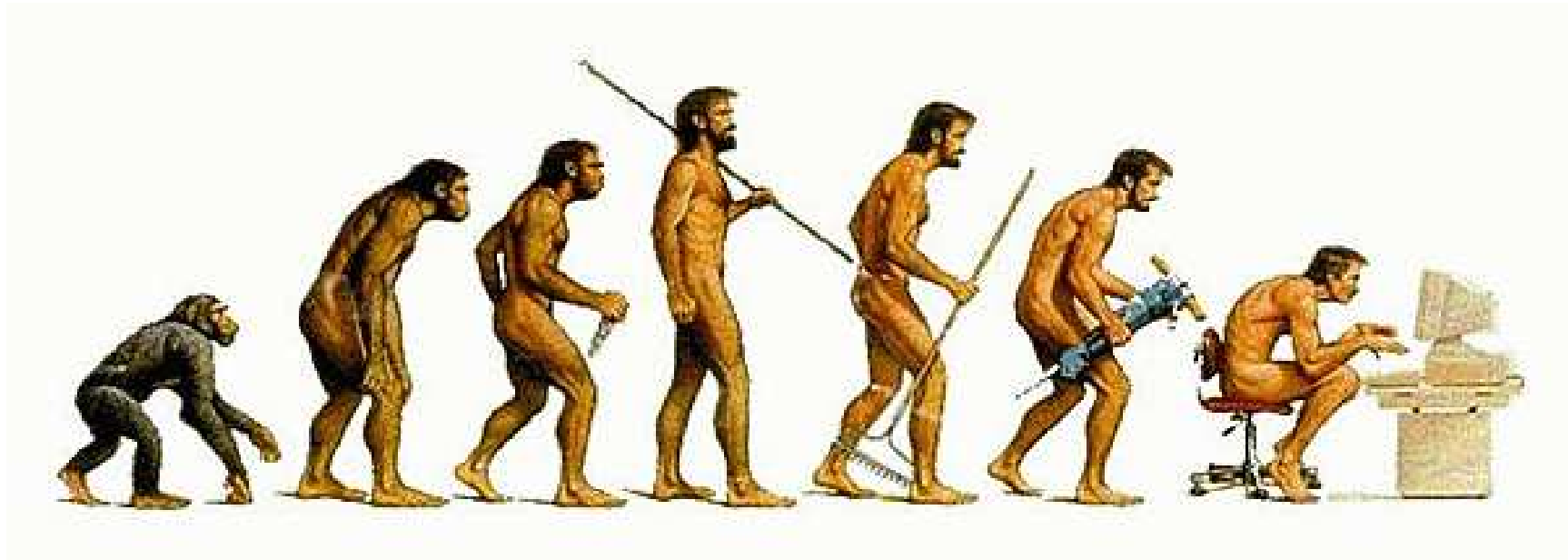

A Determinizing Compiler

Nalini Vasudevan Stephen A. Edwards

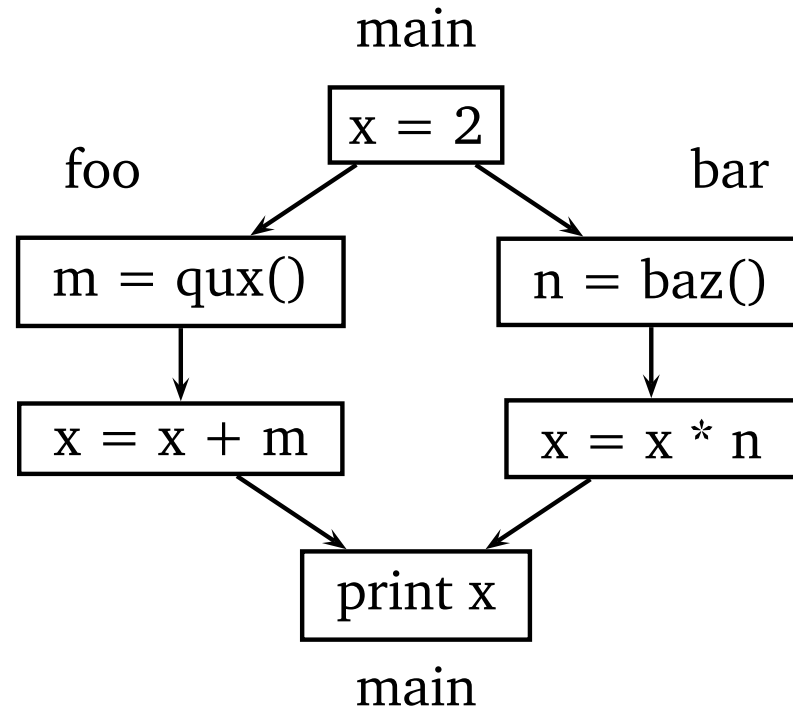
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	Library		Performance		Non-	
Parallel	Support	Parallel		Data	Determinism	
Computers		Languages		Races		Hard-to-debug

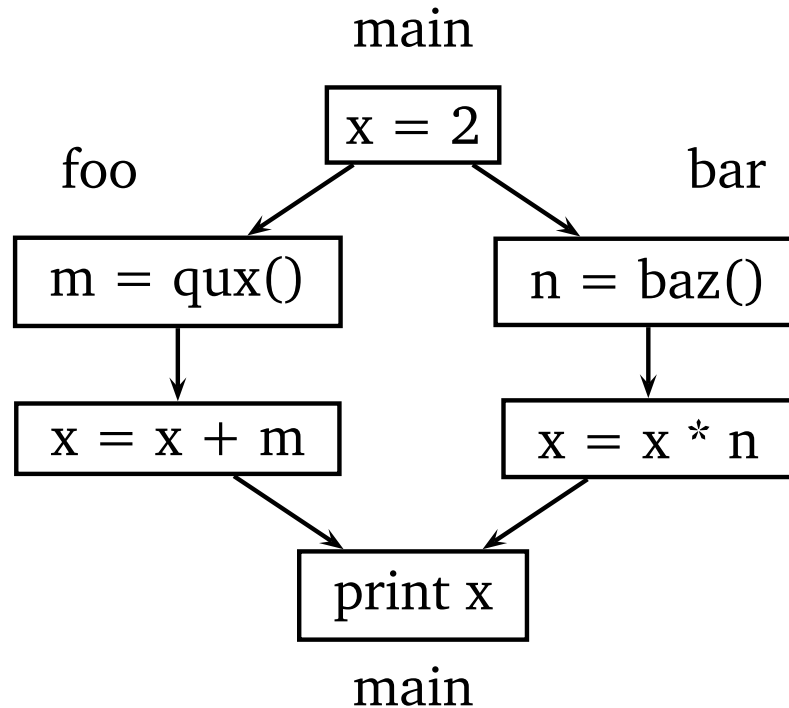
An Example

```
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);
}
```



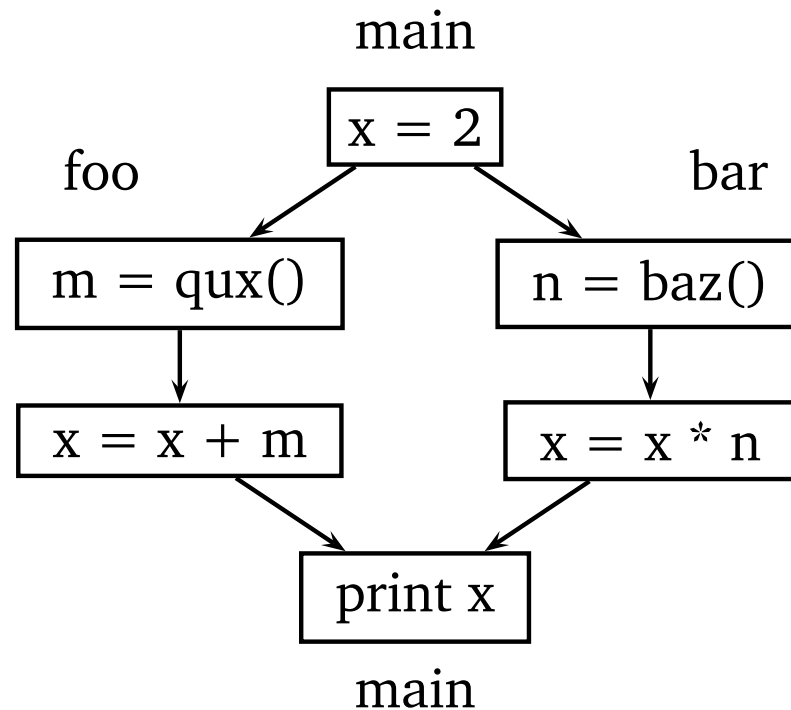
An Example

```
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

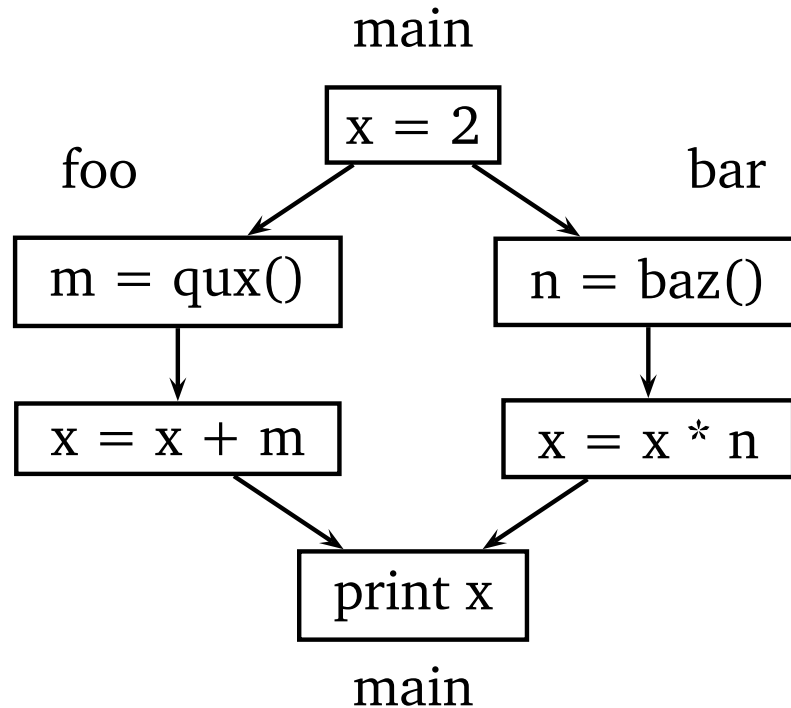
```
int x;
foo(){
  int m;
  m = qux();
  lock(x);
  x = x + m;
  unlock(x);
}
bar(){
  int n;
  n = baz();
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  unlock(x);
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main() {
  x = 2;
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  thread_create(bar);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



if $m = n = 2$

An Example

```
int x;
foo(){
  int m;
  m = qux();
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  x = x + m;
  unlock(x);
}
bar(){
  int n;
  n = baz();
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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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LATE CITY EDITION

BANK OF ARTICA EMPLOYEE FIRED

Bank loses 10 million in a day

U.S. AND NEW JERSEY STATE TO MEET

American Scores the Film in Straight
Race Against Russians Who Have
Captured Officers From Color

WORLD TRADE, ECONOMIC BARGAIN

Third Day Scheduled To Show First Commercial
Notes—Global Show Starts in the North
Trading Office—Countries Forming United

The first day of the World Trade Conference...
The second day...
The third day...

NEW JERSEY GOES DOWN FOR PLANS

New Jersey's...
The state's...
The plans...



NEW YORK STATE IT MUST STOP

From the Family Support of Children
as Central Under Study Death
to Father's Leader of 30

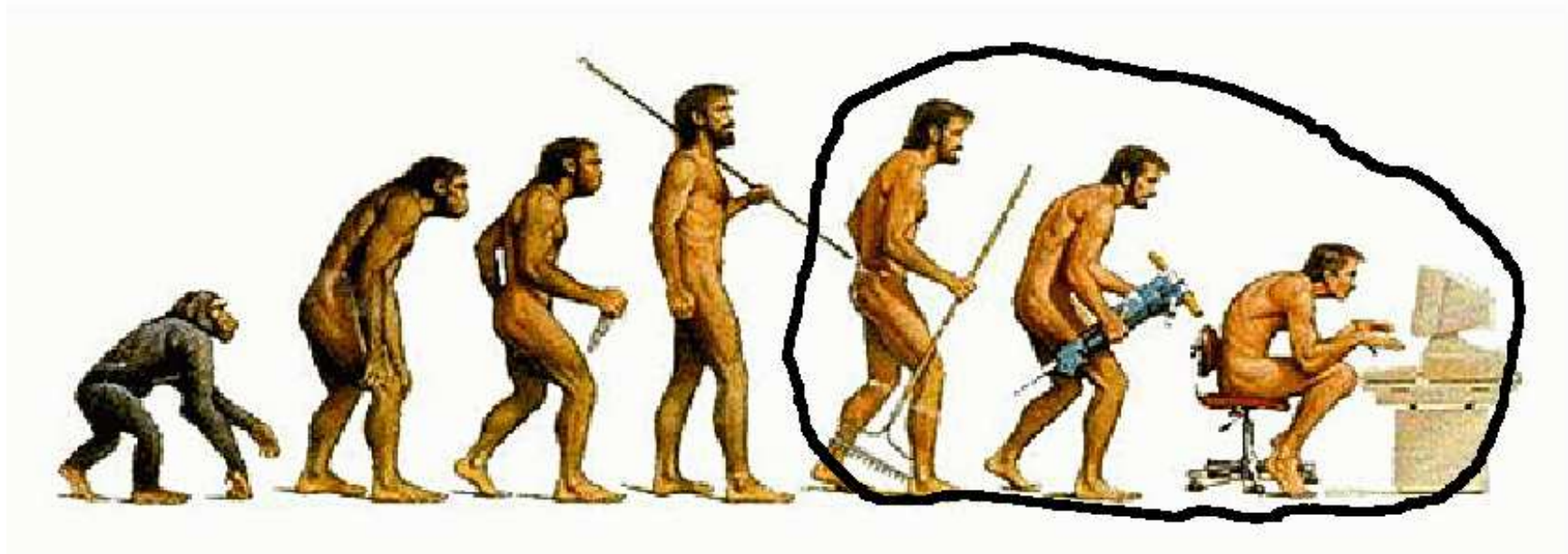
ALL-GOVERNMENT TO KEEP PACE

Peace in the World Trade Conference,
With Support of State From...
Support of New Government

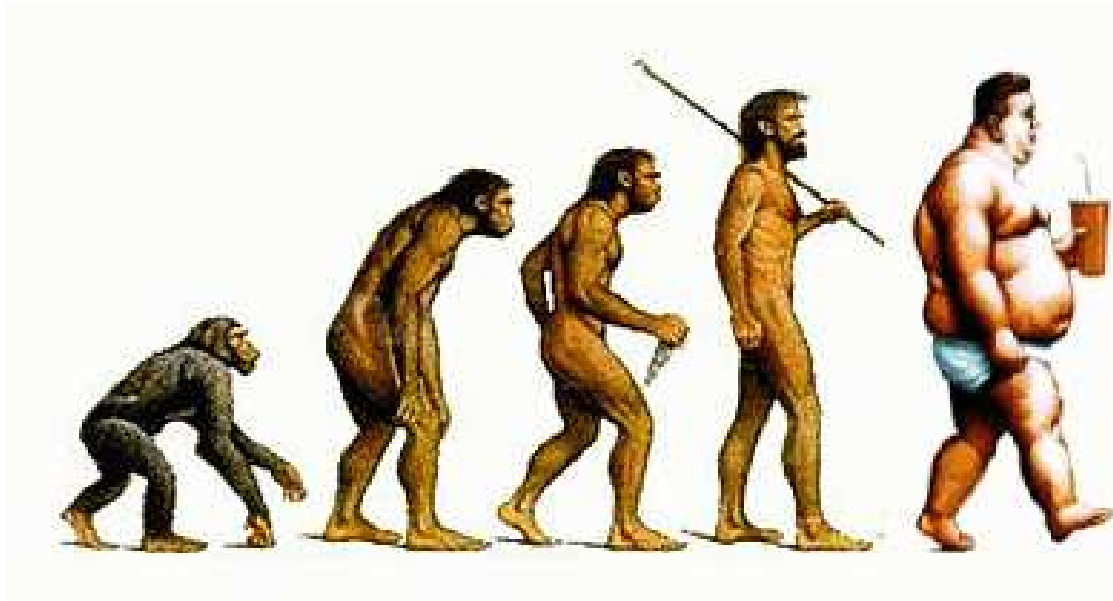
The government...
The support...
The pace...

TURKEY'S UNION WITH THE NORTH

Turkey's...
The union...
The north...



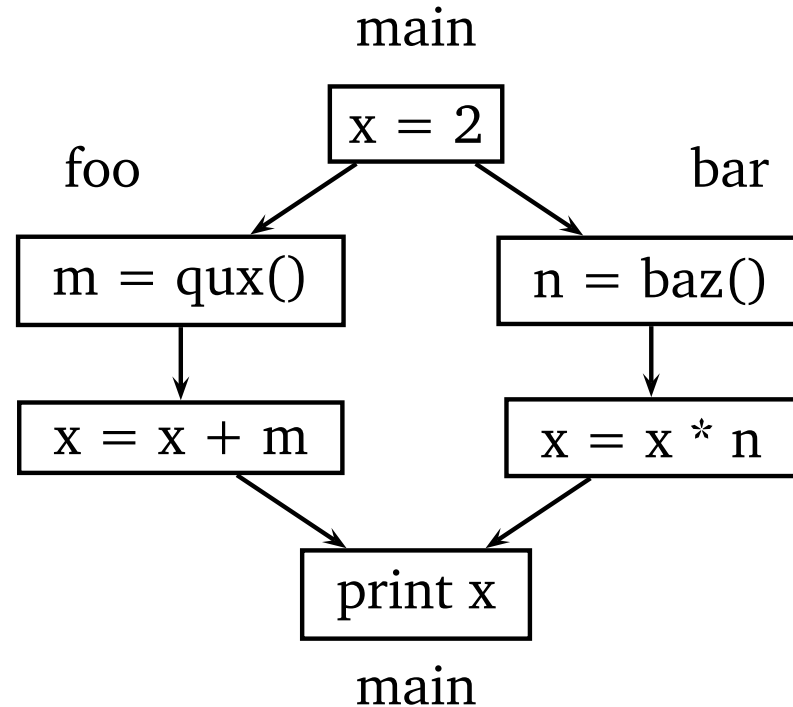
	Library		Performance		Non-
Parallel	Support	Parallel		Data	Determinism
Computers		Languages		Races	Hard-to-debug



Parallel Computers Library Support Performance Parallel Languages A Determinizing Compiler!

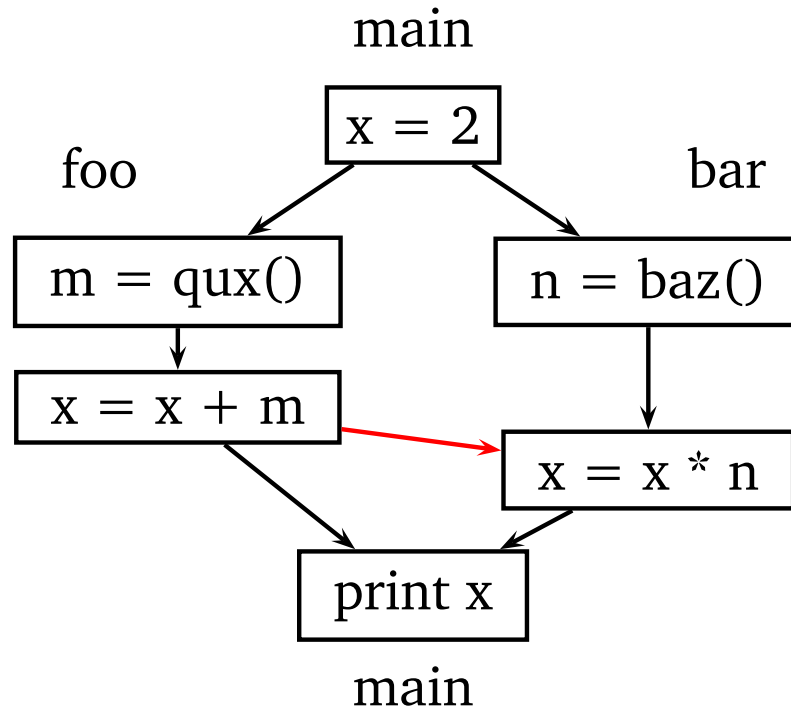
The Example

```
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);
}
```



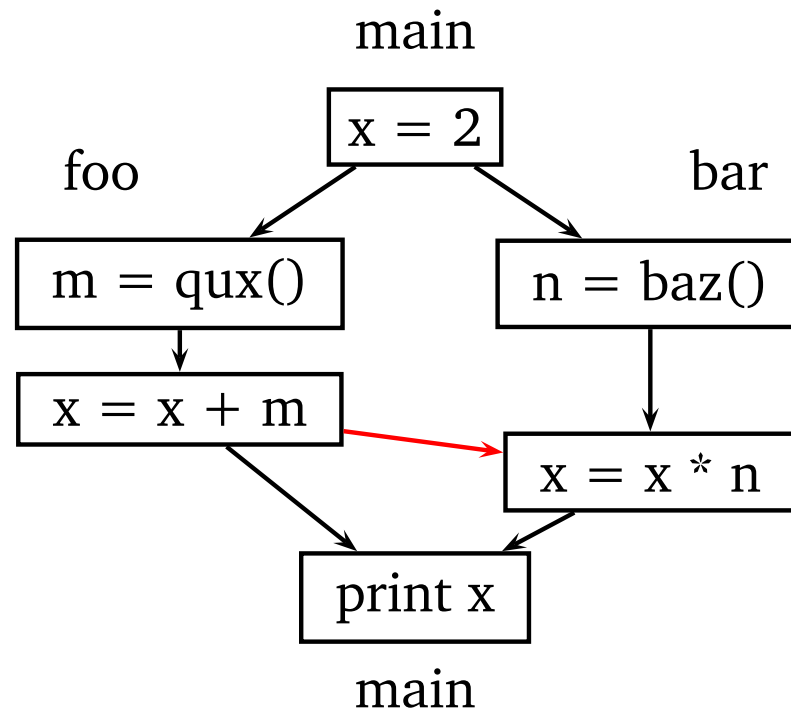
The Compiler's Role

```
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;
    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);
}
```



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**

**\$20000
REWARD**



~~A Determinizing Compiler~~ The Compiler

Nalini Vasudevan Stephen A. Edwards

Columbia University