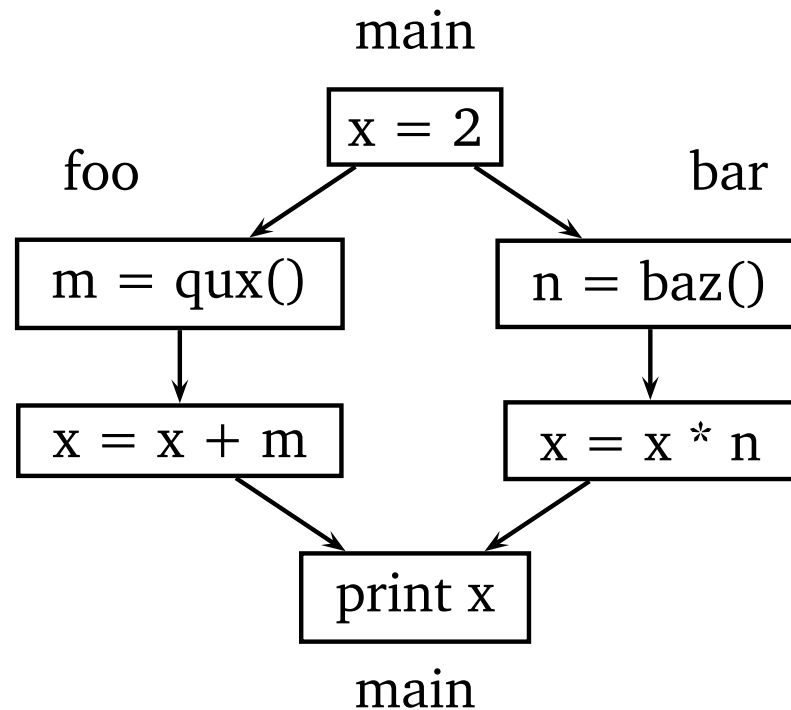
An Example

```
int x;
foo(){
  int m;
  m = qux();
  lock(x);
  x = x + m;
  unlock(x);
}
bar(){
  int n;
  n = baz();
  lock(x);
  x = x * n;
  unlock(x);
}
main() {
  x = 2;
  thread_create(foo);
  thread_create(bar);
  thread_join(foo);
  thread_join(bar);
  print(x);
}
```



An Example

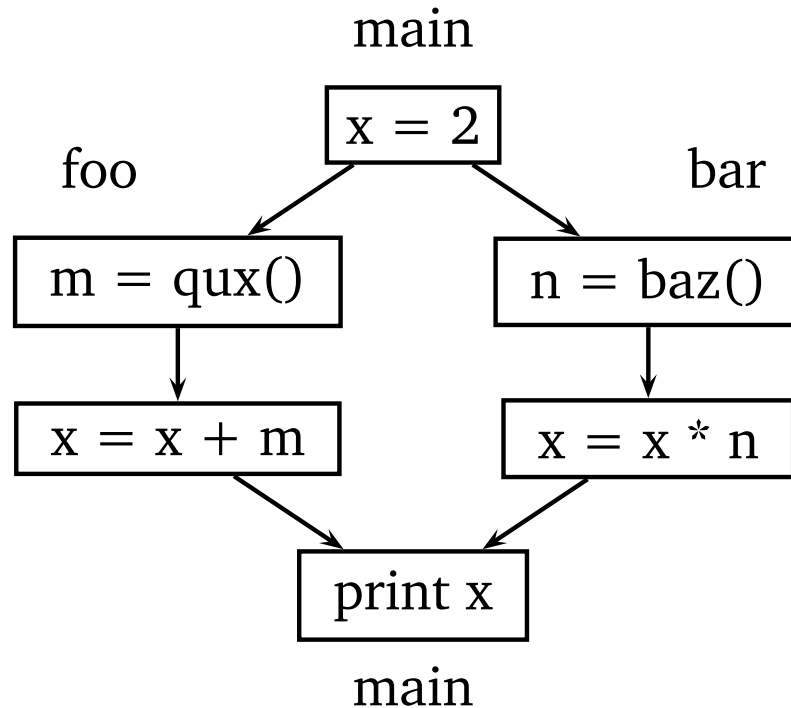
```
int x;
foo(){
  int m;
  m = qux();
  lock(x);
  x = x + m;
  unlock(x);
}
bar(){
  int n;
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}
main() {
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  thread_create(bar);
  thread_join(foo);
  thread_join(bar);
  print(x);
}
```



if $m = n = 2$

An Example

```
int x;
foo(){
  int m;
  m = qux();
  lock(x);
  x = x + m;
  unlock(x);
}
bar(){
  int n;
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}
main() {
  x = 2;
  thread_create(foo);
  thread_create(bar);
  thread_join(foo);
  thread_join(bar);
  print(x);
}
```



if $m = n = 2$

$$x = (2 + 2) * 2 = 8$$

$$x = (2 * 2) + 2 = 6$$

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Bank loses 10 million in a day

U.S. AND NEW MEXICO STATE TO REEL

American scores the film in strength
New Mexico's business who have
opened offices from color

WORLD TRADE, STATE WOULD SUFFER

That day's demand of the first Commission
order—state's first order in the North
being 100—Canadian's first order

...and the state's first order in the North
being 100—Canadian's first order

NEW MEXICO GOES DOWN FOR PLANS

...and the state's first order in the North
being 100—Canadian's first order



NEW YORK STATE IT WOULD SUFFER

From the family's demand of Canadian
as Central Order's first order
to the state's first order in the North

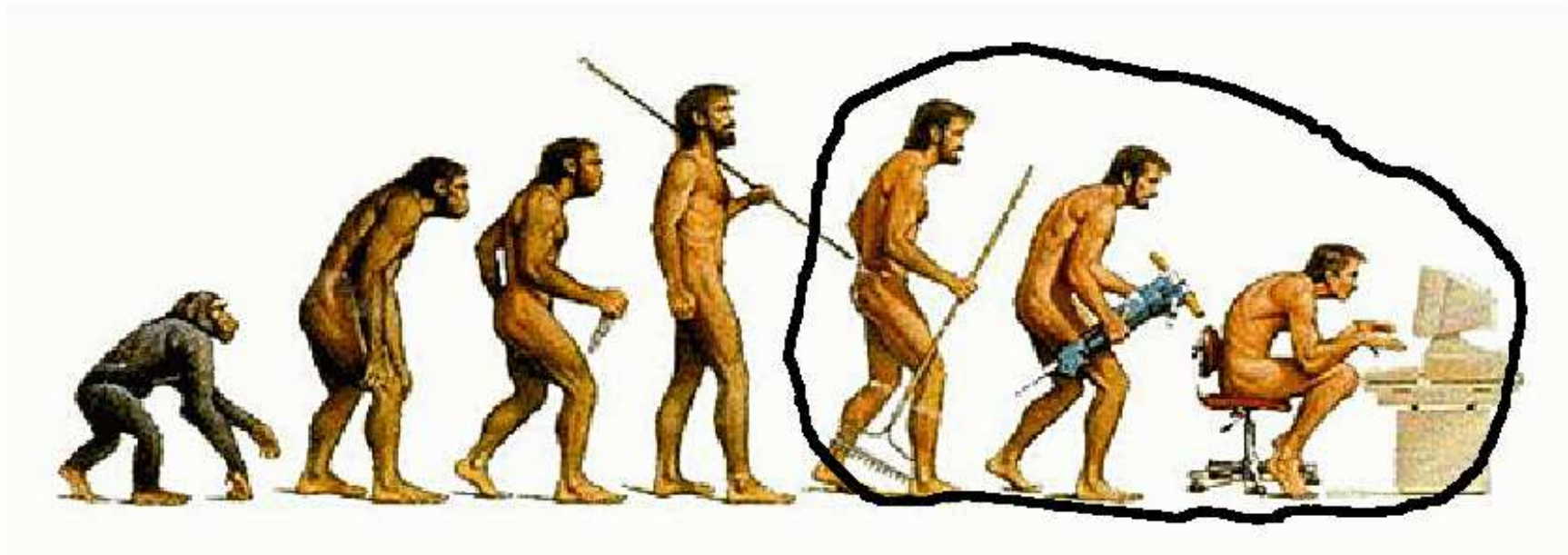
ALL-GOVT WOULD TO KEEP PACE

From the family's demand of Canadian
as Central Order's first order
to the state's first order in the North

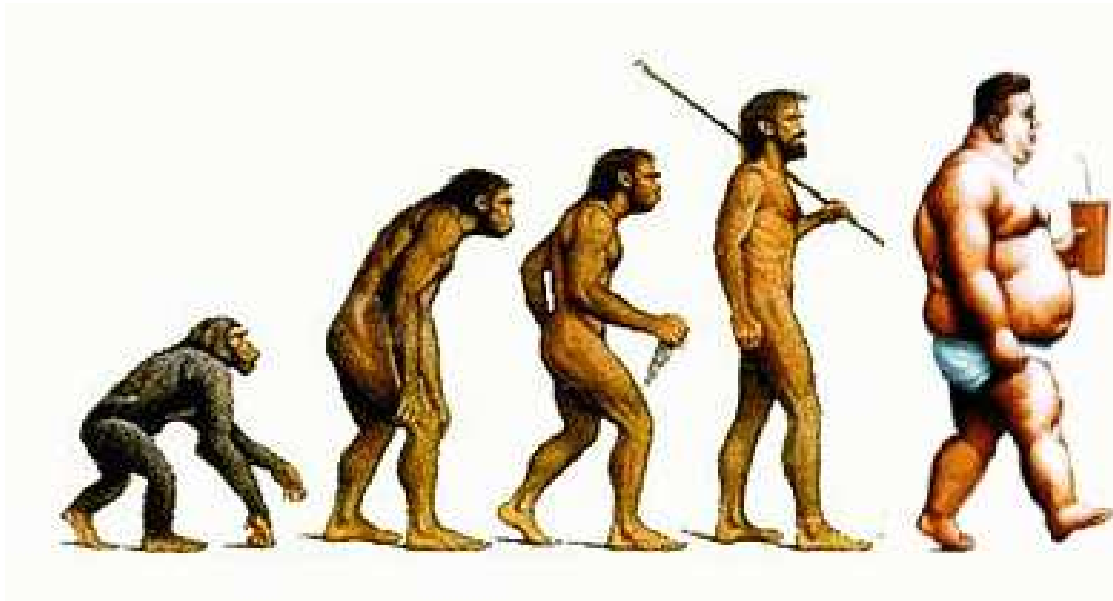
...and the state's first order in the North
being 100—Canadian's first order

TRUCKS & TRUCKS IN THE NORTH WOULD

...and the state's first order in the North
being 100—Canadian's first order



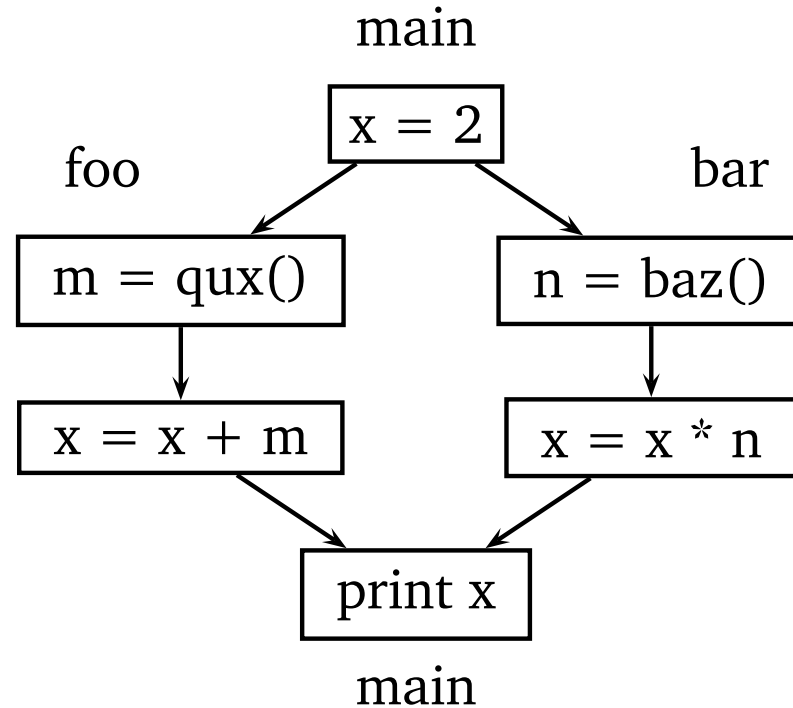
	Library		Performance		Non-
Parallel	Support	Parallel		Data	Determinism
Computers		Languages		Races	Hard-to-debug



Parallel Computers Library Support Performance Parallel Languages A Determinizing Compiler!

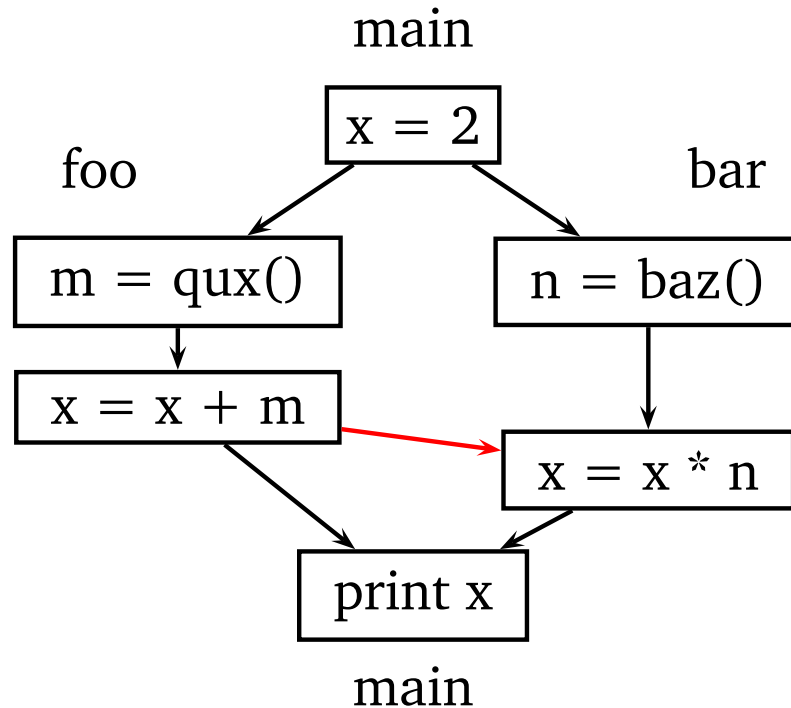
The Example

```
int x;
foo(){
  int m;
  m = qux();
  x = x + m;
}
bar(){
  int n;
  n = baz();
  x = x * n;
}
main() {
  x = 2;
  thread_create(foo);
  thread_create(bar);
  thread_join(foo);
  thread_join(bar);
  print(x);
}
```



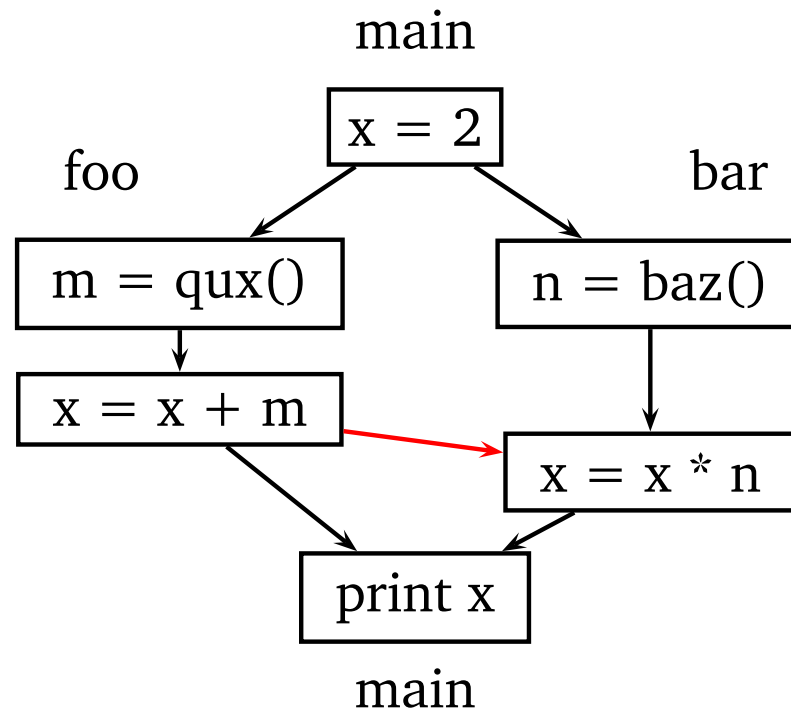
The Compiler's Role

```
int x;  
foo(){  
    int m;  
    m = qux();  
    x = x + m;  
    sync(x);  
}  
bar(){  
    int n;  
    n = baz();  
    sync(x);  
    x = x * n;  
}  
main() {  
    x = 2;  
    thread_create(foo);  
    thread_create(bar);  
    thread_join(foo);  
    thread_join(bar);  
    print(x);  
}
```



The Compiler's Role

```
int x;
foo(){
  int m;
  m = qux();
  x = x + m;
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}
bar(){
  int n;
  n = baz();
  sync(x);
  x = x * n;
}
main() {
  x = 2;
  thread_create(foo);
  thread_create(bar);
  thread_join(foo);
  thread_join(bar);
  print(x);
}
```



if $m = n = 2$
 $x = (2 + 2) * 2 = 8$
Always!

Interesting Questions

- Analysis of the program?
- Performance vs. parallelism tradeoff?
- Which execution to select?
- Avoid deadlocks?

Answers:

- **A Determinizing Compiler. PLDI '2011.** ACM, New York, NY, 1-10.



WANTED

**A
Determinizing
Compiler**

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~~A Determinizing Compiler~~ The Compiler

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Columbia University