PowerPC Backend for the Scale Compiler

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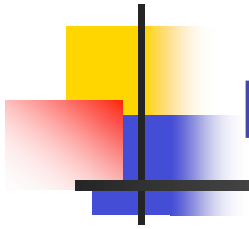
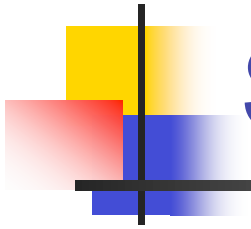
CRA-W DMP Program

Summer, 2004



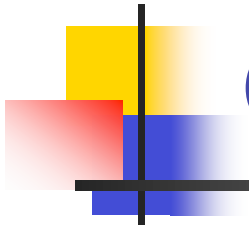
Distributed Mentor Program (DMP)

- Increase the number of women in graduate school in computer science
- Involve women in research
- Interact with graduate students and professors
- Work with successful researchers



Synopsis

- Goals and motivation
- Scale compiler overview
- Project status
- Challenges we have encountered
- Impact and future work

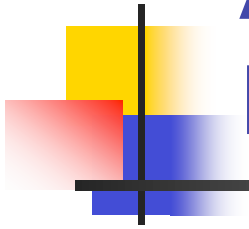


Goals

- Implement a backend for the Scale compiler for the PowerPC architecture for Mac OS X and Linux
- Experience the graduate school environment
- Gain research experience
- Senior thesis topics and research

Why is DMP Important to You?

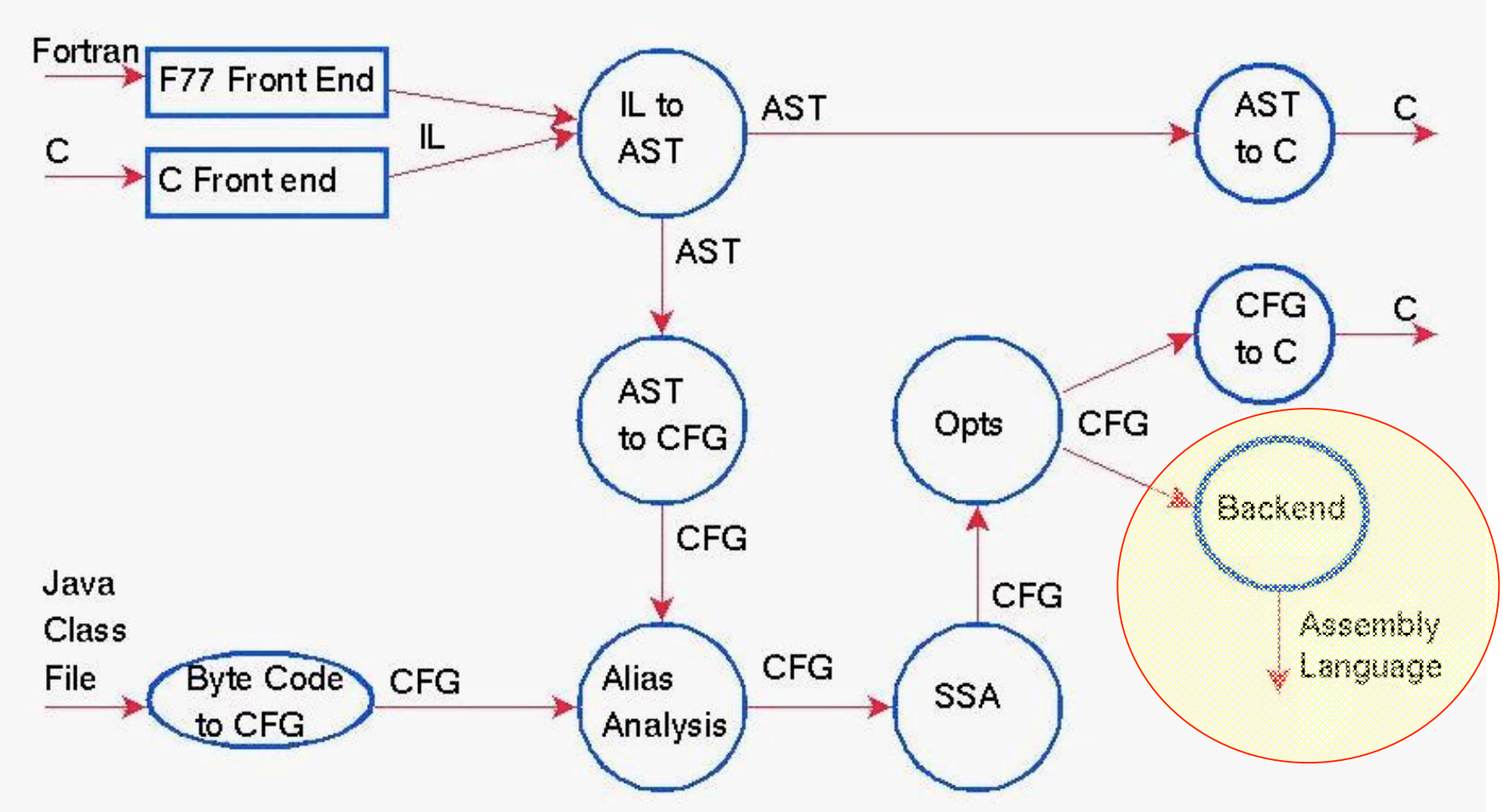
- You can help encourage qualified women to seek a graduate education, possibly at UT
- You can serve as a role model
- You can positively influence the lives of DMP students



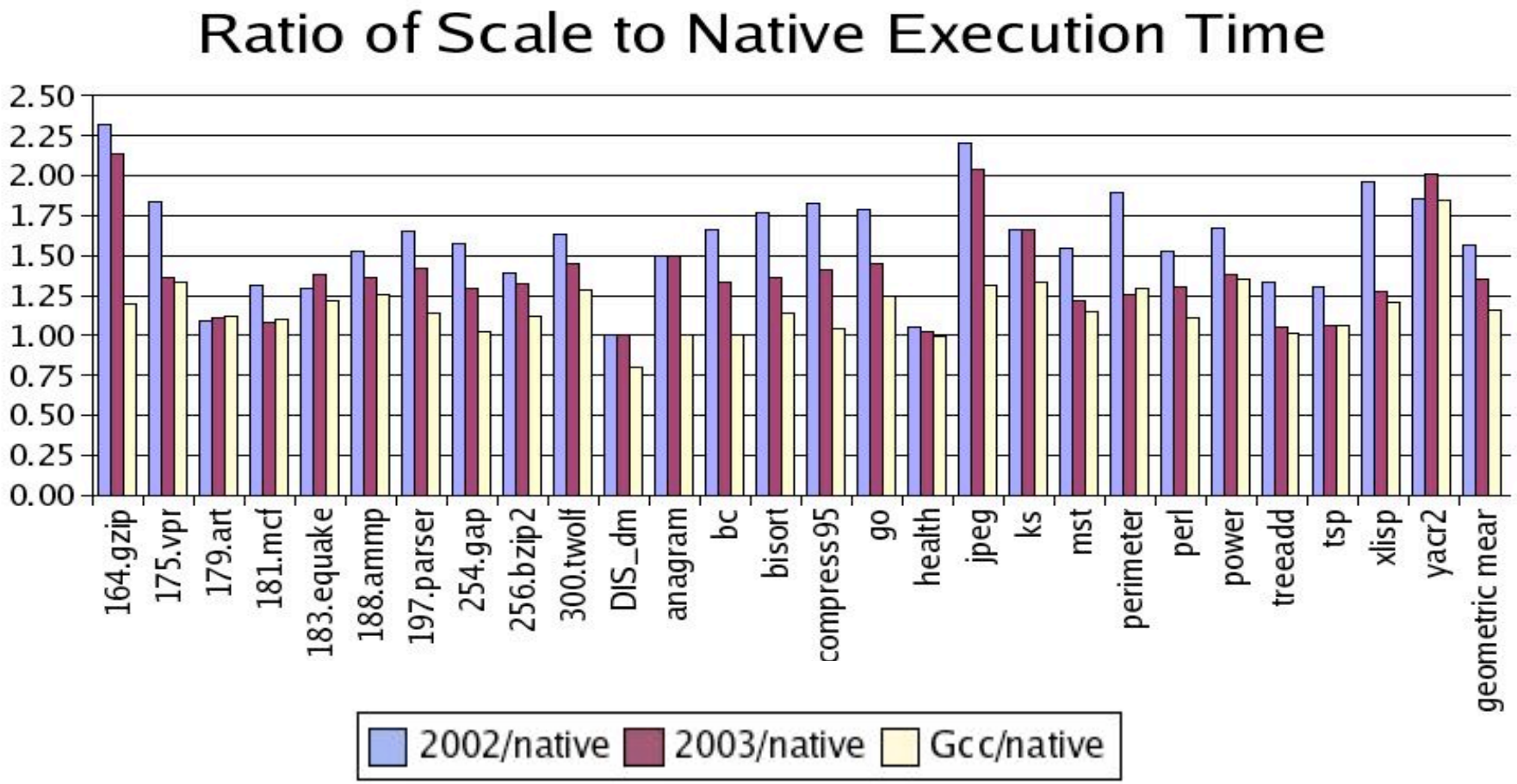
A Scalable Compiler for Analytical Experiments (SCALE)

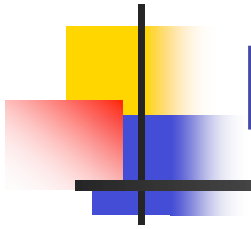
- Framework for research in compiler optimizations
- Modular
- Flexible
- Optimized
- Target multiple architectures

SCALE Data Flow Diagram



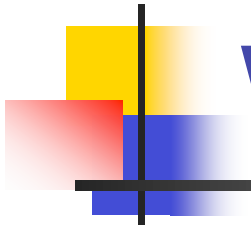
Ratio of Scale to Native Execution Time





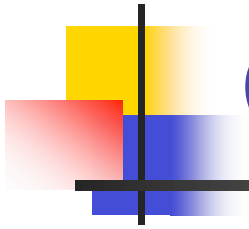
Motivation

- Existing backends: Alpha, Sparc, TRIPS
- PowerPC is an existing architecture that will, hopefully, last
- Experience working as a team
- Experience working as a part of a much larger project



What We Have Accomplished

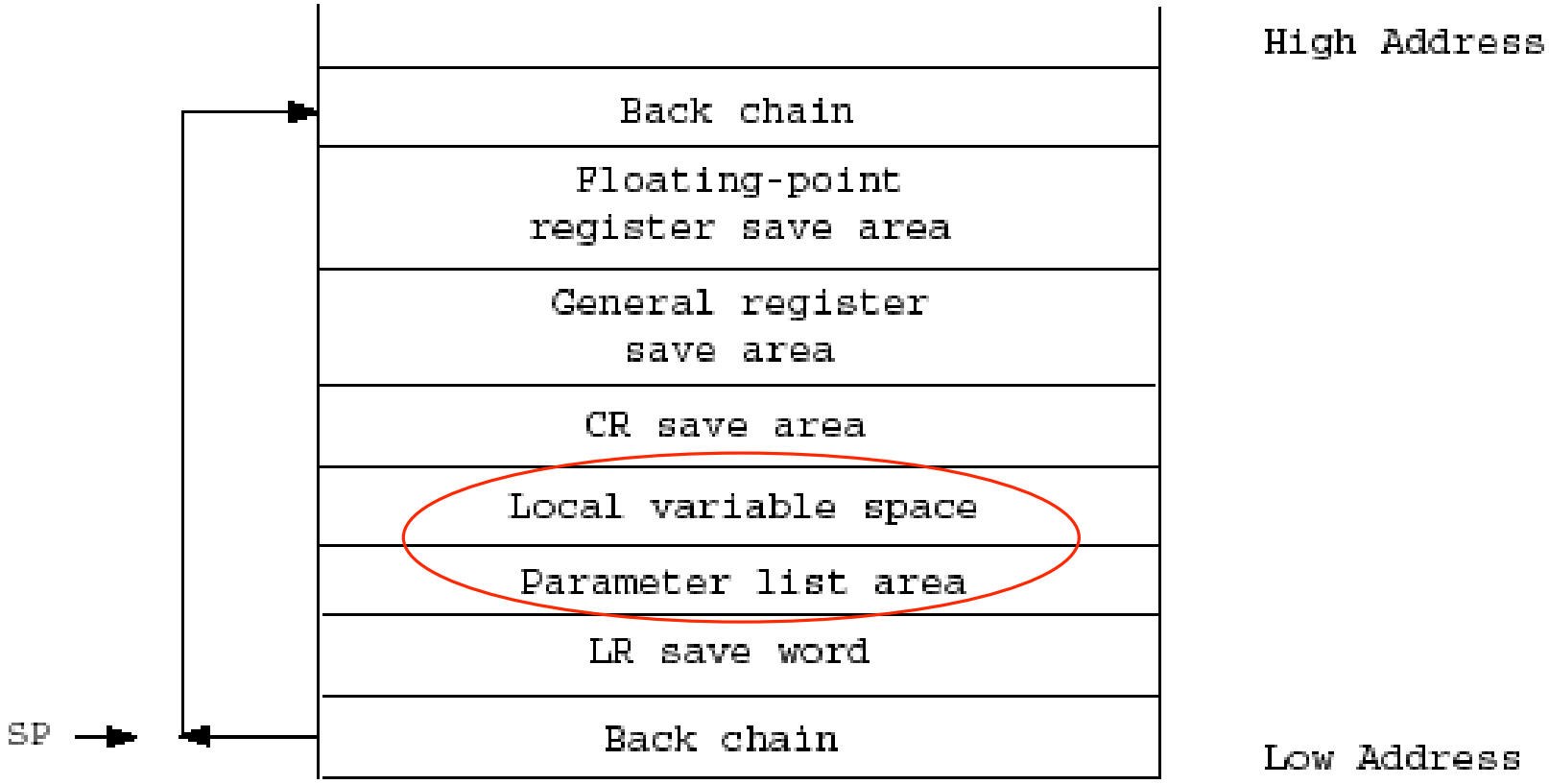
- Setting up the stack frame
- Function calls
- Basic flow control
- Structures - Passing, returning
- Integer and floating point arithmetic
- Conversions - int to real and real to int
- Arrays



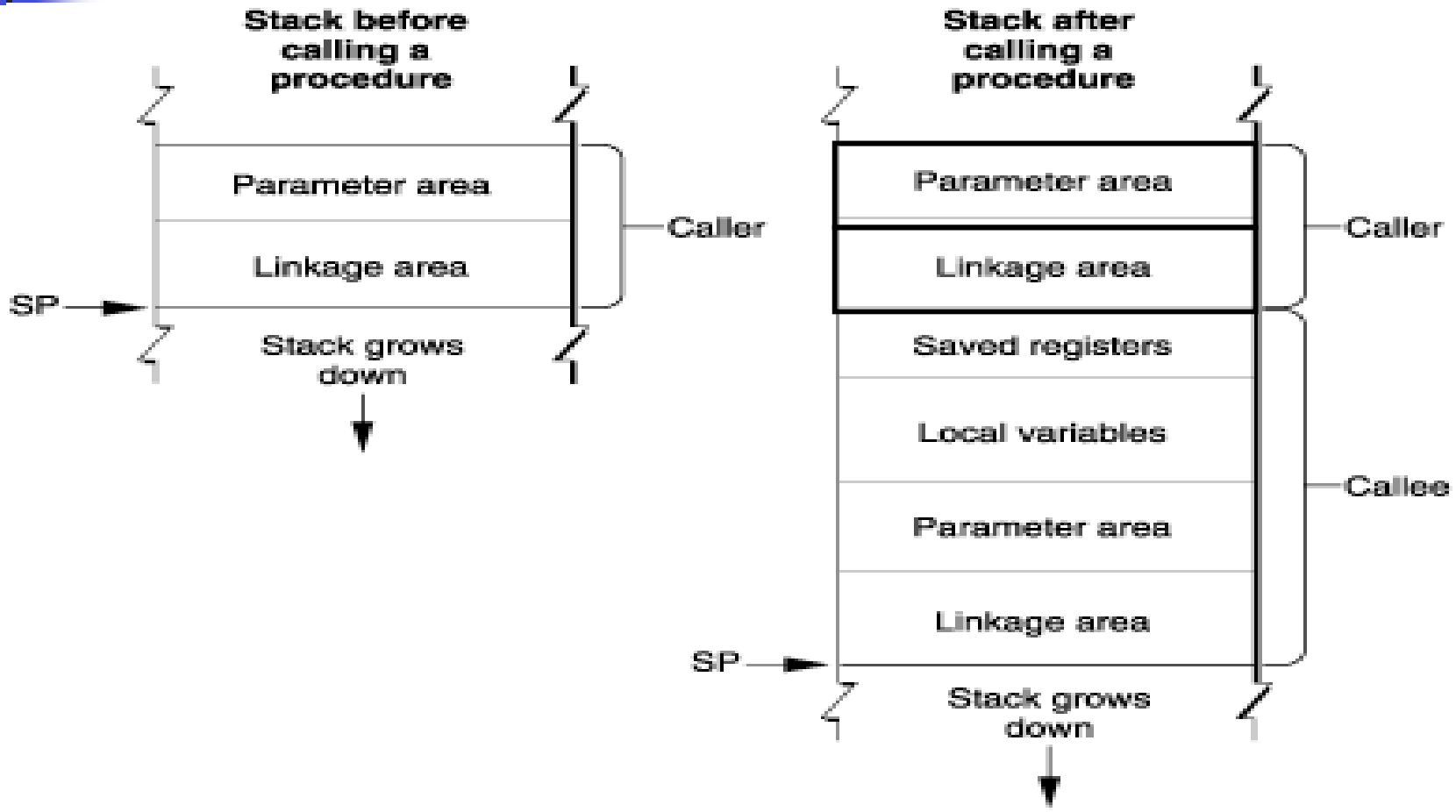
Challenges

- Different ABIs
- Position-independent code
- Source control
- Learning multiple ISAs
- Corner cases

Stack Frame - Linux



Stack Frame - Mac OS X



Stack Frame Comparison

Mac OS X

	fp reg save area (optional)
	ireg save area (optional)
	Padding (optional)
	Local storage (optional)
24(r1)	Parameter area (>= 8 words)
20(r1)	TOC save area
16(r1)	Link editor doubleword
12(r1)	Compiler doubleword
8(r1)	Link register (LR) save
4(r1)	Condition register (CR) save
0(r1)	ptr to callee's stack

SP→

Linux

	fp reg save area (optional)
	ireg save area (optional)
	CR save area (optional)
	Local storage (optional)
8(r1)	Parameter area (optional)
4(r1)	Link register (LR) save
0(r1)	ptr to callee's stack

Register Usage Comparison

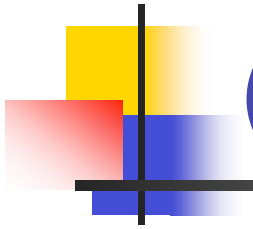
Mac OS X

Reg	Usage	Callee Save
r0	Prolog/epilog	No
r1	Stack pointer	Yes
r2	TOC pointer	Yes
r3-r4	1/2 para/return	No
r5-r10	3-8th integer para	No
r11	Env.pointer	No
r12	Used by global linkage	No
r13-31	Global int registers	Yes

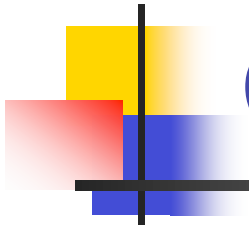
Linux

Reg	Usage	Callee Save
r0	Prolog/epilog	No
r1	Stack pointer	Yes
r2	TOC pointer	Yes
r3-r4	1/2 para/return	No
r5-r10	3-8th integer para	No
r11-r12	Func linkage regs	No
r13	Small data area ptr	No
r14-r30	Global int registers	Yes
r31	Global/env. pointer	Yes

Position-Independent Code (PIC)

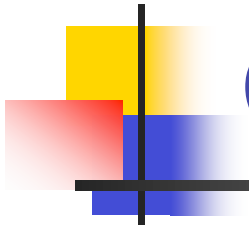


- Required for external linkage in Mac OS X
- Inhibits debugging if not implemented - no printf!
- No precedent in Scale Compiler



Call to printf - Linux

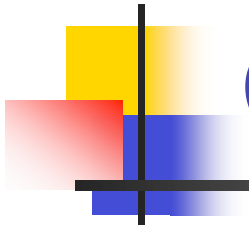
```
bl printf
```



Call to printf - Mac OS X

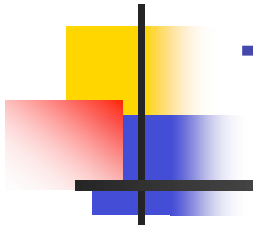
```
 bl L_printf$stub

.data
.section
__TEXT,__picsymbolstub1,symbol_stubs,pure_instructions,32
        .align 2
L_printf$stub:
        .indirect_symbol _printf
        mflr r0
        bcl 20,31,L0$_printf
```



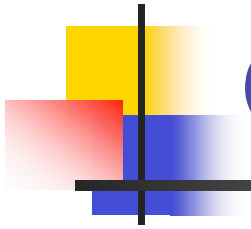
Call to printf - Mac OS X

```
L0$_printf:
        mflr r11
        addis r11,r11,ha16(L_printf$lazy_ptr-L0$_printf)
        mtlr r0
        lwzu r12,lo16(L_printf$lazy_ptr-L0$_printf)(r11)
        mtctr r12
        bctr
.data
.lazy_symbol_pointer
L_printf$lazy_ptr:
        .indirect_symbol _printf
        .long dyld_stub_binding_helper
```



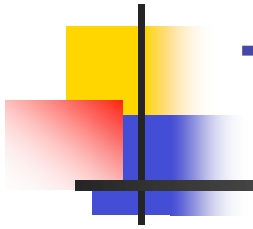
Tasks Remaining

- Position-independent code
- Variable-length argument lists
- Passing structs as arguments on stack
- Exponential, bit complement, remainder, absolute value expressions
- Extensive testing



Outside of the Scale Compiler

- Research meetings - Speedway and TRIPS
- Reading research papers
- Research for senior thesis topics
- Meetings and lunches with Kathryn
- First Bytes

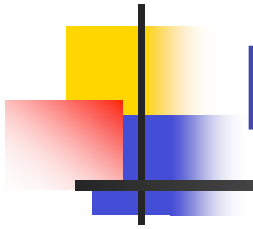


Things We've Learned

- Take initiative
- Read papers in your field
- Don't be intimidated
- Don't be afraid to ask questions
- Take advantage of the little time you have with your professors

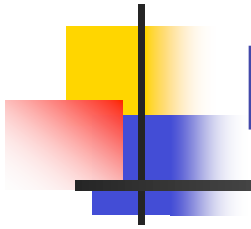
How You Have Helped

- Technical help - accounts, environment setup
- Weekly research meetings
- Helped us feel comfortable in this environment
- Receiving your respect and encouragement has been vital



Re-Cap

- CRA-W DMP program helps women consider graduate education in computer science
- The role of current graduate students and faculty is vital in making this program succeed



Re-Cap

- Helped achieve Scale project goals
- Provided Scale backend for a lasting architecture
- Future of PowerPC backend