Boostache Exposed

the internals of Boost's template engine

ciere consulting

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boostache

boostache

boostache

boo{stache

boo{stache}

caterpillar

Part I

Introduction

C++Now 2014
Library in a Week
Challenge

What is it?

C++ Template Engine

What is it?

C++ Template Engine

What!!

What is it?

Boostache is a text template processing engine.

Takes in a document (*the template*) and a data source and generates an output document based on values from the data source

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Takes in a document (*the template*) and a data source and generates an output document based on values from the data source

Example Libraries

- Mustache
- Handlebars
- ctemplate
- Dust
- Django
- Jade
- Jinja

Original Cast

- Michal Bukovsky
- Michael Caisse
- Jeff Garland
- Jeroen Habraken
- Kevin Harris
- Dan Nuffer

Design Goals

Design Goals (morning session):

- Integrate STL well
- Type Safety
- Template parsing error handling
- Provide customization of markup language
- Make configuration simple
- Any data structure convertible to text should work

Features

- “Compiled templates” (for speed)

Design Decisions

- Use C++11

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Data Model Design Discussion

- Force a model on the user. (hash of strings to strings ...)
- Accept user defined model

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Credit

Following examples are for the Mustache Man pages

Mustache Example

Template

```
Hello {{name}}
You have just won {{value}} dollars!
{{#in_ca}}
Well, {{taxed_value}} dollars, after taxes.
{{/in_ca}}
```

Data

```
{
  "name": "Chris",
  "value": 10000,
  "taxed_value": 10000 - (10000 * 0.4),
  "in_ca": true
}
```

Result

```
Hello Chris
You have just won 10000 dollars!
Well, 6000.0 dollars, after taxes.
```

Mustache Example

Template

```
{{#repo}}
  <b>{{name}}</b>
{{/repo}}
```

Data

```
{
  "repo": [
    { "name": "resque" },
    { "name": "hub" },
    { "name": "rip" }
  ]
}
```

Result

```
<b>resque</b>
<b>hub</b>
<b>rip</b>
```

Using Boostache - Example 1

```cpp
using map_t = std::map<std::string, std::string>;

int main()
{

    // template
    std::string input("My name is {{name}}. I am {{age}} years old.");

    // data
    map_t data = { { "name"  , "Jeroen" },
                   { "age"   , "42"     }
    };

    using boostache::load_template;

    auto iter = input.begin();
    auto templ = load_template<boostache::format::stache>( iter
                                                         , input.end());

    std::stringstream stream;
    boostache::generate(stream, templ, data);

    std::cout << stream.str();

}
```

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    using boostache::load_template;

    auto iter = input.begin();
    auto templ = load_template<boostache::format::stache>( iter
                                                         , input.end())

    std::stringstream stream;
    boostache::generate(stream, templ, data);

    std::cout << stream.str();

}
```

Using Boostache - Example 2

```
using item_t = std::map<std::string, std::string>;
using item_list_t = std::vector<item_t>;
using invoice_t = std::map<std::string, item_list_t>;


int main()
{
    std::string input(
                        "Invoice"
                        "\n"
                        "{{#lines}}"
                        "  {{item_code}}  {{description}}  {{amount}}\n"
                        "{{/lines}}"
        );


    item_list_t invoice_items = {
                                  { {"item_code"    , "1234"},
                                    {"description"  , "Jolt"},
                                    {"amount"       , "$23"} },
                                  { {"item_code"    , "1235"},
                                    {"description"  , "computer"},
                                    {"amount"       , "$9"} }
    };

    invoice_t invoice = {{"lines"  , invoice_items}};
```

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```

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    using boostache::load_template;

    auto iter = input.begin();
    auto templ = load_template<boostache::format::stache>( iter
                                                         , input.end());

    std::stringstream stream;
    boostache::generate(stream, templ, invoice);

    std::cout << stream.str();

}
```

Using Boostache - Example 2

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    using boostache::load_template;

    auto iter = input.begin();
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                                                         , input.end());

    std::stringstream stream;
    boostache::generate(stream, templ, invoice);

    std::cout << stream.str();

}
```

Using Boostache - Example 3

```
std::string input(
                    "Invoice {{invoice_number}}"
                    "\n"
                    "{{# company}}"
                    "Company: {{name}}\n"
                    "         {{street}}\n"
                    "         {{city}}, {{state}}  {{zip}}\n"
                    "{{/ company}}"
                    "----------------------------------------\n"
                    "{{#lines}}"
                    "  {{item_code}}  {{description}}  {{amount}}\n"
                    "{{/lines}}"
    );
```

Using Boostache - Example 3

```
using boost::spirit::extended_variant;

struct value_t;
using object_t = std::map<std::string, value_t>;
using list_t = std::vector<value_t>;

struct value_t : extended_variant< std::string
                                 , object_t
                                 , list_t
                                 >
{
   value_t() : base_type() {}
   value_t(std::string const & rhs) : base_type(rhs) {}
   value_t(char const * rhs) : base_type(std::string{rhs}) {}
   value_t(object_t const & rhs) : base_type(rhs) {}
   value_t(list_t const & rhs) : base_type(rhs) {}
};
```

Using Boostache - Example 3

```
object_t invoice =
    {{"invoice_number", "1234"},
     {"company"       , object_t{{"name"    , "FizSoft"},
                                 {"street"  , "42 Level St."},
                                 {"city"    , "Ytic"},
                                 {"state"   , "CA"},
                                 {"zip"     , "98765"} }},
     {"lines"         , list_t{ object_t{{"item_code"    , "1234-2"},
                                         {"description"  , "Jolt Case"},
                                         {"amount"       , "$23"}},
                                object_t{{"item_code"    , "1235-1"},
                                         {"description"  , "Computer"},
                                         {"amount"       , "$9"}}   }}
};
```

Using Boostache - Example 3

```
using boostache::load_template;

auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end());



std::stringstream stream;
boostache::generate(stream, templ, invoice);
```

Using Boostache - Example 4

```
std::string input(
                    "Hello {{first_name}} {{last_name}} - \n\n"
                    "Congratulations on the acceptance of {{library}} "
                    "to Boost!"
                    "\n"
   );


author sue = { "Jones", "Sue", "sue@jones.net", "Wicket" };


using boostache::load_template;

auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end());

std::stringstream stream;
boostache::generate(stream, templ, sue);
```

Using Boostache - Example 4

```
struct author
{
   std::string last_name;
   std::string first_name;
   std::string email;
   std::string library;
};
```

```
std::string input(
                    "Hello {{first_name}} {{last_name}} - \n\n"
                    "Congratulations on the acceptance of {{library}} "
                    "to Boost!"
                    "\n"
   );
```

```
author sue = { "Jones", "Sue", "sue@jones.net", "Wicket" };
```

Using Boostache - Example 4

```
struct author
{
   std::string last_name;
   std::string first_name;
   std::string email;
   std::string library;
};
```

```
BOOST_FUSION_ADAPT_STRUCT(
   author,
   (std::string , last_name)
   (std::string , first_name)
   (std::string , library)
)
```

Using Boostache - Example 5

```
std::string input(
                    "Invoice {{invoice_number}}"
                    "\n"
                    "{{# company}}"
                    "Company: {{name}}\n"
                    "         {{street}}\n"
                    "         {{city}}, {{state}}  {{zip}}\n"
                    "{{/ company}}"
                    "----------------------------------------\n"
                    "{{#lines}}"
                    "  {{item_code}}  {{description}}  {{amount}}\n"
                    "{{/lines}}"
    );
```

Using Boostache - Example 5

```
struct company
{
    std::string name;
    std::string street;
    std::string city;
    std::string state;
    std::string zip;
};

struct line
{
    std::string item_code;
    std::string description;
    std::string amount;
};

struct invoice
{
    int invoice_number;
    company company_;
    std::vector<line> lines;
};
```

Using Boostache - Example 5

```
BOOST_FUSION_ADAPT_STRUCT(
    company,
    (std::string , name)
    (std::string , street)
    (std::string , city)
    (std::string , state)
    (std::string , zip)
)

BOOST_FUSION_ADAPT_STRUCT(
    line,
    (std::string , item_code)
    (std::string , description)
    (std::string , amount)
)

BOOST_FUSION_ADAPT_STRUCT(
    invoice,
    (int                  , invoice_number)
    (company              , company_)
    (std::vector<line> , lines)
)
```

Using Boostache - Example 5

```
using boostache::load_template;

auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end());

std::stringstream stream;
boostache::generate(stream, templ, invoice_);
```

Using Boostache - Example 6

```
using boostache::load_template;

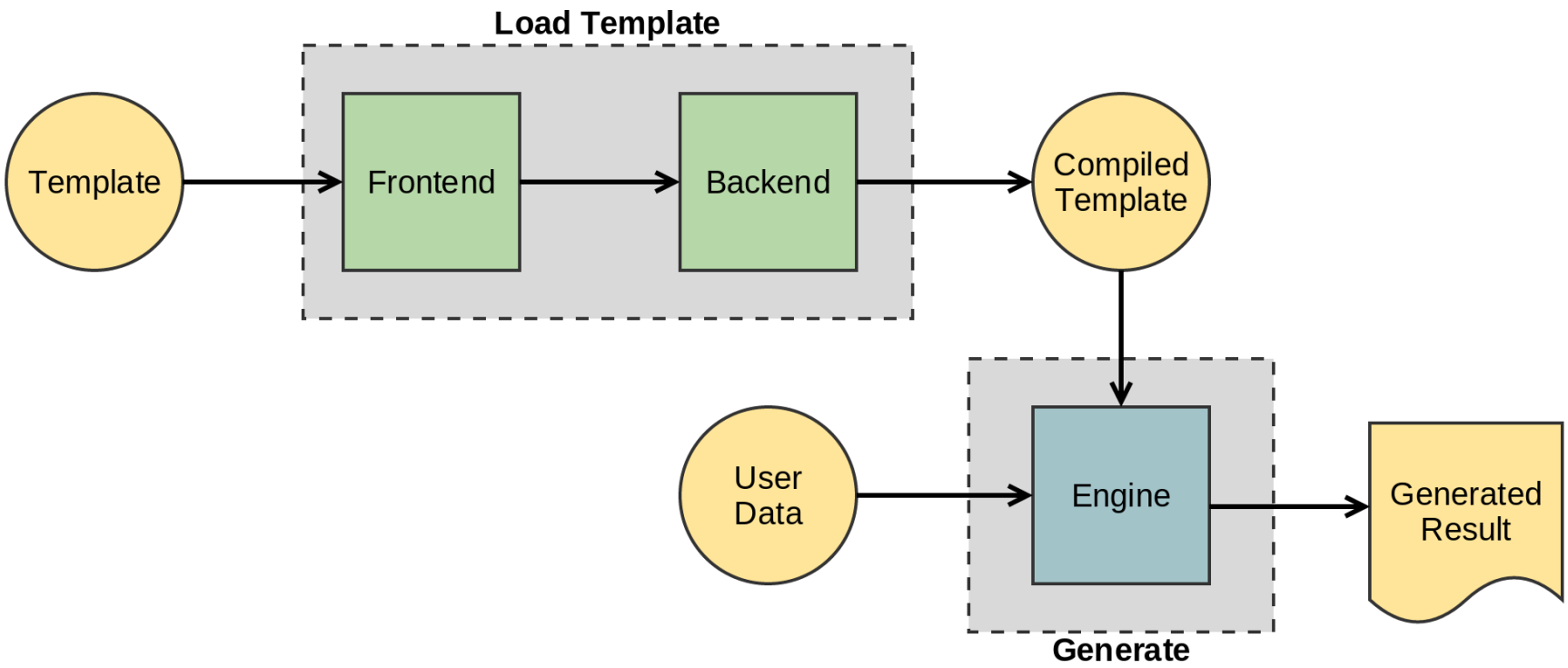
auto iter = input.begin();
auto templ = load_template<boostache::format::django>(iter, input.end());

std::stringstream stream;
boostache::generate(stream, templ, data);
```

Part II

Diving In

Starting at the Top



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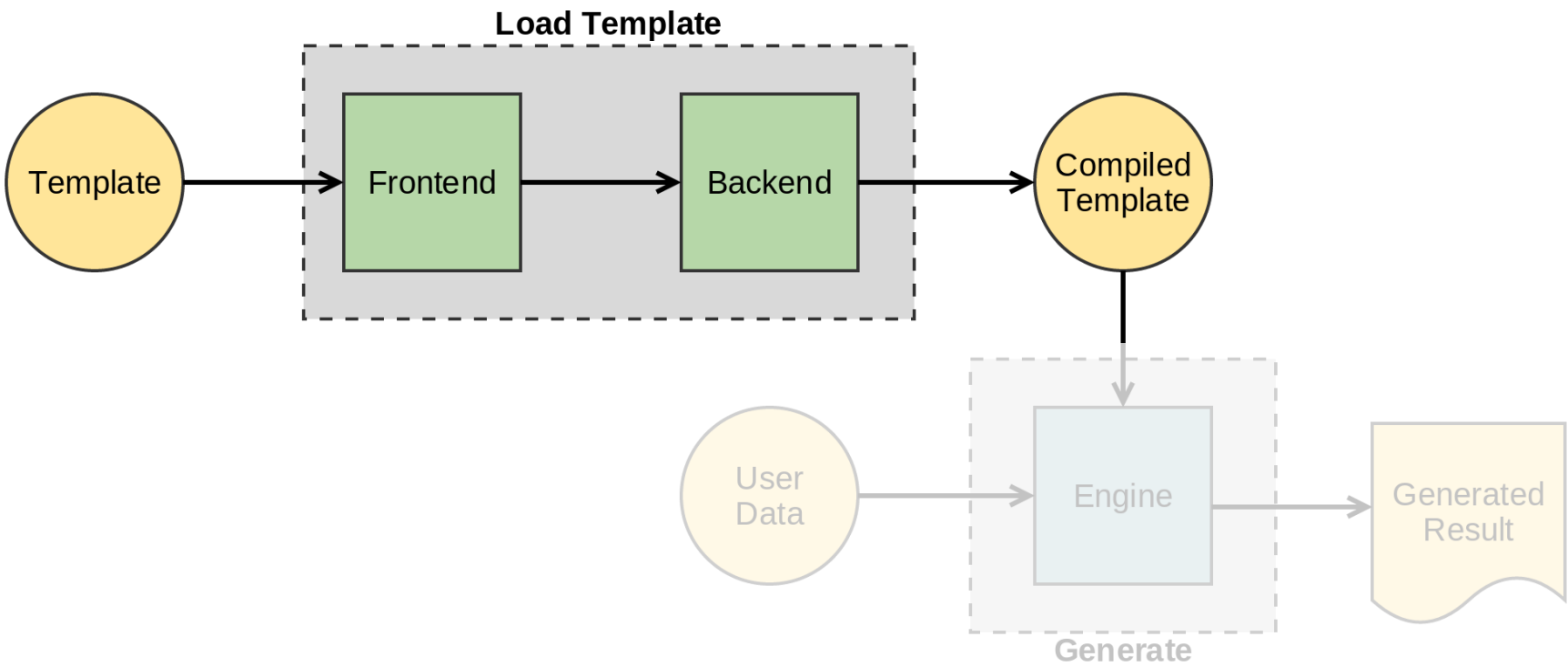
The Frontend



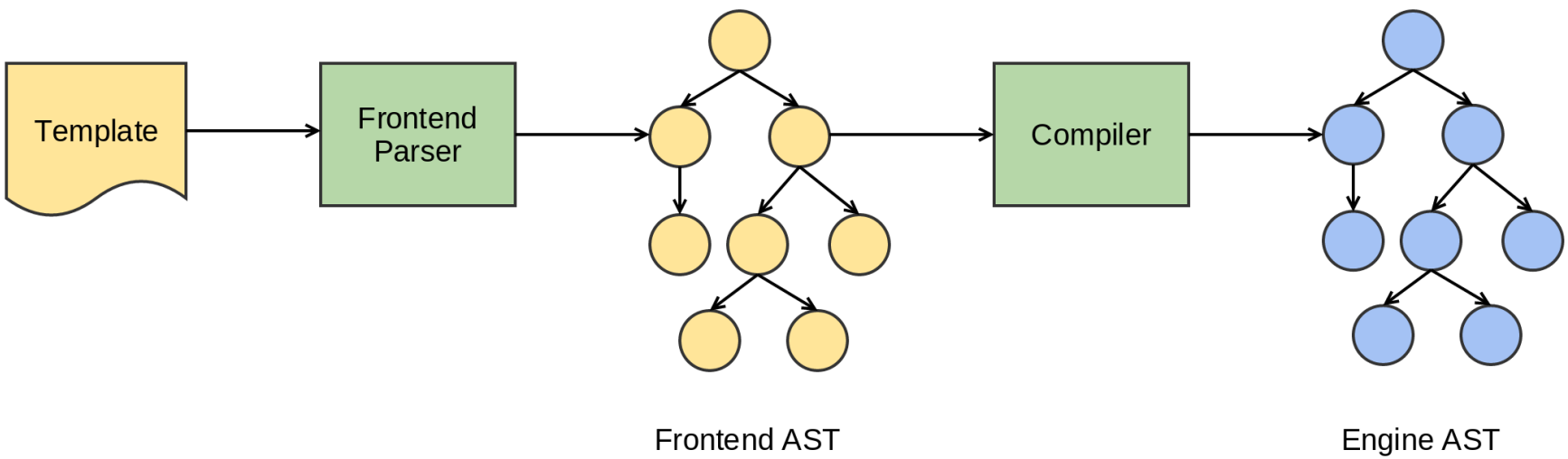
The Frontend

```
using boostache::load_template;

auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end())

std::stringstream stream;
boostache::generate(stream, templ, sue);
```

The Frontend



Starting Out - `load_template`

```
template <typename Format, typename Iterator>
inline vm::ast::node load_template(Iterator & begin, Iterator const & end)
{
   return backend::compile(frontend::parse<Format>(begin,end));
}

template <typename Format>
inline vm::ast::node load_template(std::istream & input)
{
   return backend::compile(frontend::parse<Format>(input));
}
```

Frontend Selection

```
namespace boost { namespace boostache { namespace format
{
   struct stache
   {
      template <typename Iterator>
      using grammar_t = frontend::stache::grammar<Iterator>;

      using ast_t = frontend::stache::ast::root;
      using skipper_t = boost::spirit::qi::space_type;
   };
}}}
```

Which Parser?

"Could use boost::spirit for parsing or maybe regex is enough"

Day 1 discussion notes LiaW 2014

Frontend Parse

```
template <typename Format, typename Iterator>
typename Format::ast_t parse(Iterator & begin, Iterator const & end)
{
   typename Format::ast_t ast;
   typename Format::template grammar_t<Iterator> grammar;

   if(!boost::spirit::qi::phrase_parse( begin, end
                                      , grammar
                                      , typename Format::skipper_t{}
                                      , ast ))
   {
      ast = typename Format::ast_t{};
   }
   return ast;
}
```

stache Parser

Organization:

- frontend
  - stache
    - ast.hpp — *users need*
    - ast_adapted.hpp — *fusion*
    - grammar.hpp — *declaration*
    - grammar_def.hpp — *definition*
    - printer.hpp

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stache Parser

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stache Parser

```
node_list =
    *stache_node
    ;


stache_node =
        no_skip[literal_text]
    |   comment
    |   variable
    |   variable_unescaped
    |   section
    |   partial
    ;
```

stache Parser

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        no_skip[literal_text]
    |   comment
    |   variable
    |   variable_unescaped
    |   section
    |   partial
    ;
```

stache Parser

```
literal_text =
   +(char_ - "{{")
   ;



stache_node =
      no_skip[literal_text]
   |  comment
   |  variable
   |  variable_unescaped
   |  section
   |  partial
   ;
```

stache Parser

```
comment =
        lit("{{")
    >> '!'
    >> omit[*(char_ - "}}")]
    >> "}}"
    ;
```

```
stache_node =
        no_skip[literal_text]
    |   comment
    |   variable
    |   variable_unescaped
    |   section
    |   partial
    ;
```

stache Parser

```
identifier =
    lexeme[alpha >> *(alnum | char_('_'))]
    ;

variable =
        lit("{{")
    >> matches['&']
    >> identifier
    >> "}}"
    ;



stache_node =
        no_skip[literal_text]
    |   comment
    |   variable
    |   variable_unescaped
    |   section
    |   partial
    ;
```

stache Parser

```
identifier =
    lexeme[alpha >> *(alnum | char_('_'))]
    ;

variable =
        lit("{{")
    >> matches['&']
    >> identifier
    >> "}}"
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stache_node =
        no_skip[literal_text]
    |   comment
    |   variable
    |   variable_unescaped
    |   section
    |   partial
    ;
```

stache Parser

```
section %=
      matches[&(lit("{{") >> '^')]
   >> section_begin[_a = _1]
   >> *stache_node
   >> section_end(_a)
   ;


section_begin =
      lit("{{")
   >> (lit('#') | '^')
   >> identifier
   >> "}}"
   ;


section_end =
      lit("{{")
   >> '/'
   >> lit(_r1)
   >> "}}"
   ;
```

stache Parser

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section %=
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   ;


section_begin =
      lit("{{")
   >> (lit('#') | '^')
   >> identifier
   >> "}}"
   ;


section_end =
      lit("{{")
   >> '/'
   >> lit(_r1)
   >> "}}"
   ;
```

stache AST

```
struct node : boost::spirit::extended_variant<
      undefined
    , comment
    , literal_text
    , variable
    , boost::recursive_wrapper<section>
    , partial
    >
{
    node() : base_type() {}
    node(comment const & rhs) : base_type(rhs) {}
    node(literal_text const & rhs) : base_type(rhs) {}
    node(variable const & rhs) : base_type(rhs) {}
    node(section const & rhs) : base_type(rhs) {}
    node(partial const & rhs) : base_type(rhs) {}
};

struct node_list :  std::vector<node> {};
```

stache AST

```
struct undefined {};

struct comment {};

struct identifier : std::string
{};

struct literal_text : std::string
{};

struct variable
{
   bool is_unescaped;
   identifier value;
};

struct partial : identifier
{};

struct section
{
   bool is_inverted;
   identifier name;
   node_list nodes;
};
```

stache Printer

```
inline void print(std::ostream& out, node_list const& nodes)
{
    detail::printer p(out);
    for(auto const & node : nodes)
    {
        boost::apply_visitor(p, node);
    }
}
```

stache Printer

```
class printer
{
public:
    typedef void result_type;

    printer(std::ostream& out)
        : out(out)
    {}

    void operator()(undefined) const
    {
        out << "WHOA! we have an undefined" << std::endl;
    }

    void operator()(comment) const
    {
    }



private:
    std::ostream& out;
};
```

stache Printer

```
void operator()(literal_text const & v) const
{
    out << v;
}

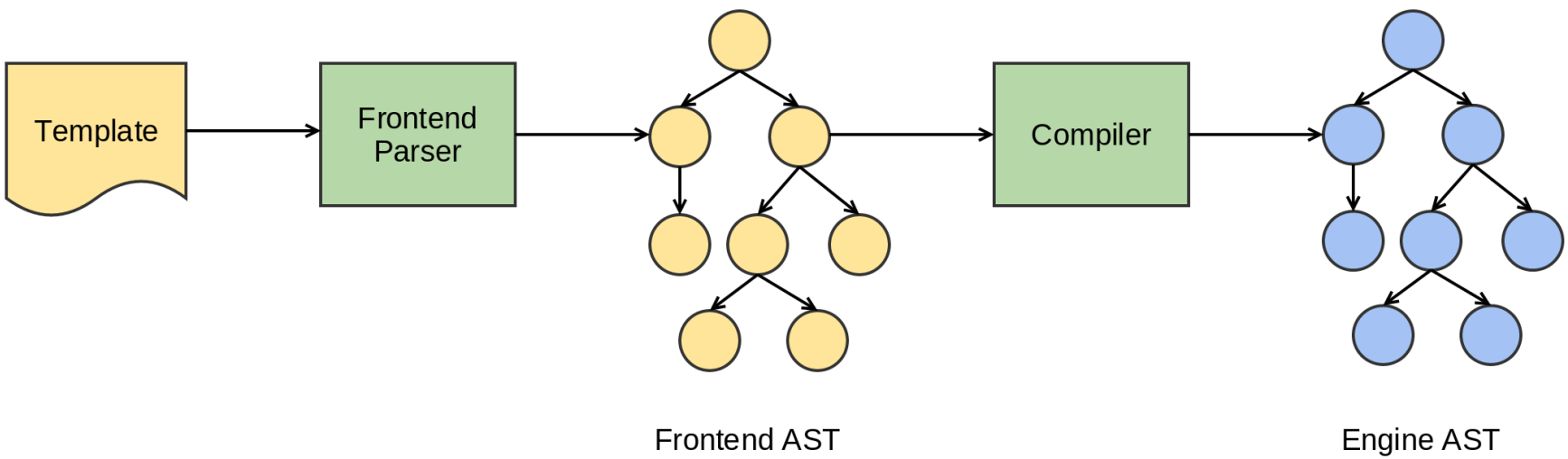
void operator()(variable const & v) const
{
    out << "{{";
    if(v.is_unescaped)
    {
        out << "&";
    }
    out << v.value << "}}";
}

void operator()(section const & v) const
{
    out << "{{";
    if(v.is_inverted) {  out << "^";    }
    else              {  out << "#";    }
    out << v.name << "}}";

    for(auto const & node : v.nodes)
    {
        boost::apply_visitor(*this, node);
    }

    out << "{{/" << v.name << "}}";
}
```

The Frontend



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inline vm::ast::node load_template(Iterator & begin, Iterator const & end)
{
   return backend::compile(frontend::parse<Format>(begin,end));
}

template <typename Format>
inline vm::ast::node load_template(std::istream & input)
{
   return backend::compile(frontend::parse<Format>(input));
}
```

stache Compile

```
namespace boost { namespace boostache { namespace backend
{
    inline vm::ast::node compile(frontend::stache::ast::root const & ast)
    {
        return stache_compiler::compile(ast);
    }
}}}
```

```
inline vm::ast::node compile(fe::stache::ast::root const & ast)
{
    detail::stache_visit visit;
    return visit(ast);
}
```

stache Compile

```
namespace boost { namespace boostache { namespace backend
{
   inline vm::ast::node compile(frontend::stache::ast::root const & ast)
   {
      return stache_compiler::compile(ast);
   }
}}}
```

```
inline vm::ast::node compile(fe::stache::ast::root const & ast)
{
   detail::stache_visit visit;
   return visit(ast);
}
```

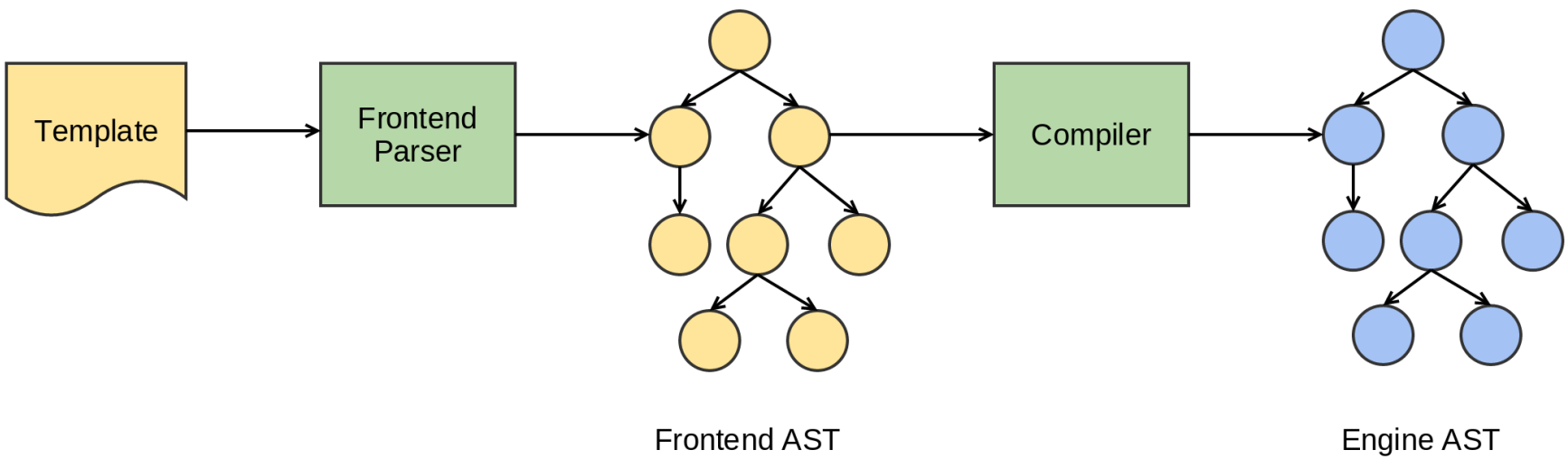
stache Compile - Vistor

```
class stache_visit
{
public:
   typedef vm::ast::node result_type;

   vm::ast::node operator()(fe::stache::ast::root const & nodes) const
   {
      vm::ast::node_list node_list;
      for(auto const & node : nodes)
      {
         node_list.nodes.push_back(boost::apply_visitor(*this, node));
      }
      return node_list;
   }

};
```

The Frontend



Engine / VM AST

```
struct node : boost::spirit::extended_variant<
      undefined
    , literal
    , variable
    , render
    , boost::recursive_wrapper<for_each>
    , boost::recursive_wrapper<if_then_else>
    , boost::recursive_wrapper<select_context>
    , boost::recursive_wrapper<node_list> >
{

    node() : base_type() {}
    node(literal const & rhs) : base_type(rhs) {}
    node(variable const & rhs) : base_type(rhs) {}
    node(render const & rhs) : base_type(rhs) {}
    node(for_each const & rhs) : base_type(rhs) {}
    node(if_then_else const & rhs) : base_type(rhs) {}
    node(select_context const & rhs) : base_type(rhs) {}
    node(node_list const & rhs) : base_type(rhs) {}

};
```

Engine / VM AST

```
struct node : boost::spirit::extended_variant<
      undefined
    , literal
    , variable
    , render
    , boost::recursive_wrapper<for_each>
    , boost::recursive_wrapper<if_then_else>
    , boost::recursive_wrapper<select_context>
    , boost::recursive_wrapper<node_list> >
{

    node() : base_type() {}
    node(literal const & rhs) : base_type(rhs) {}
    node(variable const & rhs) : base_type(rhs) {}
    node(render const & rhs) : base_type(rhs) {}
    node(for_each const & rhs) : base_type(rhs) {}
    node(if_then_else const & rhs) : base_type(rhs) {}
    node(select_context const & rhs) : base_type(rhs) {}
    node(node_list const & rhs) : base_type(rhs) {}

};
```

Engine / VM AST

```
struct literal
{
   literal(){}
   literal(std::string const & v) : value(v) {}
   std::string value;
};

struct for_each
{
   std::string name;
   node value;
};
```

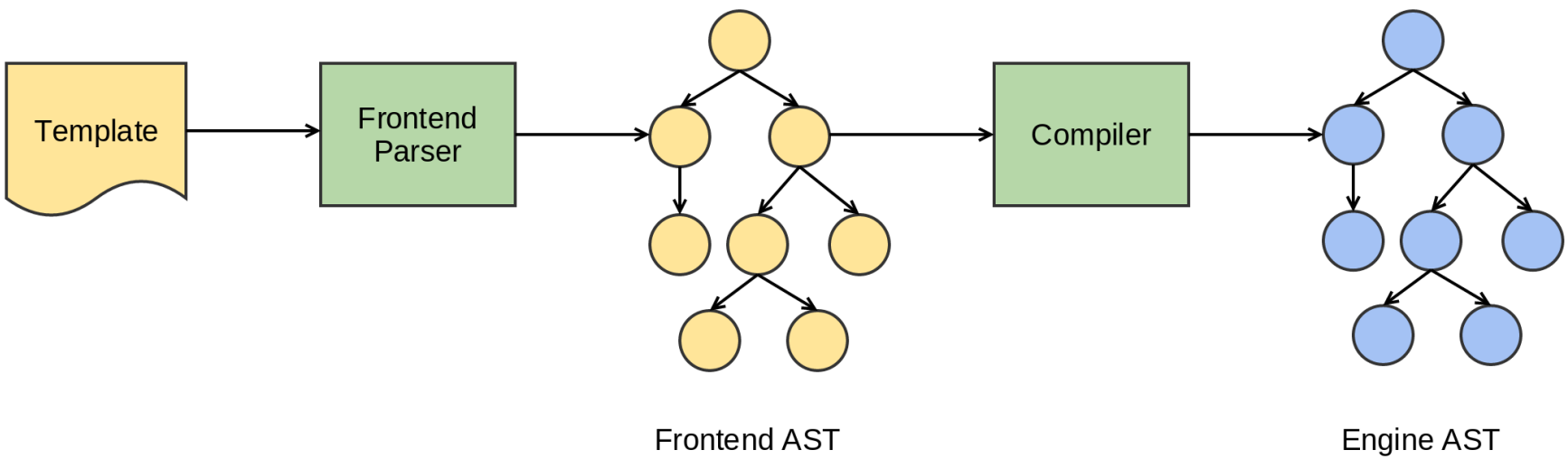
Engine / VM AST

```
struct if_then_else
{
   condition condition_;
   node then_;
   node else_;
};

struct select_context
{
   std::string tag;
   node body;
};

struct node_list
{
   std::vector<node> nodes;
};
```

The Frontend



stache Compiler

```
class stache_visit
{
public:
   typedef vm::ast::node result_type;
   vm::ast::node operator()(fe::stache::ast::undefined) const
   {
      return vm::ast::node{};
   }

   vm::ast::node operator()(fe::stache::ast::literal_text const & v) cor
   {
      return vm::ast::literal{v};
   }

   vm::ast::node operator()(fe::stache::ast::variable const & v) const
   {
      return vm::ast::render{v.value};
   }
   vm::ast::node operator()(fe::stache::ast::comment const & v) const
   {
      return vm::ast::literal{};
   }

   vm::ast::node operator()(fe::stache::ast::partial const & v) const
   {
      return vm::ast::literal{};
   }
};
```

stache Compiler - Section

```
vm::ast::node operator()(fe::stache::ast::section const & sec) const
{
   vm::ast::node_list vm_ast;
   for(auto const & node : sec.nodes)
   {
      vm_ast.nodes.push_back(boost::apply_visitor(*this, node));
   }

   vm::ast::for_each section_body;
   section_body.name = sec.name;
   section_body.value = vm_ast;

   vm::ast::if_then_else if_block;
   if_block.condition_.name = sec.name;

   vm::ast::select_context select;
   select.tag = sec.name;
   select.body = section_body;

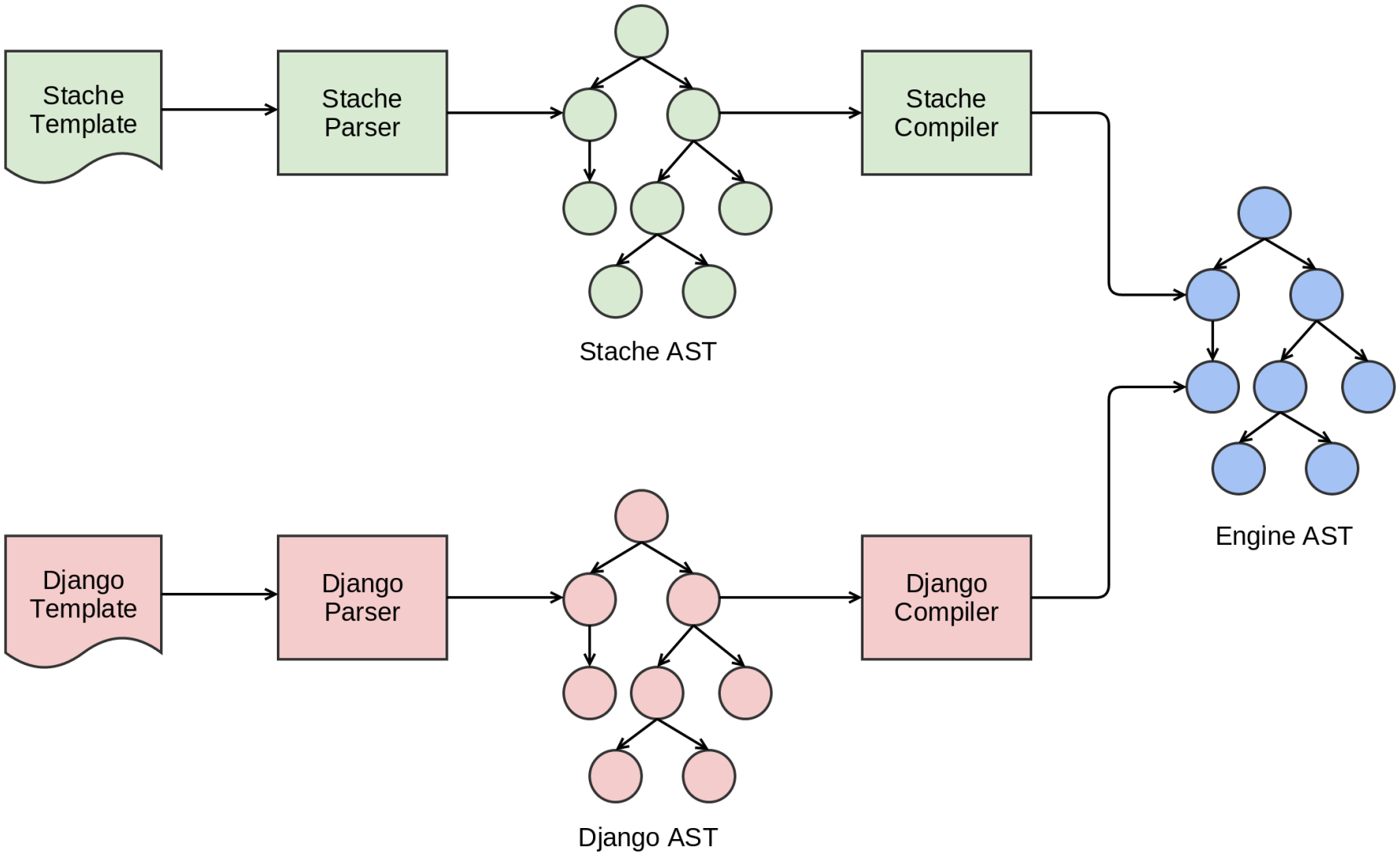
   if(sec.is_inverted) {  if_block.else_ = select;  }
   else                {  if_block.then_ = select;  }

   return if_block;
}
```

Compiler - AST Transform

Frontend AST $\rightarrow$ Engine/VM AST

Multiple Frontends



Sample Django Template

```
std::string input(
      "My name is {{another.name}}. "
      "{# This is a comment #}"
      "I am {{pet}} years old."
      "{%% if another.notok %%}"
      "Nope"
      "{%% else %%}"
      "Yep"
      "{%% endif %%}\n");
```

Django dot notation

```
vm::ast::node operator()(fe::django::ast::variable const & v) const
{
   vm::ast::node body = vm::ast::render{v.back()};
   for(auto iter = --v.rend(); iter != v.rbegin(); --iter)
   {
      vm::ast::select_context select;
      select.tag = *iter;
      select.body = std::move(body);
      body = std::move(select);
   }
   return body;
}
```

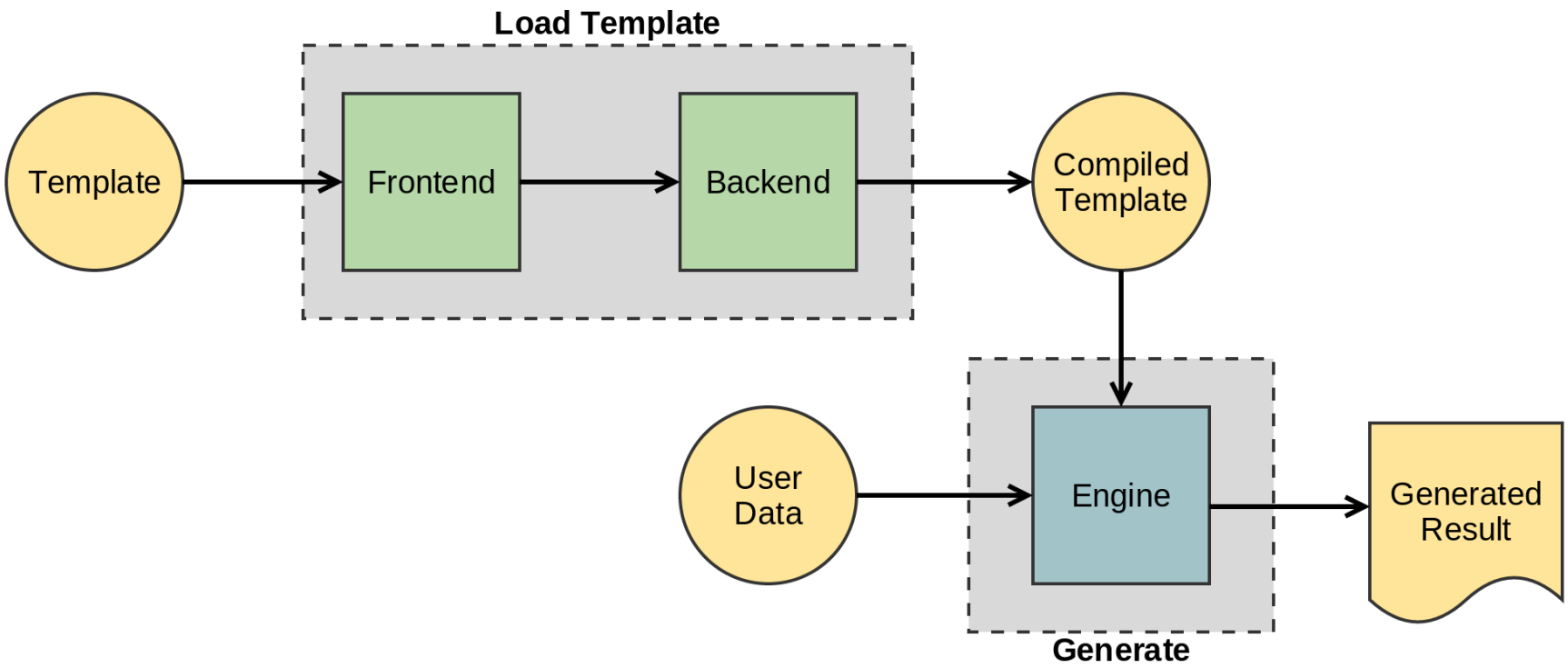
Django If

```
vm::ast::node operator()(fe::django::ast::if_elif_else const & if_elif_e
{
   vm::ast::node_list then_;
   for(auto const & node : if_elif_else.if_.body)
   {
      then_.nodes.push_back(boost::apply_visitor(*this, node));
   }

   vm::ast::if_then_else if_then_else;
   if_then_else.condition_.name = if_elif_else.if_.condition.front();
   if_then_else.then_ = std::move(then_);
   if(static_cast<bool>(if_elif_else.else_))
   {
      vm::ast::node_list else_;
      for(auto const & node : if_elif_else.else_.get())
      {
         else_.nodes.push_back(boost::apply_visitor(*this, node));
      }
      if_then_else.else_ = std::move(else_);
   }

   return if_then_else;
}
```

The Big Picture



generate

```
using boostache::load_template;

auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end());



std::stringstream stream;
boostache::generate(stream, templ, invoice);
```

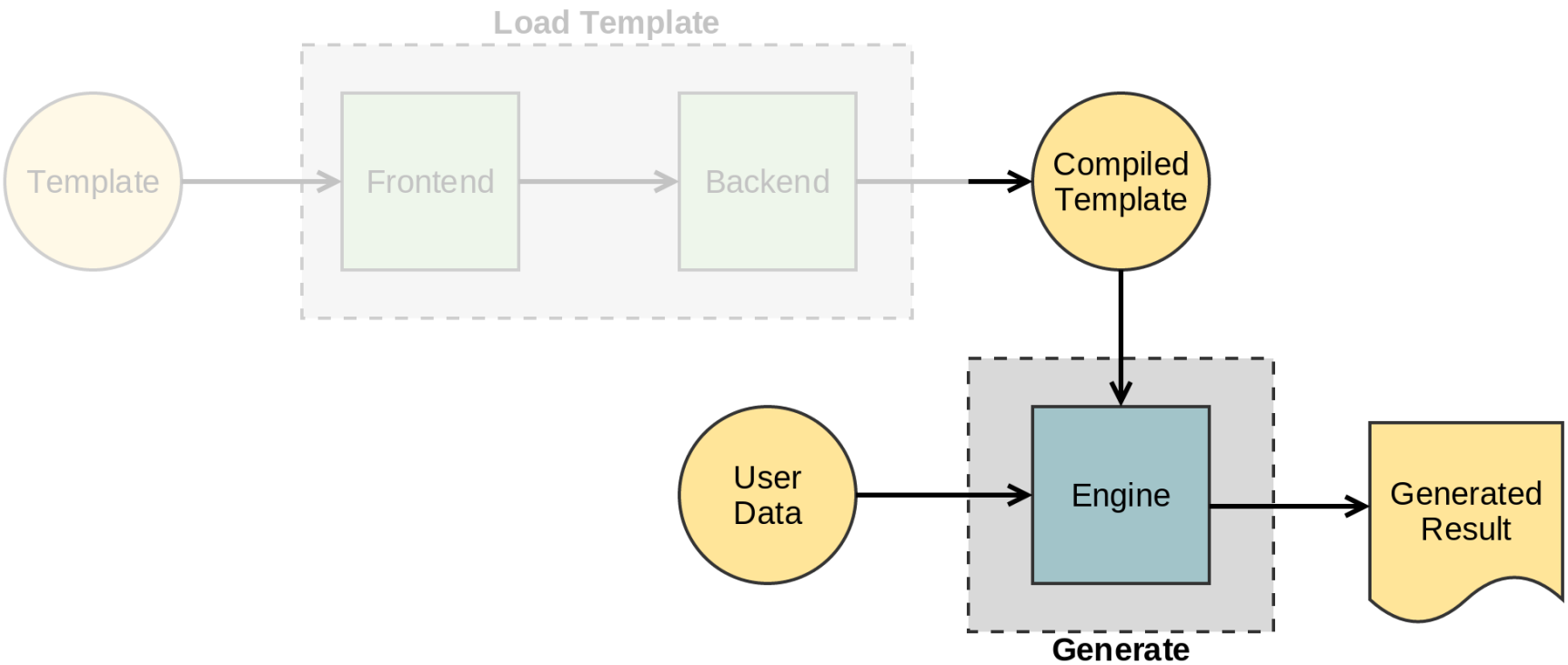
generate

```
using boostache::load_template;

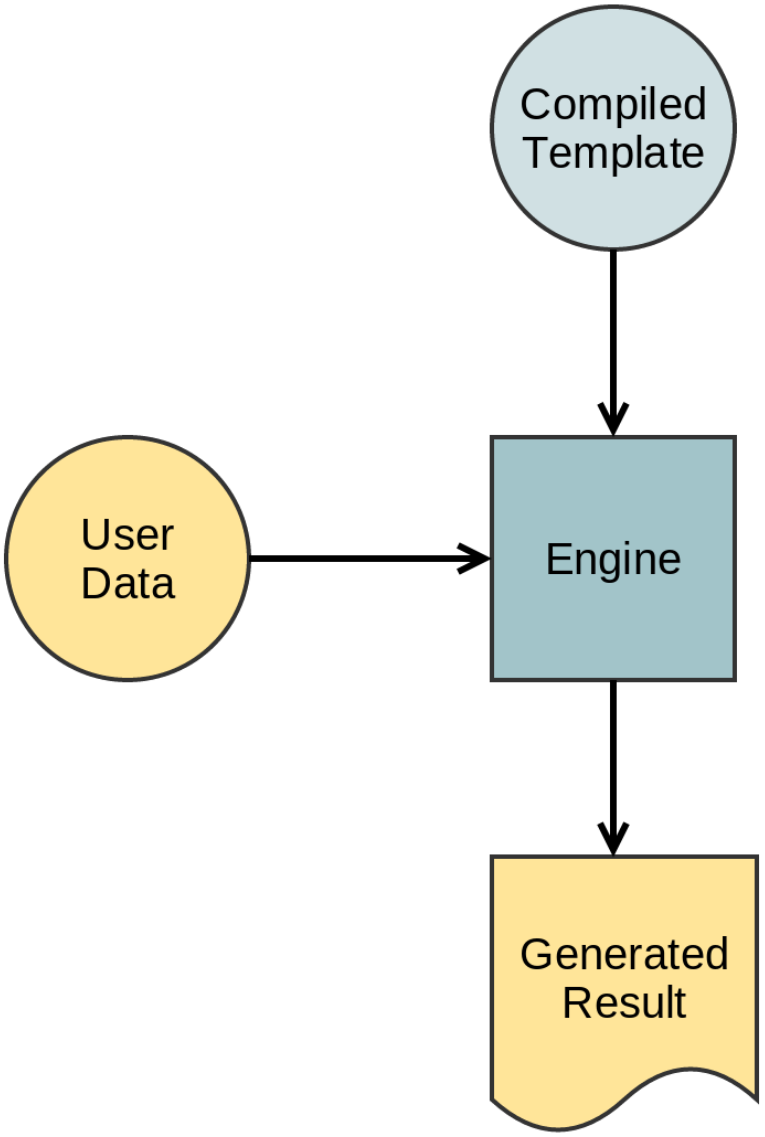
auto iter = input.begin();
auto templ = load_template<boostache::format::stache>(iter, input.end());


std::stringstream stream;
boostache::generate(stream, templ, invoice);
```

The Engine / VM



The Engine



generate

```
template <typename Stream, typename Context>
void generate( Stream & stream
             , vm::ast::node const & templ
             , Context const & context)
{
   vm::generate(stream,templ,context);
}
```

Detail **generate** call:

```
template <typename Stream, typename Template, typename Context>
void generate( Stream & stream
             , Template const & templ
             , Context const & ctx)
{
   engine_visitor_base<Stream,Context> engine(stream, ctx);
   engine(templ);
}
```

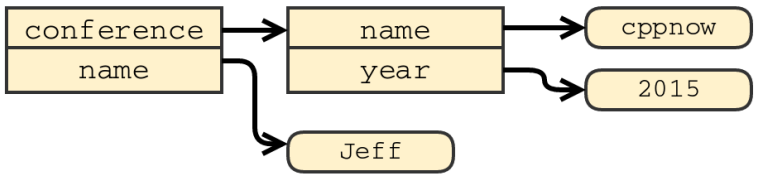
generate

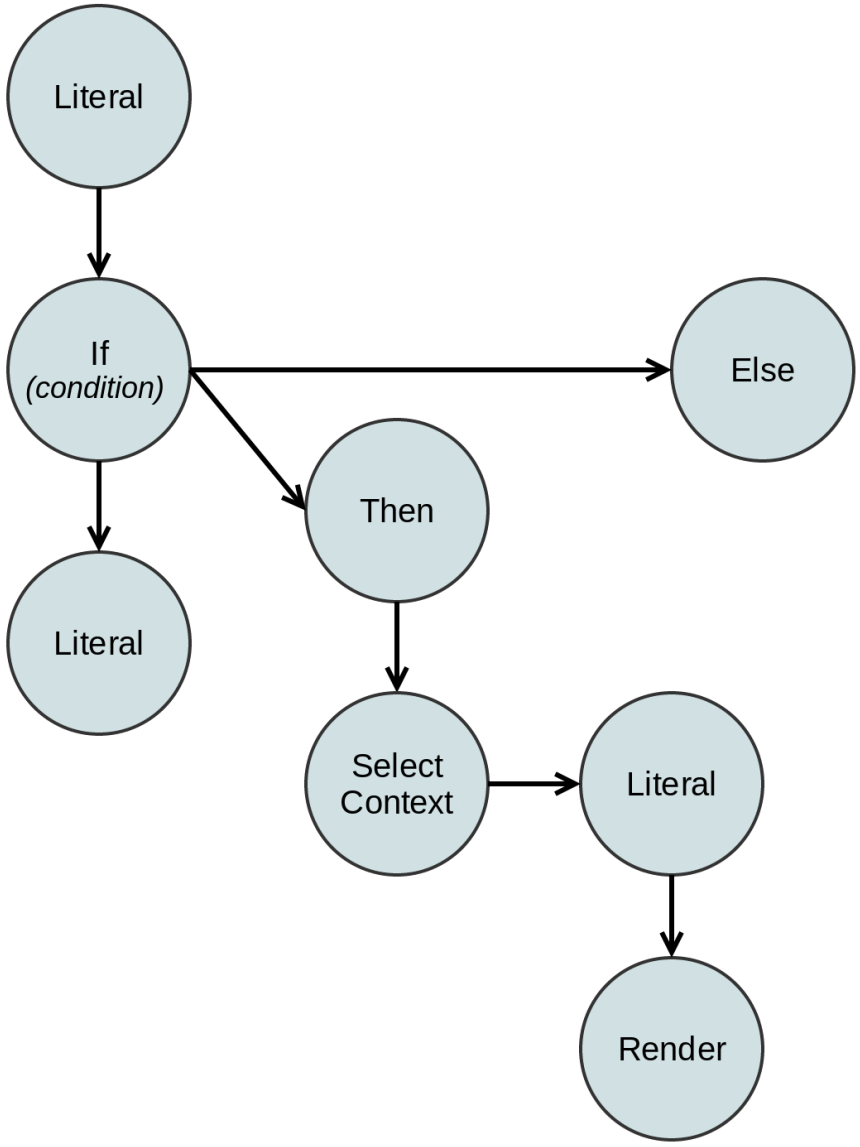
```
template <typename Stream, typename Context>
void generate( Stream & stream
             , vm::ast::node const & templ
             , Context const & context)
{
   vm::generate(stream,templ,context);
}
```

Detail **generate** call:

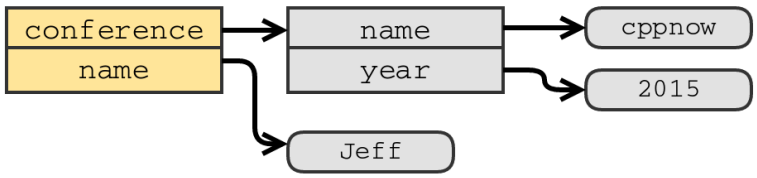
```
template <typename Stream, typename Template, typename Context>
void generate( Stream & stream
             , Template const & templ
             , Context const & ctx)
{
   engine_visitor_base<Stream,Context> engine(stream, ctx);
   engine(templ);
}
```

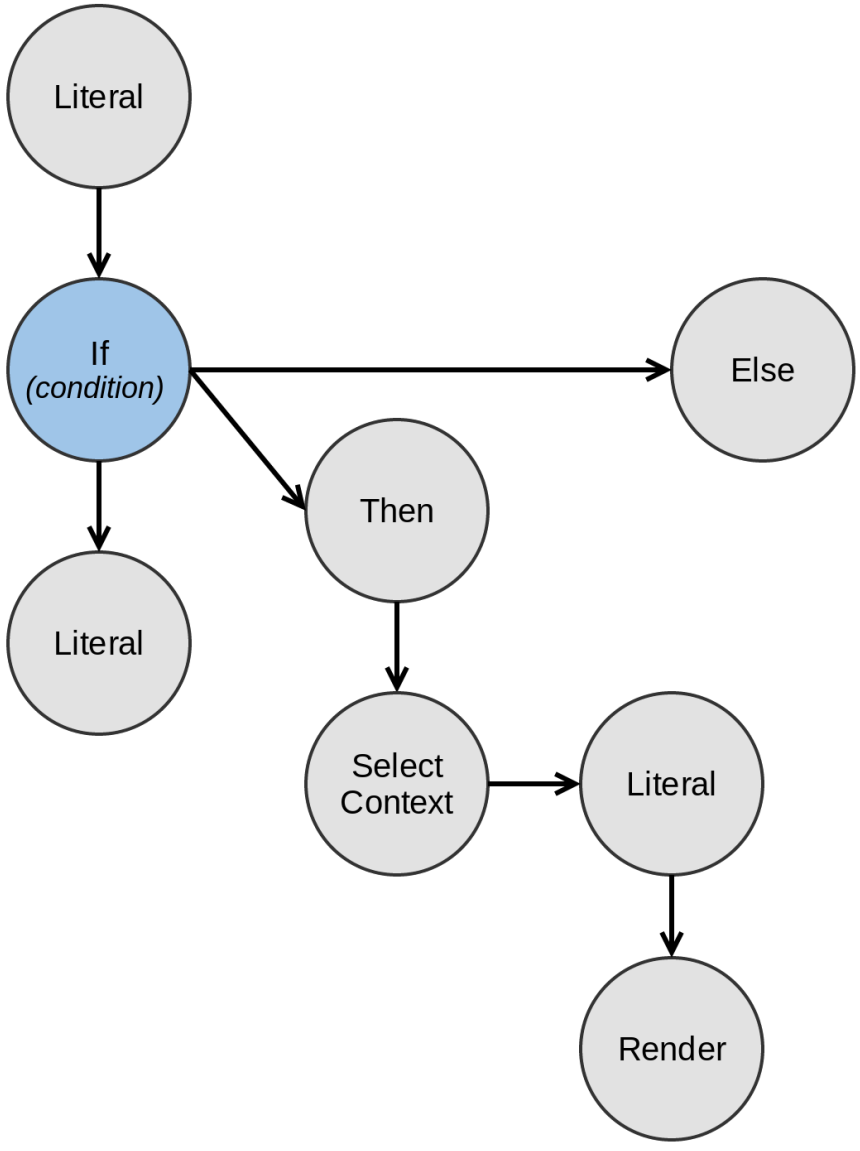
VM Processing



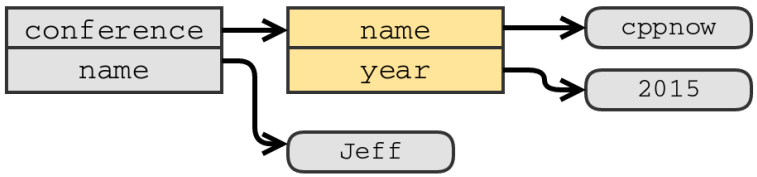


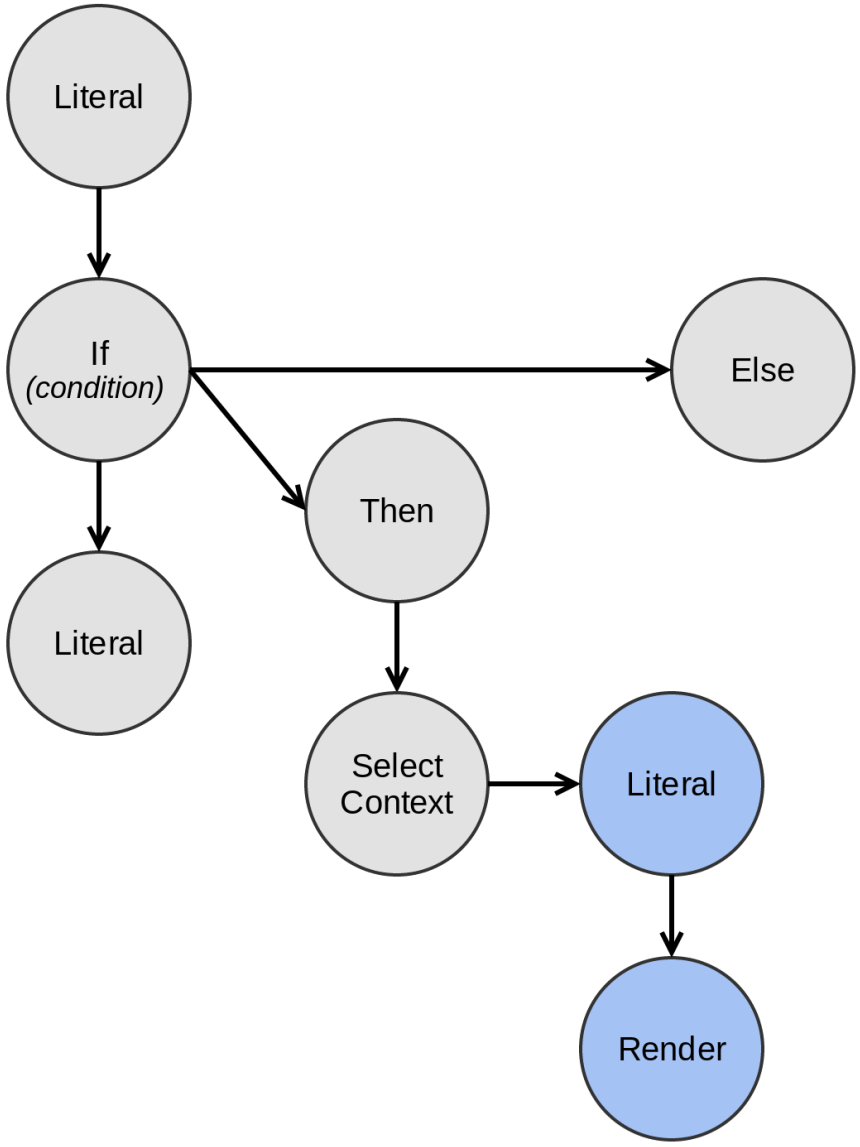
VM Processing





VM Processing





engine_visitor

```
template <typename Stream, typename Context>
class engine_visitor_base
{
public:
   typedef void result_type;

   engine_visitor_base(Stream & s, Context const & c)
      : stream(s)
      , context(c)
   {}

   void operator()(ast::node_list const & nodes) const
   {
      for(auto const & node : nodes.nodes)
      {
         boost::apply_visitor(*this, node);
      }
   }

   void operator()(ast::node const & node) const
   {
      boost::apply_visitor(*this, node);
   }

private:
   Stream & stream;
   Context const & context;
};
```

engine_visitor

```
void operator()(ast::undefined) const
{}

void operator()(ast::literal const & lit) const
{
   using boost::boostache::extension::render;
   render(stream, lit.value);
}


void operator()(ast::render const & r) const
{
   using boost::boostache::extension::render;
   render(stream, context, r.name);
}
```

engine_visitor

```
void operator()(ast::if_then_else const & v) const
{
   using boost::boostache::extension::test;
   if(test(context, v.condition_.name))
   {
      boost::apply_visitor(*this, v.then_);
   }
   else
   {
      boost::apply_visitor(*this, v.else_);
   }
}
```

engine_visitor

```
void operator()(ast::for_each const & v) const
{
    using boost::boostache::vm::detail::foreach;
    foreach(stream, v, context);
}
```

foreach magic

```
template <typename Stream, typename Node, typename Context>
void foreach(Stream & stream, Node const & node, Context const & context)
{
   using boostache::vm::detail::foreach;
   foreach( stream
          , node
          , context
          , typename extension::foreach_category<Context>::type{});
}
```

foreach magic

```
namespace boost { namespace boostache { namespace extension
{
    // ------------------------------
    // classifications
    struct category_attribute {};
    struct unused_attribute : category_attribute {};
    struct plain_attribute : category_attribute {};
    struct container_attribute : category_attribute {};
    struct associative_attribute : category_attribute {};
    struct tuple_attribute : category_attribute {};
    struct variant_attribute : category_attribute {};
    struct optional_attribute : category_attribute {};
}}}
```

foreach magic

```
template <typename T, typename Enable = void>
struct foreach_category
    : mpl::identity<plain_attribute> {};

template <>
struct foreach_category<std::string>
    : mpl::identity<plain_attribute> {};

template <typename T>
struct foreach_category<boost::optional<T>>
    : mpl::identity<optional_attribute> {};

template <typename T>
struct foreach_category<std::map<std::string,T>>
    : mpl::identity<associative_attribute> {};
```

foreach magic

```
template <typename T>
struct foreach_category<T,
                        typename enable_if<vm::trait::is_variant<T>>::type>
   : mpl::identity<variant_attribute> {};

template <typename T>
struct foreach_category< T
                       , typename std::enable_if<
                            vm::trait::has_begin<
                               typename vm::trait::not_a_map<T>::type
                               >::value
                            >::type
                         >
   : mpl::identity<container_attribute>
{};
```

foreach magic

```
template < typename Stream, typename Node, typename Context
         , typename Category>
void foreach( Stream & stream
            , Node const & node
            , Context const & context
            , Category)
{
   generate(stream, node.value, context);
}
```

foreach magic

```
template <typename Stream, typename Node>
struct unwrap_variant_foreach
{
   typedef void result_type;

   unwrap_variant_foreach(Stream & stream, Node const & node)
      : stream_(stream), node_(node)
   {}

   template <typename T>
   void operator()(T const & context) const
   {
      vm::detail::foreach(stream_, node_, context);
   }

   Stream & stream_;
   Node const & node_;
};

template <typename Stream, typename Node, typename Context>
void foreach( Stream & stream
            , Node const & node
            , Context const & context
            , extension::variant_attribute)
{
   extension::detail::unwrap_variant_foreach<Stream,Node>
      variant_foreach(stream, node);
   boost::apply_visitor(variant_foreach, context);
}
```

foreach magic

```
template <typename Stream, typename Node>
struct unwrap_variant_foreach
{
   typedef void result_type;

   unwrap_variant_foreach(Stream & stream, Node const & node)
      : stream_(stream), node_(node)
   {}

   template <typename T>
   void operator()(T const & context) const
   {
      vm::detail::foreach(stream_, node_, context);
   }

   Stream & stream_;
   Node const & node_;
};

template <typename Stream, typename Node, typename Context>
void foreach( Stream & stream
            , Node const & node
            , Context const & context
            , extension::variant_attribute)
{
   extension::detail::unwrap_variant_foreach<Stream,Node>
      variant_foreach(stream, node);
   boost::apply_visitor(variant_foreach, context);
}
```

foreach magic

```
template <typename Stream, typename Node, typename Context>
void foreach( Stream & stream
            , Node const & node
            , Context const & ctx
            , extension::optional_attribute)
{
   if(ctx)
   {
      foreach( stream, node, *ctx
             , typename
                 extension::foreach_category<decltype(*ctx)>::type{});
   }
   else
   {
      generate(stream, node.value, ctx);
   }
}
```

foreach magic

```
template <typename Stream, typename Node, typename Context>
void foreach( Stream & stream
            , Node const & node
            , Context const & context
            , extension::container_attribute)
{
   for(auto const & item : context)
   {
      generate(stream, node.value, item);
   }
}
```

Select Context Magic

```
void operator()(ast::select_context const & select_ctx) const
{
   select_context_dispatch(
      stream, select_ctx, context
    , typename extension::select_category<Context>::type{} );
}
```

Select Context Magic

```
template <typename Stream, typename Context, typename Category>
void select_context_dispatch( Stream & stream
                            , ast::select_context const & templ
                            , Context const & ctx, Category)
{
   generate(stream, templ.body, ctx);
}
```

Select Context Magic

```
template <typename Stream, typename Context>
void select_context_dispatch( Stream & stream
                            , ast::select_context const & templ
                            , Context const & ctx
                            , extension::associative_attribute)
{
   auto iter = ctx.find(templ.tag);
   if(iter != ctx.end())
   {
      select_context( stream, templ.body, ctx, iter->second
                    , typename
                        extension::
                         select_category<decltype(iter->second)>::type{});
   }
   else
   {
      generate(stream, templ.body, ctx);
   }
}
```

Select Context Magic

```
template < typename Stream, typename Template
         , typename Context1, typename Context2
         , typename CategoryChild
         >
void select_context( Stream & stream, Template const & templ
                   , Context1 const & ctx_parent
                   , Context2 const & /*ctx_child*/
                   , CategoryChild)
{
   generate(stream, templ, ctx_parent);
}
```

Select Context Magic

```
template < typename Stream, typename Template
         , typename Context1, typename Context2
         >
void select_context( Stream & stream, Template const & templ
                   , Context1 const & /*ctx_parent*/
                   , Context2 const & ctx_child
                   , extension::associative_attribute)
{
   generate(stream, templ, ctx_child);
}
```

```
template < typename Stream, typename Template
         , typename Context1, typename Context2
         >
void select_context( Stream & stream, Template const & templ
                   , Context1 const & /*ctx_parent*/
                   , Context2 const & ctx_child
                   , extension::container_attribute)
{
   generate(stream, templ, ctx_child);
}
```

Select Context Magic

```
template < typename Stream, typename Template
         , typename Context1, typename Context2
         >
void select_context( Stream & stream, Template const & templ
                   , Context1 const & ctx_parent
                   , Context2 const & ctx_child
                   , extension::variant_attribute)
{
   boost::apply_visitor(
        unwrap_and_select_context< Stream
                                 , Template
                                 , Context1>{ stream
                                            , templ
                                            , ctx_parent}
      , ctx_child
     );

}
```

Select Context Magic

```
template < typename Stream, typename Template
         , typename Context1, typename Context2
         >
void select_context( Stream & stream, Template const & templ
                   , Context1 const & ctx_parent
                   , Context2 const & ctx_child
                   , extension::variant_attribute)
{

   boost::apply_visitor(
        unwrap_and_select_context< Stream
                                 , Template
                                 , Context1>{ stream
                                            , templ
                                            , ctx_parent}
        , ctx_child
      );

}
```

Customization Point

```
std::string input(
                    "LiaW subject topic is: \n"
                    "{{# secret}}Not telling{{/ secret}}"
                    "{{^ secret}}{{name}}{{/ secret}}"
    );



std::function<bool()> conf_started =
    [](){return true;};

std::function<std::string()> liaw_topic =
    [](){return "Jeff's latest issue";};


smodel_t data = {
    {"name"   , liaw_topic},
    {"secret" , conf_started}
};
```

Customization Point

```
namespace boost { namespace boostache { namespace extension
{
   template <typename T>
   bool test( std::string const & name
            , std::function<T()> const & context
            , extn::plain_attribute)
   {
      return test(name, context());
   }

   template< typename Stream
           , typename T       >
   void render( Stream & stream
              , std::function<T()> const & context
              , std::string const & name
              , extn::plain_attribute)
   {
      render(stream, context(), name);
   }
}}}
```

Part III

Future

What is next?

- General clean-up
- Complete Mustache and Django support
- Complete generalizing category handling
- Flesh out the extension mechanism
- Docs, docs, docs

Where do I find it?

https://github.com/cierelabs/boostache

ciere.com

Part IV

Bonus

Fusion

```
template <typename Seq>
int tag_index(std::string const & tag)
{
   return
      detail::tag_index
         < Seq
         , fusion::extension::struct_size<Seq>::value-1
         >::call(tag);
}


template <typename Seq>
bool has_tag(std::string const & tag)
{
   return tag_index<Seq>(tag) >= 0;
}
```

Fusion

```
template <typename Seq, int I>
struct tag_index
{
    static int call(std::string const & tag)
    {
        if(fusion::extension::struct_member_name<Seq,I>::call()
            == tag)
        {
            return I;
        }
        else
        {
            return tag_index<Seq,I-1>::call(tag);
        }
    }
};
```

Fusion

```
template <typename Seq>
struct tag_index<Seq,0>
{
    static int call(std::string const & tag)
    {
        if(fusion::extension::struct_member_name<Seq,0>::call()
            == tag)
        {
            return 0;
        }
        else
        {
            return -1;
        }
    }
};
```

Fusion

```
template <typename S>
void render_tag(S & s, std::string const & tag)
{
   detail::render_tag
      < S
      , fusion::extension::struct_size<S>::value-1
      >::call(s, tag);
}
```

Fusion

```
template <typename S, int I>
struct render_tag
{
    static void call(S & s, std::string const & tag)
    {
        if(fusion::extension::struct_member_name<S,I>::call()
            == tag)
        {
            render<S,I>(s);
        }
        else
        {
            return render_tag<S,I-1>::call(s, tag);
        }
    }
};
```

Fusion

```
template <typename S>
struct render_tag<S,0>
{
    static void call(S & s, std::string const & tag)
    {
        if(fusion::extension::struct_member_name<S,0>::call()
            == tag)
        {
            render<S,0>(s);
        }
    }
};
```

Fusion

```
template <typename S, int I>
void render(S & s)
{
   std::cout
      << boost::fusion::extension::
                access::struct_member<S,I>::
                template apply<S> :: call(s)
      ;
};
```