Compiling and Optimizing Scripting Languages

Paul Biggar and David Gregg

Department of Computer Science and Statistics
Trinity College Dublin

LLNL, 17th March, 2009

Compiling and Optimizing Scripting Languages

Paul Biggar and David Gregg

Department of Computer Science and Statistics
Trinity College Dublin

LLNL, 17th March, 2009

1. dont have to obduscate your code for performance

Motivation

- User needs web page in 0.5 seconds
  - Execution time
  - DB access
  - Network latency
  - Browser rendering
- Easier maintainance
- What if execution was:
  - 2x as fast?
  - 10x as fast?

Motivation

- User needs web page in 0.5 seconds
  - Execution time
  - DB access
  - Network latency
  - Browser rendering
- Easier maintainance
- What if execution was:
  - 2x as fast?
  - 10x as fast?

Outline

Outline

1. Introduction to phc
2. Current state of phc
   - Challenges to compilation?
   - phc solution: use the C API
   - Speedup
3. Next for phc - Analysis and Optimization
   - Simple Optimizations
   - Advanced Optimizations
4. Security

Outline

Outline

1. BSD licence useful since its easy to extend
2. Well engineered - turns out you dont get a phd for that

phc

- http://phpcompiler.org
- Ahead-of-time compiler for PHP
- Edsko de Vries, John Gilbert, Paul Biggar
- BSD license
- Latest release: 0.2.0.3 - compiles non-OO
- svn trunk: compiles most OO

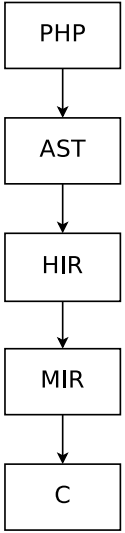
phc

- http://phpcompiler.org
- Ahead-of-time compiler for PHP
- Edsko de Vries, John Gilbert, Paul Biggar
- BSD license
- Latest release: 0.2.0.3 - compiles non-OO
- svn trunk: compiles most OO

1. maketea
2. All can be unparsed to PHP

Structure of **phc**

Structure of **phc**



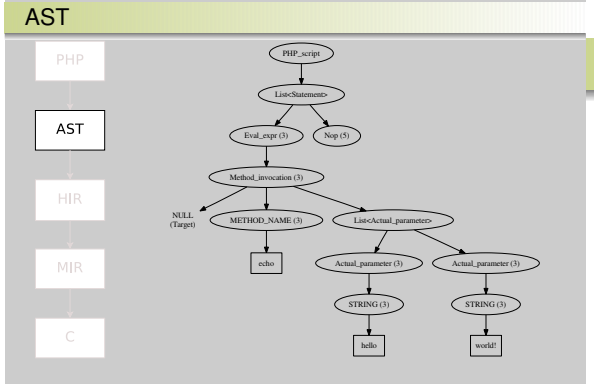
PHP

PHP

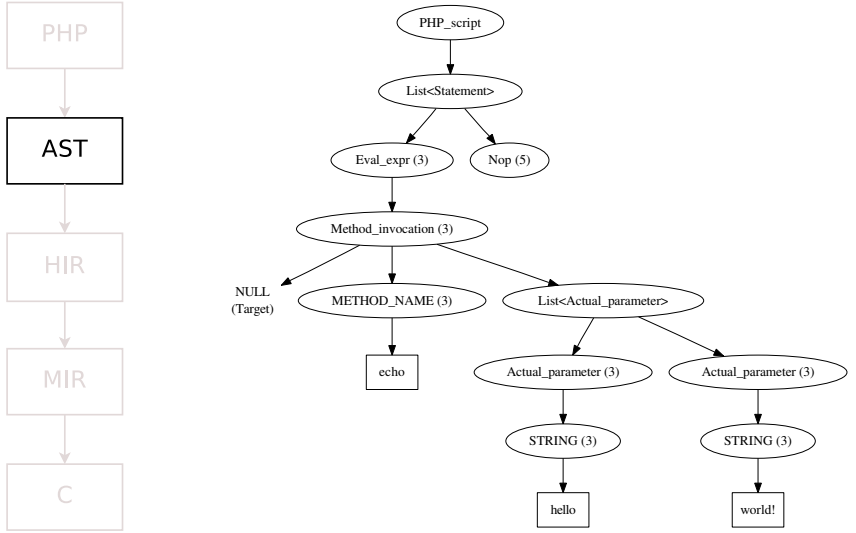

```
<?php
  echo "hello", "world!";
?>
```

1. better than parse (“concrete syntax”) tree

AST

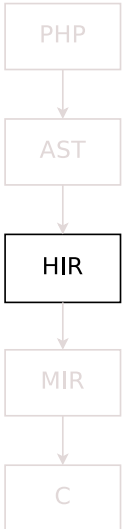


AST



1. 3AC
2. Still PHP

HIR




```
<?php
  $x = $a + $b + $c + $d;
?>
```

```
<?php
  $TLE0 = ($a + $b);
  $TLE1 = ($TLE0 + $c);
  $x = ($TLE1 + $d);
?>
```

1. Not PHP
2. Gotos

MIR

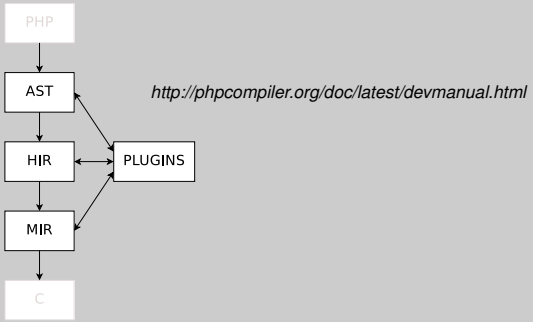

```
<?php
  while ($cond)
    echo "hello", "world!";
?>

<?php
L7:
  $TLE0 = !$cond;
  if ($TLE0) goto L3 else goto L6;
L6:
  print('hello');
  print('world!');
  goto L7;
L3:
?>
```

MIR


```
<?php
  while ($cond)
    echo "hello", "world!";
?>

<?php
L7:
  $TLE0 = !$cond;
  if ($TLE0) goto L3 else goto L6;
L6:
  print('hello');
  print('world!');
  goto L7;
L3:
?>
```

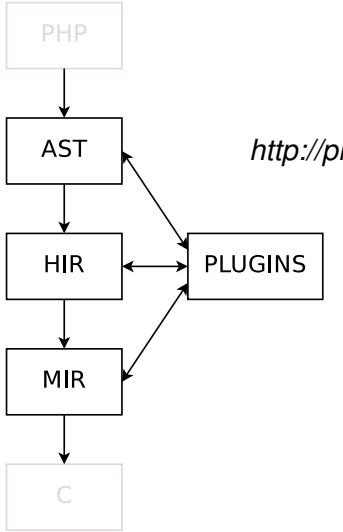
1. Visitor pattern
2. We use it for testing a lot
3. Manual documents it well
4.

Plugins



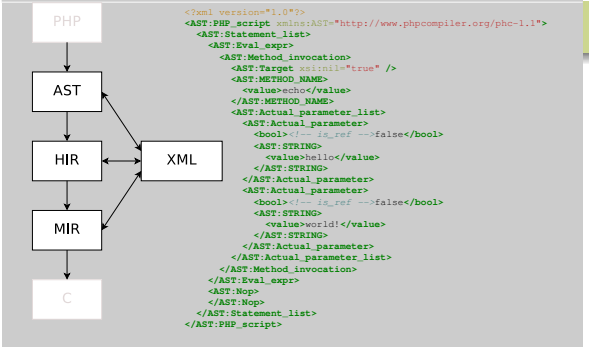
http://phpcompiler.org/doc/latest/devmanual.html

Plugins

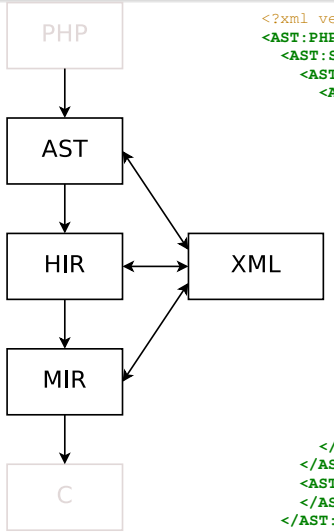


http://phpcompiler.org/doc/latest/devmanual.html

XML



XML




```
<?xml version="1.0"?>
<AST:PHP_script xmlns:AST="http://www.phpcompiler.org/phc-1.1">
  <AST:Statement_list>
    <AST:Eval_expr>
      <AST:Method_invocation>
        <AST:Target xsi:nil="true" />
        <AST:METHOD_NAME>
          <value>echo</value>
        </AST:METHOD_NAME>
        <AST:Actual_parameter_list>
          <AST:Actual_parameter>
            <bool><!-- is_ref -->false</bool>
            <AST:STRING>
              <value>hello</value>
            </AST:STRING>
          </AST:Actual_parameter>
          <AST:Actual_parameter>
            <bool><!-- is_ref -->false</bool>
            <AST:STRING>
              <value>world!</value>
            </AST:STRING>
          </AST:Actual_parameter>
        </AST:Actual_parameter_list>
      </AST:Method_invocation>
    </AST:Eval_expr>
    <AST:Nop>
    </AST:Nop>
  </AST:Statement_list>
</AST:PHP_script>
```

Outline

Outline

1. Correctness
2. Large libraries
3. Odd features
4. No spec

A Practical Solution for Scripting Language Compilers

Paul Biggar, Edsko de Vries and David Gregg

Department of Computer Science and Statistics
Trinity College Dublin

ACM Symposium on Applied Computing - PL track
12th March, 2009

SAC 2009

A Practical Solution for Scripting Language Compilers

Paul Biggar, Edsko de Vries and David Gregg

Department of Computer Science and Statistics
Trinity College Dublin

ACM Symposium on Applied Computing - PL track
12th March, 2009

Sneak peak

- Problem: Scripting languages present “unique” problems (in practice)
- Solution: Re-use as much of the ~~*Canonical*~~ *Reference Implementation* as possible.

Sneak peak

- Problem: Scripting languages present “unique” problems (in practice)
- Solution: Re-use as much of the ~~*Canonical*~~ *Reference Implementation* as possible.

Outline

Outline

Undefined

The PHP group claim that they have the final say in the specification of PHP. This group's specification is an implementation, and there is no prose specification or agreed validation suite. There are alternate implementations [...] that claim to be compatible (they don't say what this means) with some version of PHP.

D. M. Jones. Forms of language specification: Examples from commonly used computer languages. ISO/IEC JTC1/SC22/OWG/N0121, February 2008.

Undefined

The PHP group claim that they have the final say in the specification of PHP. This group's specification is an implementation, and there is no prose specification or agreed validation suite. There are alternate implementations [...] that claim to be compatible (they don't say what this means) with some version of PHP.

D. M. Jones. Forms of language specification: Examples from commonly used computer languages. ISO/IEC JTC1/SC22/OWG/N0121, February 2008.

1. all written in C, not PHP
2. Mike Furr earlier: 1000 methods/classes in C
3. 4870 functions, 1000 methods

Batteries included

Jeff Atwood, Coding Horror, May 20th, 2008
http://www.codinghorror.com/blog/archives/001119.html

Batteries included

abs() acos() acosh() addcslashes() addslashes() aggregate() aggregate_info() aggregate_methods() aggregate_methods_by_list() aggregate_methods_by_regexp() aggregate_properties() aggregate_properties_by_list() aggregate_properties_by_regexp() aggregation_info() apache_child_terminate() apache_get_modules() apache_get_version() apache_getenv() apache_lookup_uri() apache_note() apache_request_headers() apache_reset_timeout() apache_response_headers() apache_setenv() apc_add() apc_cache_info() apc_clear_cache() apc_compile_file() apc_define_constants() apc_delete() apc_fetch()
apc_load_constants() apc_sma_info() apc_store() apd_breakpoint() apd_callstack() apd_clunk() apd_continue() apd_croak() apd_dump_function_table() apd_dump_persistent_resources() apd_dump_regular_resources() apd_echo() apd_get_active_symbols() apd_set_pprof_trace() apd_set_session() apd_set_session_trace() apd_set_socket_session_trace() array() array_change_key_case() array_chunk() array_combine() array_count_values() array_diff() array_diff_assoc() array_diff_key() array_diff_uassoc() array_diff_ukey() array_fill() array_fill_keys() array_filter() array_flip()
array_intersect() array_intersect_assoc() array_intersect_key() array_intersect_uassoc() array_intersect_ukey() array_key_exists() array_keys() array_map() array_merge() array_merge_recursive() array_multisort() array_pad() array_pop() array_product() array_push() array_rand() array_reduce() array_reverse() array_search() array_shift() array_slice() array_splice() array_sum() array_udiff() array_udiff_assoc() array_udiff_uassoc() array_uintersect() array_uintersect_assoc() array_uintersect_uassoc() array_unique() array_unshift()
array_values() array_walk() array_walk_recursive() ArrayIterator::current() ArrayIterator::key() ArrayIterator::next() ArrayIterator::rewind() ArrayIterator::seek() ArrayIterator::valid() ArrayObject::__construct() ArrayObject::append() ArrayObject::count() ArrayObject::getIterator() ArrayObject::offsetExists() ArrayObject::offsetGet() ArrayObject::offsetSet() ArrayObject::offsetUnset() arsort() ascii2ebcdic() asin() asinh() asort() aspell_check() aspell_check_raw() aspell_new() aspell_suggest() assert() assert_options() atan() atan2() atanh()

Jeff Atwood, Coding Horror, May 20th, 2008
http://www.codinghorror.com/blog/archives/001119.html

Change between releases

```
<?php
  var_dump (0x9fa0ff0b);
?>
```

PHP 5.2.1 (32-bit)

int(2147483647)

PHP 5.2.3 (32-bit)

float(2678128395)

Change between releases

```
<?php
  var_dump (0x9fa0ff0b);
?>
```

PHP 5.2.1 (32-bit)

int(2147483647)

PHP 5.2.3 (32-bit)

float(2678128395)

1. scripting langs are typically made for interpreters
2. can do source inclusion at compile time
3. same mechanism for plugins

Run-time code generation

```
<?php
  eval ($argv[1]);
?>


<?php
  include ("mylib.php");
  ...
  include ("plugin.php");
  ...
?>
```

Run-time code generation

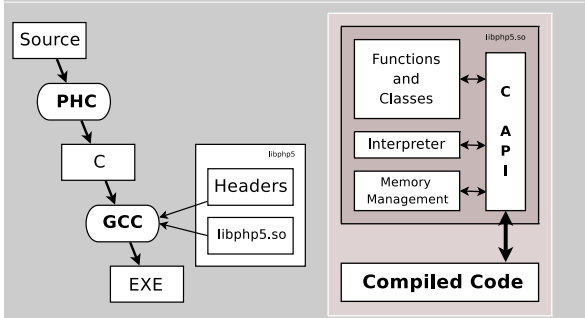

```
<?php
  eval ($argv[1]);
?>


<?php
  include ("mylib.php");
  ...
  include ("plugin.php");
  ...
?>
```

Outline

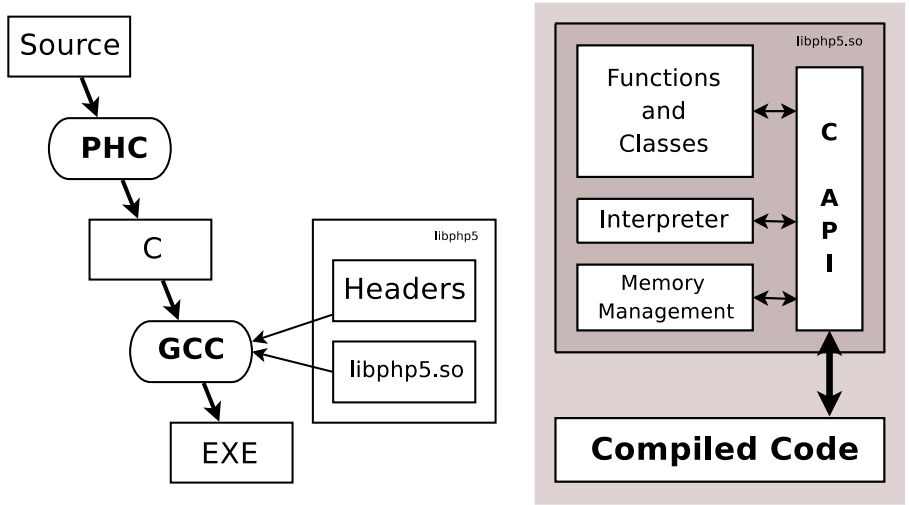
Outline

1. RTCG
2. Functions
3. Changes between releases: also use C API at compile-time

Use C API



Use C API



1. C API is just zval + macros and functions
2. Use (target) PHP's C API at run-time

More detail

PHP	zval
Python	PyObject
Ruby	VALUE
Lua	TValue

H. Muhammad and R. Ierusalimschy. C APIs in extension and extensible languages. Journal of Universal Computer Science, 13(6):839–853, 2007.

More detail

PHP	zval
Python	PyObject
Ruby	VALUE
Lua	TValue

H. Muhammad and R. Ierusalimschy. C APIs in extension and extensible languages. Journal of Universal Computer Science, 13(6):839–853, 2007.

Simple listings: $i = 0

```
// $i = 0;
{
  zval* p_i;
  php_hash_find (LOCAL_ST, "i", 5863374, p_i);
  php_destruct (p_i);
  php_allocate (p_i);
  ZVAL_LONG (*p_i, 0);
}
```

Simple listings: $i = 0

```
// $i = 0;
{
  zval* p_i;
  php_hash_find (LOCAL_ST, "i", 5863374, p_i);
  php_destruct (p_i);
  php_allocate (p_i);
  ZVAL_LONG (*p_i, 0);
}
```

Example: $i = 0

```
// $i = 0;
{
  if (local_i == NULL)
  {
    local_i = EG (uninitialized_zval_ptr);
    local_i->refcount++;
  }
  zval **p_lhs = &local_i;

  zval *value;
  if ((*p_lhs)->is_ref)
  {
    // Always overwrite the current value
    value = *p_lhs;
    zval_dtor (value);
  }
  else
  {
    ALLOC_INIT_ZVAL (value);
    zval_ptr_dtor (p_lhs);
    *p_lhs = value;
  }

  ZVAL_LONG (value, 0);
}
```

Example: $i = 0

```
// $i = 0;
{
  if (local_i == NULL)
  {
    local_i = EG (uninitialized_zval_ptr);
    local_i->refcount++;
  }
  zval **p_lhs = &local_i;

  zval *value;
  if ((*p_lhs)->is_ref)
  {
    // Always overwrite the current value
    value = *p_lhs;
    zval_dtor (value);
  }
  else
  {
    ALLOC_INIT_ZVAL (value);
    zval_ptr_dtor (p_lhs);
    *p_lhs = value;
  }

  ZVAL_LONG (value, 0);
}
```

Example: $i = $j

```
// $i = $j;
{
  if (local_i == NULL)
  {
    local_i = EG (uninitialized_zval_ptr);
    local_i->refcount++;
  }
  zval **p_lhs = &local_i;

  zval *rhs;
  if (local_j == NULL)
    rhs = EG (uninitialized_zval_ptr);
  else
    rhs = local_j;

  if (*p_lhs != rhs)
  {
    if ((*p_lhs)->is_ref)
    {
      // First, call the destructor to remove any data structures
      // associated with lhs that will now be overwritten
      zval_dtor (*p_lhs);
      // Overwrite LHS
      (*p_lhs)->value = rhs->value;
      (*p_lhs)->type = rhs->type;
      zval_copy_ctor (*p_lhs);
    }
    else
    {
      zval_ptr_dtor (p_lhs);
      if (rhs->is_ref)
      {
        // Take a copy of RHS for LHS
        *p_lhs = zvp_clone_ex (rhs);
      }
      else
      {
        // Share a copy
        rhs->refcount++;
        *p_lhs = rhs;
      }
    }
  }
}
```

Example: $i = $j

```
// $i = $j;
{
  if (local_i == NULL)
  {
    local_i = EG (uninitialized_zval_ptr);
    local_i->refcount++;
  }
  zval **p_lhs = &local_i;

  zval *rhs;
  if (local_j == NULL)
    rhs = EG (uninitialized_zval_ptr);
  else
    rhs = local_j;

  if (*p_lhs != rhs)
  {
    if ((*p_lhs)->is_ref)
    {
      // First, call the destructor to remove any data structures
      // associated with lhs that will now be overwritten
      zval_dtor (*p_lhs);
      // Overwrite LHS
      (*p_lhs)->value = rhs->value;
      (*p_lhs)->type = rhs->type;
      zval_copy_ctor (*p_lhs);
    }
    else
    {
      zval_ptr_dtor (p_lhs);
      if (rhs->is_ref)
      {
        // Take a copy of RHS for LHS
        *p_lhs = zvp_clone_ex (rhs);
      }
      else
      {
        // Share a copy
        rhs->refcount++;
        *p_lhs = rhs;
      }
    }
```

Example: printf ($f)

Example: printf ($f)

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*

1. Python used to be bad - aycock quote

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*
- Except specification
  - Lua
  - Python

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*
- Except specification
  - Lua
  - Python

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*
- Except specification
  - Lua
  - Python
- Not at all
  - Javascript

Applicability

- Everything
  - Perl
  - PHP
  - Ruby
  - Tcl – *I think*
- Except specification
  - Lua
  - Python
- Not at all
  - Javascript

Outline

Outline

1. Why is experiemental evaluation a speedup?
2. That's an interesting result. Shouldnt compilers always be faster!!!
3. PHP's interpreter isnt slowed by interpreter loop. Rather its the level of dynamicism.

Original Speed-up

0.1x
(10 times slower than the PHP interpreter)

Original Speed-up

0.1x
(10 times slower than the PHP interpreter)

1. each statement is pretty high level

The problem with copies

```
<?php
  for ($i = 0; $i < $n; $i++)
    $str = $str . "hello";
?>


<?php
  for ($i = 0; $i < $n; $i++)
  {
    $T = $str . "hello";
    $str = $T;
  }
?>
```

The problem with copies

```
<?php
  for ($i = 0; $i < $n; $i++)
    $str = $str . "hello";
?>


<?php
  for ($i = 0; $i < $n; $i++)
  {
    $T = $str . "hello";
    $str = $T;
  }
?>
```

1. We dont need to know how to fold constants - we just pass it off to PHP's eval


```
<?php
  ...
  $T = "5" + true;
  ...
?>
```

```
<?php
  ...
  $T = 6;
  ...
?>
```


Optimization

- Constant folding

```
<?php
  ...
  $T = "5" + true;
  ...
?>
```

```
<?php
  ...
  $T = 6;
  ...
?>
```

Optimization

- Constant folding
- Constant pooling

```
<?php
  $sum = 0;
  for ($i = 0; $i < 10; $i=$i+1)
  {
    $sum .= "hello";
  }
?>
```

Optimization

- Constant folding
- Constant pooling

```
<?php
  $sum = 0;
  for ($i = 0; $i < 10; $i=$i+1)
  {
    $sum .= "hello";
  }
?>
```

1. PHP implements this
2. function cant change afte first invocation - dont need lookup-cache of inline cache or polymorphic inline cache

Optimization

- Constant folding
- Constant pooling
- Function caching

```
// printf ($f);
static php_fcall_info printf_info;
{
  php_fcall_info_init ("printf", &printf_info);

  php_hash_find (
    LOCAL_ST, "f", 5863275, &printf_info.params);

  php_call_function (&printf_info);
}
```


Optimization

- Constant folding
- Constant pooling
- Function caching

```
// printf ($f);
static php_fcall_info printf_info;
{
  php_fcall_info_init ("printf", &printf_info);

  php_hash_find (
    LOCAL_ST, "f", 5863275, &printf_info.params);

  php_call_function (&printf_info);
}
```

Optimization

- Constant folding
- Constant pooling
- Function caching
- Pre-hashing

```
// $i = 0;
{
  zval* p_i;
  php_hash_find (LOCAL_ST, "i", 5863374, p_i);
  php_destruct (p_i);
  php_allocate (p_i);
  ZVAL_LONG (*p_i, 0);
}
```

Optimization

- Constant folding
- Constant pooling
- Function caching
- Pre-hashing

```
// $i = 0;
{
  zval* p_i;
  php_hash_find (LOCAL_ST, "i", 5863374, p_i);
  php_destruct (p_i);
  php_allocate (p_i);
  ZVAL_LONG (*p_i, 0);
}
```

Optimization

- Constant folding
- Constant pooling
- Function caching
- Pre-hashing
- Symbol-table removal

```
// $i = 0;
{
  php_destruct (local_i);
  php_allocate (local_i);
  ZVAL_LONG (*local_i, 0);
}
```

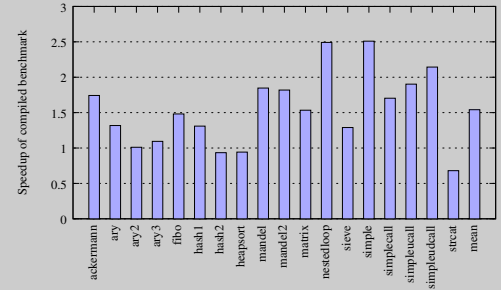
Optimization

- Constant folding
- Constant pooling
- Function caching
- Pre-hashing
- Symbol-table removal

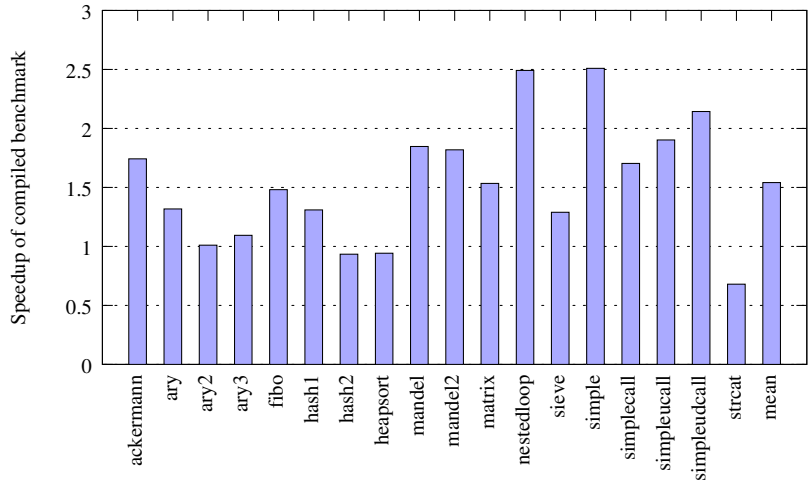
```
// $i = 0;
{
  php_destruct (local_i);
  php_allocate (local_i);
  ZVAL_LONG (*local_i, 0);
}
```

1. Explain how to read graph
2. Much better than 0.1x
3. C compiler: be 5x faster
4. PHP 40x-70x slower

Current speed-up



Current speed-up



Outline

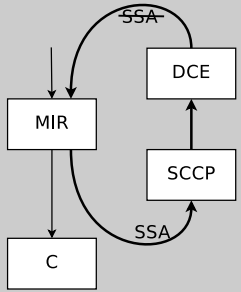
Outline

Outline

Outline

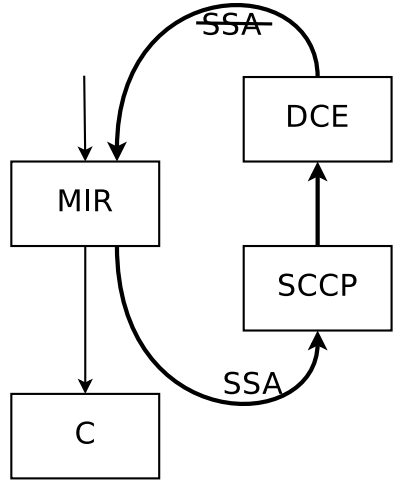
1. 2x speedup

Intra-procedural optimizations



- Dead-code elimination
- Sparse-conditional **constant propagation**

Intra-procedural optimizations



- Dead-code elimination
- Sparse-conditional **constant propagation**

Type-inference

```
<?php

  function a ($x, $y)
  {
    $str = $x . $y;
    ...
    return $str;
  }

?>
```

Type-inference

```
<?php

  function a ($x, $y)
  {
    $str = $x . $y;
    ...
    return $str;
  }

?>
```

User-space handlers

- __toString
- __get
- __set
- __isset
- __unset
- __sleep
- __wake
- __call
- __callStatic
- ...

User-space handlers

- __toString
- __get
- __set
- __isset
- __unset
- __sleep
- __wake
- __call
- __callStatic
- ...

1. So previous SSA opts were illegal
2. Complete access to interpreter internals
3. Need accurate use-defs

C API handlers

- read_property
- read_dimension
- get
- set
- cast_object
- has_property
- unset_property
- ...

C API handlers

- read_property
- read_dimension
- get
- set
- cast_object
- has_property
- unset_property
- ...

Unknown types propagate

- local symbol table
- global symbol table
- return values
- reference parameters
- callee parameters

Unknown types propagate

- local symbol table
- global symbol table
- return values
- reference parameters
- callee parameters

Outline

Outline

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls

1. Uses and defintions incomplete - this doesnt use them

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls
- Uses and definitions incomplete
  - Can't use *def-use chains*
  - Can't use *SSA*

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls
- Uses and definitions incomplete
  - Can't use *def-use chains*
  - Can't use *SSA*

1. Imprecise callgraph - do it lazily

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls
- Uses and definitions incomplete
  - Can't use *def-use chains*
  - Can't use *SSA*
- Imprecise callgraph

Analysis design

- Must model types precisely
  - (Possibly unnamed) fields, arrays, variables and method calls
- Uses and definitions incomplete
  - Can't use *def-use chains*
  - Can't use *SSA*
- Imprecise callgraph

Algorithm

- Abstract Execution / Interpretation

Algorithm

- Abstract Execution / Interpretation

1. flow, context, object, field

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive
- Constant-propagation
  - Precision
  - Array-indices/field names
  - Implicit conversions

A. Pioli. Conditional pointer aliasing and constant propagation. Master's thesis, SUNY at New Paltz, 1999.

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive
- Constant-propagation
  - Precision
  - Array-indices/field names
  - Implicit conversions

A. Pioli. Conditional pointer aliasing and constant propagation. Master's thesis, SUNY at New Paltz, 1999.

1. Make polymorphic calls monomorphic
2. Go through each of the problems on the previous slide
3. model types precisely
4. need to model many functions - in contrast to SAC stuff
5. much easier than reimplementing, however

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive
- Constant-propagation
  - Precision
  - Array-indices/field names
  - Implicit conversions
- Type-inference
  - Virtual calls
  - Function annotations

Algorithm

- Abstract Execution / Interpretation
- Points-to analysis
  - *-sensitive
- Constant-propagation
  - Precision
  - Array-indices/field names
  - Implicit conversions
- Type-inference
  - Virtual calls
  - Function annotations

1. Static-includes optimization needs to be deployment-time
2. hashtables - SAC javascript talk

Complex cases

- Hashtables
- Implicit conversions
- Variable-variables
- $GLOBALS
- Static includes
- $SESSION
- Compiler temporaries

Complex cases

- Hashtables
- Implicit conversions
- Variable-variables
- $GLOBALS
- Static includes
- $SESSION
- Compiler temporaries

1. just like hotspot

Interesting thoughts

- Strip off first loop iteration

Interesting thoughts

- Strip off first loop iteration

1. Would it go well with Gal/Franz tracing?

- Strip off first loop iteration
- JITs or Gal/Franz Tracing?

Interesting thoughts

- Strip off first loop iteration
- JITs or Gal/Franz Tracing?

Interesting thoughts

- Strip off first loop iteration
- JITs or Gal/Franz Tracing?
- Use string transducer analysis

Interesting thoughts

- Strip off first loop iteration
- JITs or Gal/Franz Tracing?
- Use string transducer analysis

Outline

Outline

Security

- Davis - if we include it, we'll do better

Sound and Precise Analysis of Web Applications
for Injection Vulnerabilities
Gary Wassermann, Zhendong Su, PLDI'07.

Static approximation of dynamically generated Web pages
Yasuhiko Minamide, WWW 2005

Security

- Davis - if we include it, we'll do better

Sound and Precise Analysis of Web Applications
for Injection Vulnerabilities
Gary Wassermann, Zhendong Su, PLDI'07.

Static approximation of dynamically generated Web pages
Yasuhiko Minamide, WWW 2005

Security

- Davis - if we include it, we'll do better
- Tuwien/Pixy - taint analysis (literal analysis + points to)

Security

- Davis - if we include it, we'll do better
- Tuwien/Pixy - taint analysis (literal analysis + points to)

Security

- Davis - if we include it, we'll do better
- Tuwien/Pixy - taint analysis (literal analysis + points to)
- Utrecht/Stanford - dont remember

Security

- Davis - if we include it, we'll do better
- Tuwien/Pixy - taint analysis (literal analysis + points to)
- Utrecht/Stanford - dont remember

Summary

- Re-use existing run-time for language
- Better yet: standardize libraries (and language?), including FFI
- Analysis needs to be precise, and whole-program
- Pessimistic assumptions spread
- Language, implementation and community need to be fixed
  - All related?

Summary

- Re-use existing run-time for language
- Better yet: standardize libraries (and language?), including FFI
- Analysis needs to be precise, and whole-program
- Pessimistic assumptions spread
- Language, implementation and community need to be fixed
  - All related?

Thanks

phc needs contributors

- contribute: `http://phpcompiler.org/contribute.html`
- mailing list: `phc-general@phpcompiler.org`
- slides: `http://www.cs.tcd.ie/~pbiggar/`
- contact: `paul.biggar@gmail.com`

Thanks

phc needs contributors

- contribute: `http://phpcompiler.org/contribute.html`
- mailing list: `phc-general@phpcompiler.org`
- slides: `http://www.cs.tcd.ie/~pbiggar/`
- contact: `paul.biggar@gmail.com`

1. Static-includes optimization needs to be deployment-time
2. hashtables - SAC javascript talk

Complex cases

- Hashtables
- Implicit conversions
- Variable-variables
- $GLOBALS
- Static includes
- $SESSION
- Compiler temporaries

Complex cases

- Hashtables
- Implicit conversions
- Variable-variables
- $GLOBALS
- Static includes
- $SESSION
- Compiler temporaries