construction techniques for domain specific languages

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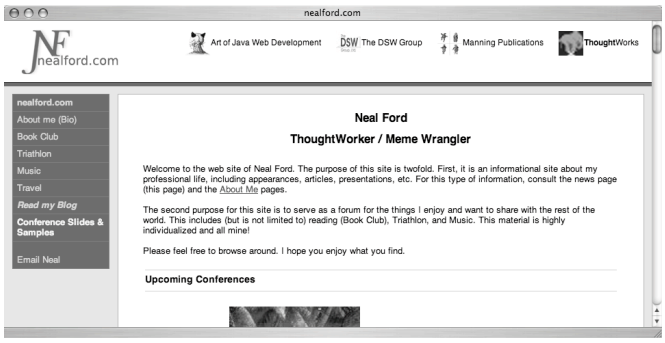
housekeeping

ask questions anytime

download slides from nealford.com



download samples from **`github.com/nealford`**

agenda

an extended example

definitions

techniques for supplying implicit context

lots of language techniques in java, groovy, and ruby

dsl variants

secret compartments

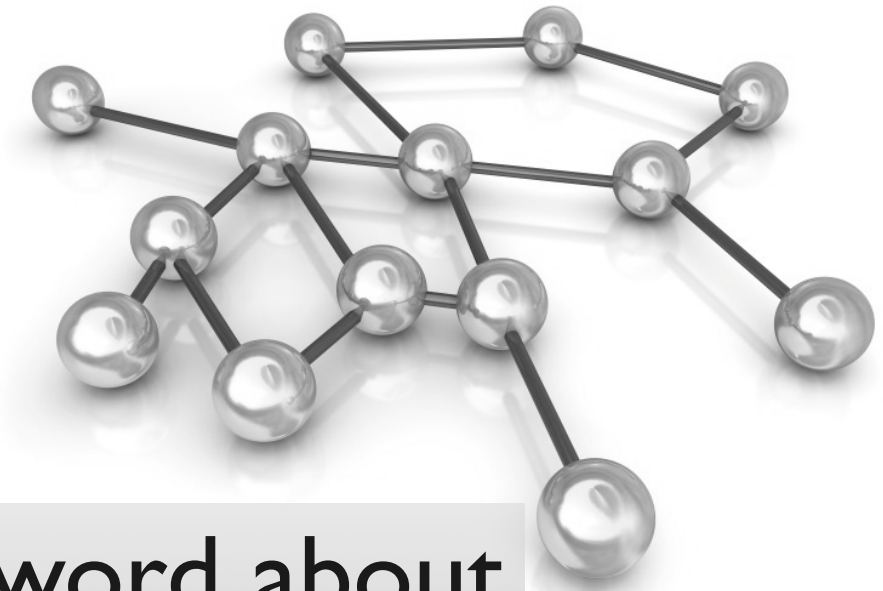
a company that supplies secret compartments

written in java, utilizing left-over java-powered toasters

expensive to re-flash the toasters

general behavior

configuration



a word about patterns

Mrs. H

1. close the door

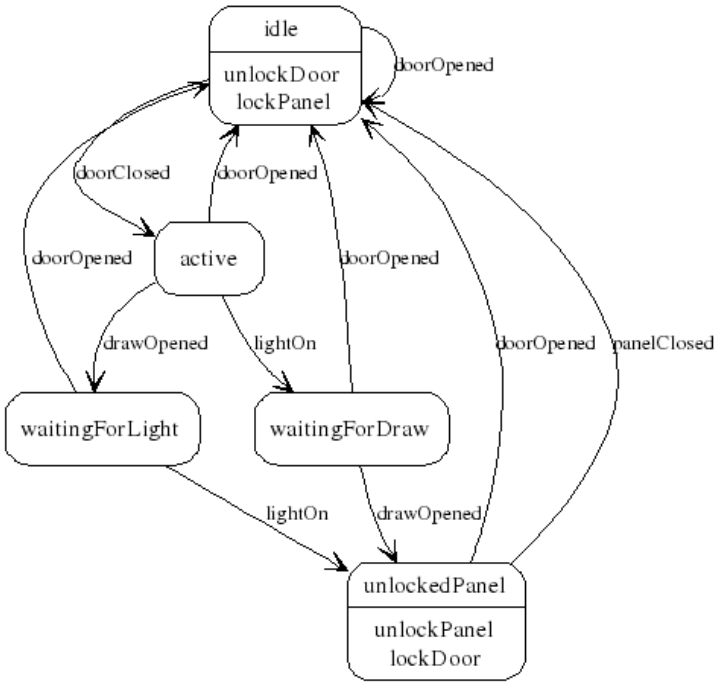
2. open the second draw in her chest

3. turn her bedside light on

must be in sequence

missed steps requires restart of the sequence

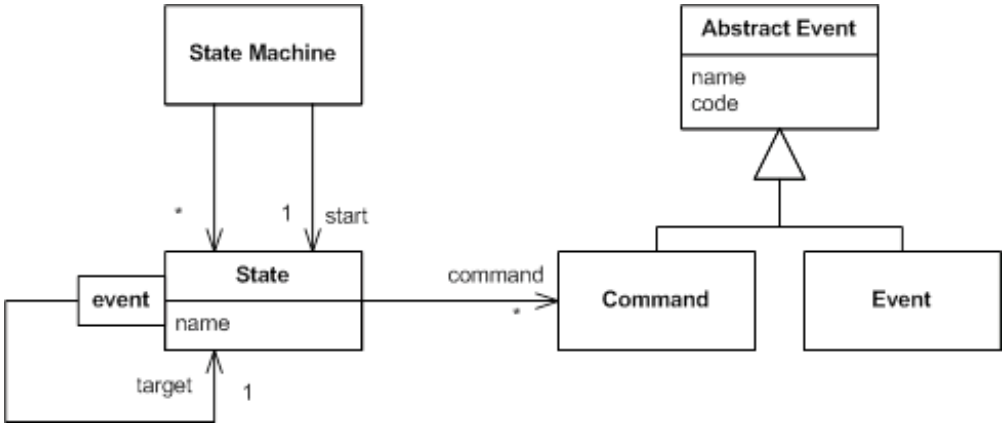
state diagram



events

```
class AbstractEvent
  private String name, code;

  public AbstractEvent(String name, String code) {
    this.name = name;
    this.code = code;
  }

  public String getCode() { return code;}
  public String getName() { return name;}
}

public class Command extends AbstractEvent {}

public class Event extends AbstractEvent {}
```

states



states

```
class State...
  private String name;
  private Map<Event, State> transitions = new HashMap<Event, State>();
  private Map<String, State> transitionsByCode = new HashMap<String, State>();
  private List<Command> commands = new ArrayList<Command>();

  public void addTransition(Event event, State targetState) {
    transitions.put(event, targetState);
    transitionsByCode.put(event.getCode(), targetState);
  }
```

state machine

```
class StateMachine
  private State start;

  public StateMachine(State start) {
    this.start = start;
  }
  public Collection<State> getStates() {
    List<State> result = new ArrayList<State>();
    gatherForwards(result, start);
    return result;
  }

  private void gatherForwards(Collection<State> result, State start) {
    if (result.contains(start)) return;
    else {
      result.add(start);
      for (State next : start.getAllTargets()) gatherForwards(result, next);
      return;
    }
  }
```

configuration

```
Event doorClosed = new Event("doorClosed", "D1CL");
Event drawOpened = new Event("drawOpened", "D2OP");
Event lightOn = new Event("lightOn", "L1ON");
Event doorOpened = new Event("doorOpened", "D1OP");
Event panelClosed = new Event("panelClosed", "PNCL");

Command unlockPanelCmd = new Command("unlockPanel", "PNUL");
Command lockPanelCmd = new Command("lockPanel", "PNLK");
Command lockDoorCmd = new Command("lockDoor", "D1LK");
Command unlockDoorCmd = new Command("unlockDoor", "D1UL");

State idle = new State("idle");
State activeState = new State("active");
State waitingForLightState = new State("waitingForLight");
State waitingForDrawState = new State("waitingForDraw");
State unlockedPanelState = new State("unlockedPanel");
```

configuration

```
StateMachine machine = new StateMachine(idle);

idle.addTransition(doorClosed, activeState);
idle.addCommand(unlockDoorCmd);
idle.addCommand(lockPanelCmd);

activeState.addTransition(drawOpened, waitingForLightState);
activeState.addTransition(lightOn, waitingForDrawState);

waitingForLightState.addTransition(lightOn, unlockedPanelState);

waitingForDrawState.addTransition(drawOpened, unlockedPanelState);

unlockedPanelState.addCommand(unlockPanelCmd);
unlockedPanelState.addCommand(lockDoorCmd);
unlockedPanelState.addTransition(panelClosed, idle);

machine.addResetEvents(doorOpened);
```

alternate configuration: XML

```
<stateMachine start = "idle">
    <event name="doorClosed" code="D1CL"/>
    <event name="drawOpened" code="D2OP"/>
    <event name="lightOn" code="L1ON"/>
    <event name="doorOpened" code="D1OP"/>
    <event name="panelClosed" code="PNCL"/>

    <command name="unlockPanel" code="PNUL"/>
    <command name="lockPanel" code="PNLK"/>
    <command name="lockDoor" code="D1LK"/>
    <command name="unlockDoor" code="D1UL"/>

  <state name="idle">
    <transition event="doorClosed" target="active"/>
    <action command="unlockDoor"/>
    <action command="lockPanel"/>
  </state>

  <state name="active">
    <transition event="drawOpened" target="waitingForLight"/>
    <transition event="lightOn" target="waitingForDraw"/>
  </state>

  <state name="waitingForLight">
    <transition event="lightOn" target="unlockedPanel"/>
  </state>

  <state name="waitingForDraw">
    <transition event="drawOpened" target="unlockedPanel"/>
  </state>

  <state name="unlockedPanel">
    <action command="unlockPanel"/>
    <action command="lockDoor"/>
    <transition event="panelClosed" target="idle"/>
   </state>

  <resetEvent name = "doorOpened"/>
</stateMachine>
```

external configuration

late binding

no recompiling toaster code to change configuration

more expressive

declarative

ubiquitous

another representation

```
events
  doorClosed  D1CL
  drawOpened  D2OP
  lightOn     L1ON
  doorOpened  D1OP
  panelClosed PNCL
end

resetEvents
  doorOpened
end

commands
  unlockPanel PNUL
  lockPanel   PNLK
  lockDoor    D1LK
  unlockDoor  D1UL
end

state idle
  actions {unlockDoor lockPanel}
  doorClosed => active
end

state active
  drawOpened => waitingForLight
  lightOn    => waitingForDraw
end

state waitingForLight
  lightOn => unlockedPanel
end

state waitingForDraw
  drawOpened => unlockedPanel
end

state unlockedPanel
  actions {unlockPanel lockDoor}
  panelClosed => idle
end
```

characteristics of DSLs

very narrow focus

no control structures, exceptions, types, etc.

what's the difference between DSL and XML?

DSL written with a custom parser (ANTLR)

configuration file == DSL

another alternative

```
event :doorClosed, "D1CL"
event :drawOpened,  "D2OP"
event :lightOn, "L1ON"
event :doorOpened,  "D1OP"
event :panelClosed, "PNCL"

command  :unlockPanel, "PNUL"
command  :lockPanel,   "PNLK"
command  :lockDoor,    "D1LK"
command  :unlockDoor,  "D1UL"

resetEvents :doorOpened

state :idle do
  actions :unlockDoor, :lockPanel
  transitions :doorClosed => :active
end
```

```
state :active do
  transitions :drawOpened => :waitingForLight,
              :lightOn => :waitingForDraw
end

state :waitingForLight do
  transitions :lightOn => :unlockedPanel
end

state :waitingForDraw do
  transitions :drawOpened => :unlockedPanel
end

state :unlockedPanel do
  actions :unlockPanel, :lockDoor
  transitions :panelClosed => :idle
end
```

types of DSLs

internal (or embedded):

DSL expressed within the syntax of a general purpose language

stylized use of language for a domain specific purpose

external:

separate language to the main programming language

is this a DSL?

```
Event doorClosed = new Event("doorClosed", "D1CL");
Event drawOpened = new Event("drawOpened", "D2OP");
Event lightOn = new Event("lightOn", "L1ON");
Event doorOpened = new Event("doorOpened", "D1OP");
Event panelClosed = new Event("panelClosed", "PNCL");

Command unlockPanelCmd = new Command("unlockPanel", "PNUL");
Command lockPanelCmd = new Command("lockPanel", "PNLK");
Command lockDoorCmd = new Command("lockDoor", "D1LK");
Command unlockDoorCmd = new Command("unlockDoor", "D1UL");

State idle = new State("idle");
State activeState = new State("active");
State waitingForLightState = new State("waitingForLight");
State waitingForDrawState = new State("waitingForDraw");
State unlockedPanelState = new State("unlockedPanel");
```

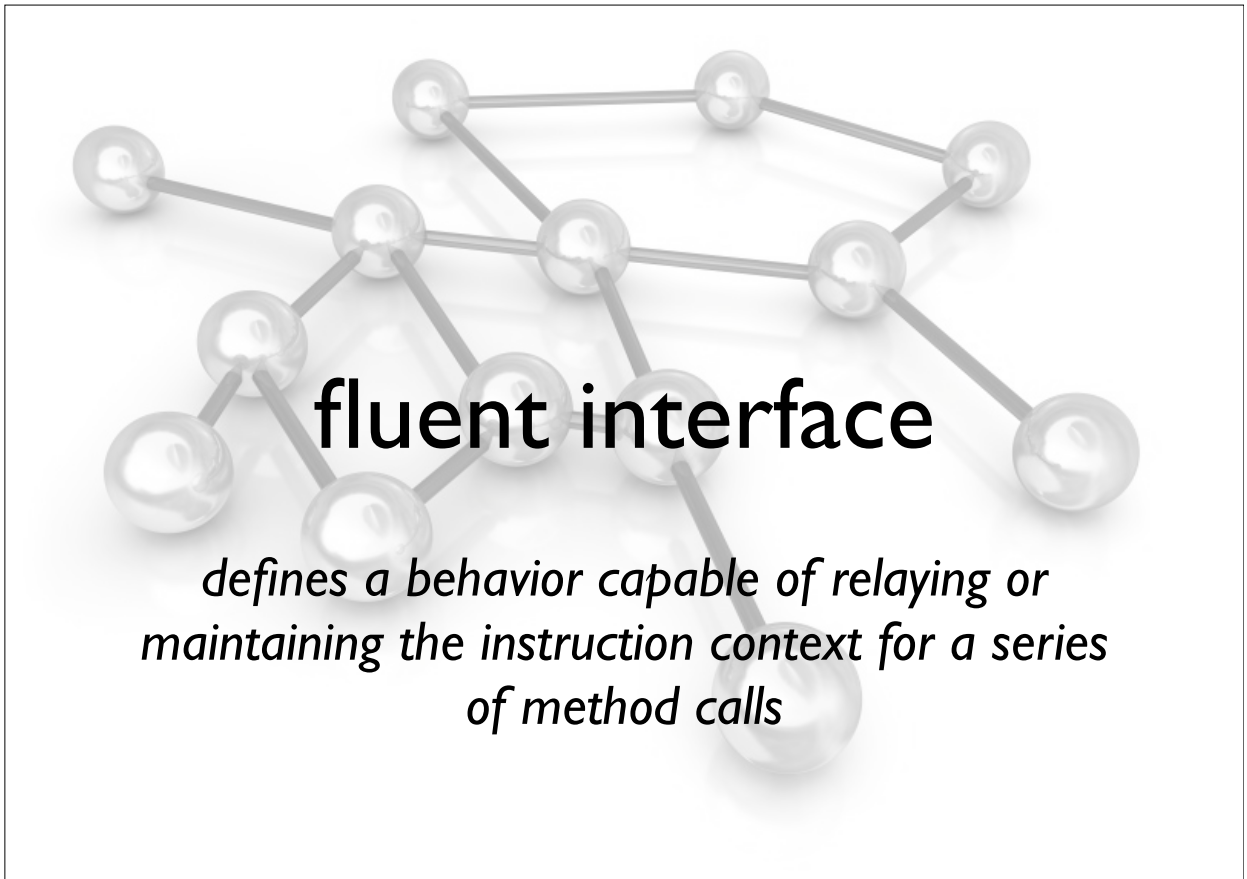
API

OK, what about this one?

```
public class BasicStateMachine extends StateMachineBuilder {

  Events doorClosed, drawOpened, lightOn, panelClosed;
  Commands unlockPanel, lockPanel, lockDoor, unlockDoor;
  States idle, active, waitingForLight, waitingForDraw, unlockedPanel;
  ResetEvents doorOpened;

  protected void defineStateMachine() {
    doorClosed. define("D1CL");
    drawOpened. define("D2OP");
    lightOn.    define("L1ON");
    panelClosed.define("PNCL");

    doorOpened. define("D1OP");

    unlockPanel.define("PNUL");
    lockPanel.  define("PNLK");
    lockDoor.   define("D1LK");
    unlockDoor. define("D1UL");
```

OK, what about *this* one?

```
    .actions(unlockDoor, lockPanel)
        .transition(doorClosed).to(active)
        ;

    active
        .transition(drawOpened).to(waitingForLight)
        .transition(lightOn).   to(waitingForDraw)
        ;

    waitingForLight
        .transition(lightOn).to(unlockedPanel)
        ;

    waitingForDraw
        .transition(drawOpened).to(unlockedPanel)
        ;

    unlockedPanel
        .actions(unlockPanel, lockDoor)
        .transition(panelClosed).to(idle)
        ;
}
```



fluent interface

defines a behavior capable of relaying or maintaining the instruction context for a series of method calls

domain specific language (noun)

a computer programming language of limited expressiveness focused on a particular domain

5 key elements

computer programming language

language nature

domain focus

limited expressiveness

not Turing complete

DSL or not DSL?

regular expressions?

XSLT?

serialized data structures (i.e., properties file)?

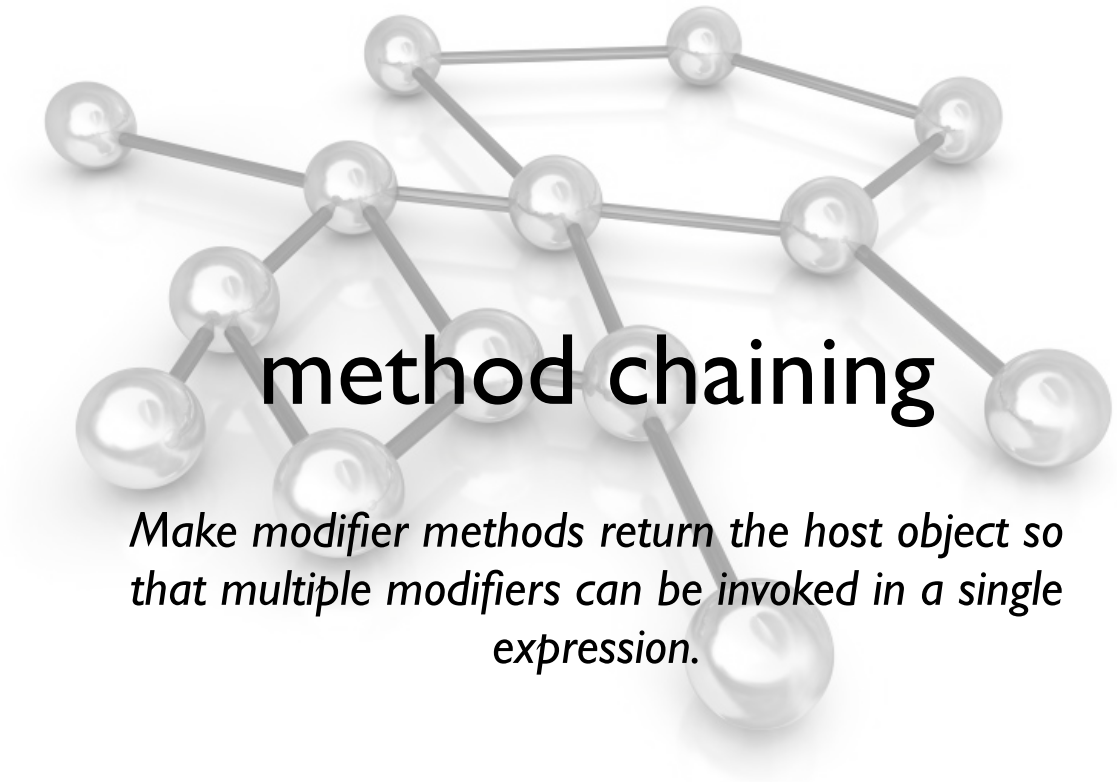
struts-config?

Starbucks?

context

the goal syntax

```
Calendar fourPM = Calendar.getInstance();
fourPM.set(Calendar.HOUR_OF_DAY, 16);
Calendar fivePM = Calendar.getInstance();
fivePM.set(Calendar.HOUR_OF_DAY, 17);

AppointmentCalendarChained calendar =
        new AppointmentCalendarChained();

calendar.add("dentist")
        .from(fourPM)
        .to(fivePM)
        .at("123 main street");

calendar.add("birthday party").at(fourPM);
displayAppointments(calendar);
```



method chaining

Make modifier methods return the host object so that multiple modifiers can be invoked in a single expression.

appointments

```
public class Appointment {
    private String _name;
    private String _location;
    private Calendar _startTime;
    private Calendar _endTime;

    public Appointment at(String location) {
        _location = location;
        return this;
    }

    public Appointment at(Calendar startTime) {
        _startTime = startTime;
        return this;
    }

    public Appointment from(Calendar startTime) {
        _startTime = startTime;
        return this;
    }
```

appointment calendar

```
public class AppointmentCalendarChained {
    private List<Appointment> appointments;

    public AppointmentCalendarChained() {
        appointments = new ArrayList<Appointment>();
    }

    public List<Appointment> getAppointments() {
        return appointments;
    }

    public Appointment add(String name) {
        Appointment appt = new Appointment(name);
        appointments.add(appt);

        return appt;
    }
}
```

run it!

```
public CalendarDemoChained() {
    Calendar fourPM = Calendar.getInstance();
    fourPM.set(Calendar.HOUR_OF_DAY, 16);
    Calendar fivePM = Calendar.getInstance();
    fivePM.set(Calendar.HOUR_OF_DAY, 17);

    AppointmentCalendarChained calendar =
            new AppointmentCalendarChained();

    calendar.add("dentist").
            from(fourPM).
            to(fivePM).
            at("123 main street");

    calendar.add("birthday party").at(fourPM);
    displayAppointments(calendar);
}
```

```
Appointment:dentist, location:123 main street, Start time:16, End time: 17
Appointment:birthday party, Start time:16
```

but!...

```
public class AppointmentCalendarChained {
    private List<Appointment> appointments;

    public AppointmentCalendarChained() {
        appointments = new ArrayList<Appointment>();
    }

    public List<Appointment> getAppointments() {
        return appointments;
    }

    public Appointment add(String name) {
        Appointment appt = new Appointment(name);
        appointments.add(appt);
        System.out.println(appt.toString());
        return appt;
    }
}
```

oops

```
public CalendarDemoChained() {
    Calendar fourPM = Calendar.getInstance();
    fourPM.set(Calendar.HOUR_OF_DAY, 16);
    Calendar fivePM = Calendar.getInstance();
    fivePM.set(Calendar.HOUR_OF_DAY, 17);

    AppointmentCalendarChained calendar =
            new AppointmentCalendarChained();

    calendar.add("dentist").
            from(fourPM).
            to(fivePM).
            at("123 main street");

    calendar.add("birthday party").at(fourPM);
    displayAppointments(calendar);
}
```

```
Exception in thread "main" java.lang.NullPointerException
    at com.nealford.dsl.calendar.stopping.Appointment.toString(Appointment.java:42)
    at com.nealford.dsl.calendar.stopping.AppointmentCalendarChained.add(AppointmentC
    at com.nealford.dsl.calendar.stopping.CalendarDemoChained.<init>(CalendarDemoChai
    at com.nealford.dsl.calendar.stopping.CalendarDemoChained.main(CalendarDemoChaine
```

finishing problem

```
public class AppointmentCalendarChained {
    private List<Appointment> appointments;

    public AppointmentCalendarChained() {
        appointments = new ArrayList<Appointment>();
    }

    public List<Appointment> getAppointments() {
        return appointments;
    }

    public Appointment add(String name) {
        Appointment appt = new Appointment(name);
        appointments.add(appt);
        System.out.println(appt.toString());
        return appt;
    }
}
```

appointment calendar redux

```
public class AppointmentCalendar {
    private List<Appointment> appointments;

    public AppointmentCalendar() {
        appointments = new ArrayList<Appointment>();
    }

    public AppointmentCalendar add(Appointment appt) {
        appointments.add(appt);
        return this;
    }

    public List<Appointment> getAppointments() {
        return appointments;
    }
}
```

wrapper via parameter

```
calendar.add(
        new Appointment("Dentist")
        .at(fourPM));
calendar.add(
        new Appointment("Conference Call")
        .from(fourPM)
        .to(fivePM)
        .at("555-123-4321"));
calendar.add(
            new Appointment("birthday party")
            .from(fourPM)
            .to(fivePM))
        .add(
            new Appointment("Doctor")
            .at("123 Main St"));
calendar.add(
        new Appointment("No Fluff, Just Stuff")
        .at(fourPM));
displayAppointments(calendar);
```

wrapping context

method chaining

wrapping via parameters

functional specification

the target

```
public AppointmentCalendarContextDemo() {
    final Calendar fourPM = Calendar.getInstance();
    fourPM.set(Calendar.HOUR_OF_DAY, 16);
    final Calendar fivePM = Calendar.getInstance();
    fivePM.set(Calendar.HOUR_OF_DAY, 17);

    AppointmentCalendar calendar = new AppointmentCalendar();
    calendar.add(new Appointment() {{
        name("dentist");
        from(fourPM);
        to(fivePM);
        at("123 main street");
    }});

    calendar.add(new Appointment() {{
        name("birthday party");
        at(fourPM);
    }});

    displayAppointments(calendar);
}
```

initializers

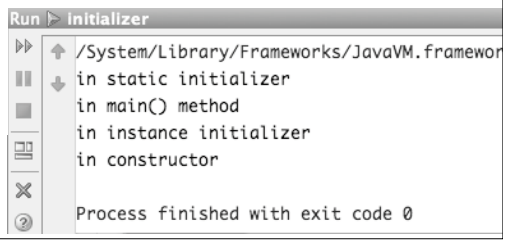
```
public class InitializerDemo {
    public InitializerDemo() {
        out.println("in constructor");
    }

    static {
        out.println("in static initializer");
    }

    {
        out.println("in instance initializer");
    }

    public static void main(String[] args) {
        out.println("in main() method");
        new InitializerDemo();
    }
}
```

4

1

3

2



the target

```
public AppointmentCalendarContextDemo() {
    final Calendar fourPM = Calendar.getInstance();
    fourPM.set(Calendar.HOUR_OF_DAY, 16);
    final Calendar fivePM = Calendar.getInstance();
    fivePM.set(Calendar.HOUR_OF_DAY, 17);

    AppointmentCalendar calendar = new AppointmentCalendar();
    calendar.add(new Appointment() {{
        name("dentist");
        from(fourPM);
        to(fivePM);
        at("123 main street");
    }});

    calendar.add(new Appointment() {{
        name("birthday party");
        at(fourPM);
    }});

    displayAppointments(calendar);
}
```

changes to `Appointment`

default constructor

nothing else!

functional specification allows you to reuse existing classes with minor impact

fluentizing existing classes...

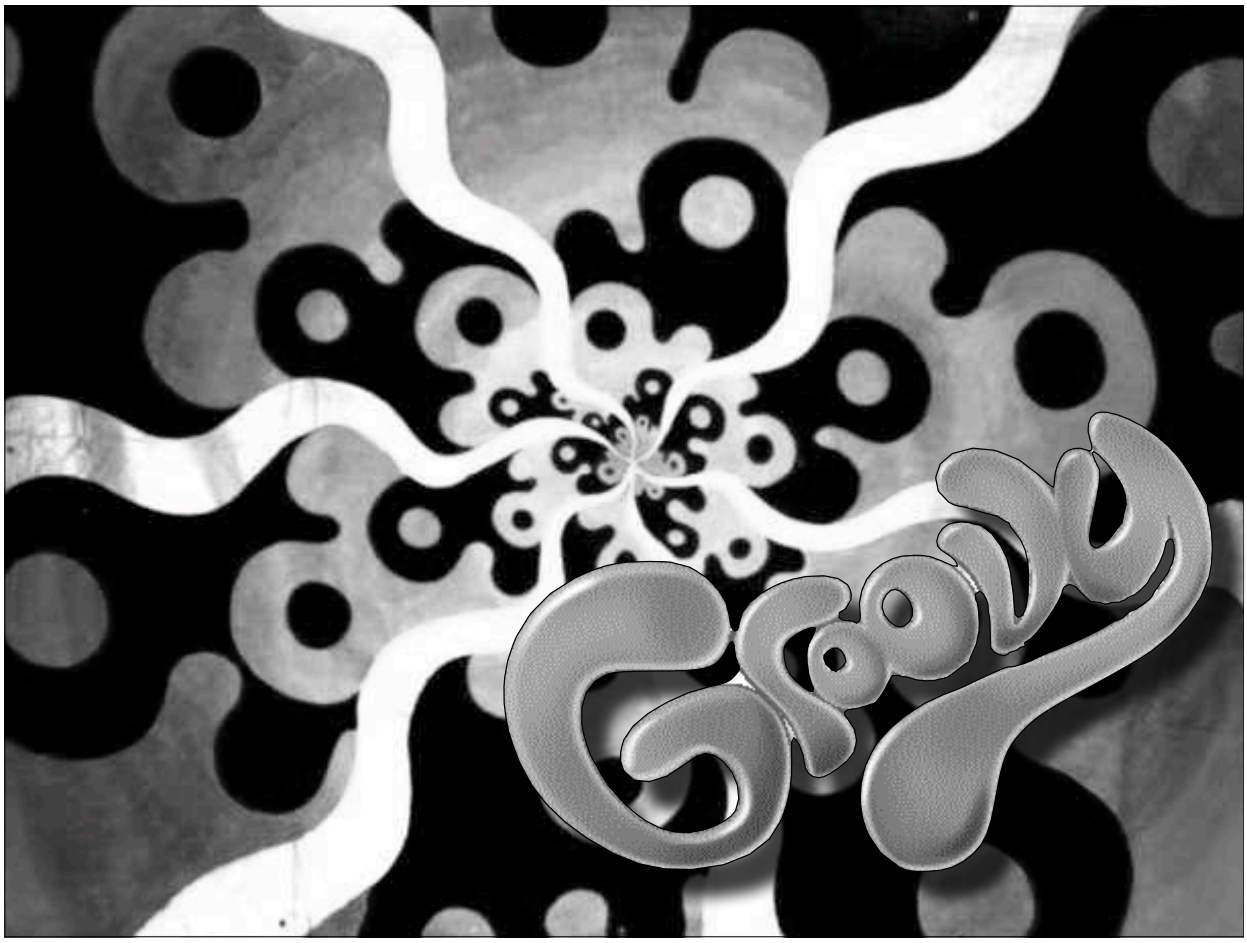
...with ugly syntax!

jmock expectations

```
@RunWith(JMock.class)
public class ClassifierWithMockTest {
    Mockery context = new JUnit4Mockery() {{
        setImposteriser(ClassImposteriser.INSTANCE);
    }};

    @Test public void external_factors() {
        final Finder facts = context.mock(Finder.class);
        Classifier7 c = new Classifier7(42, facts);
        final Set<Integer> expected =
                new HashSet(Arrays.asList(1, 2, 3, 6, 7, 21, 14, 42));
        context.checking(new Expectations() {{
            one(facts).factors(); will(returnValue(expected));
        }});
        assertThat(c.sumOfFactors(), is(1 + 2 + 3 + 6 + 7 + 21 + 14 + 42));
        context.assertIsSatisfied();
    }
}
```

limits in java

```
public AppointmentCalendarContextDemo() {
    final Calendar fourPM = Calendar.getInstance();
    fourPM.set(Calendar.HOUR_OF_DAY, 16);
    final Calendar fivePM = Calendar.getInstance();
    fivePM.set(Calendar.HOUR_OF_DAY, 17);

    AppointmentCalendar calendar = new AppointmentCalendar();
    calendar.add(new Appointment() {{
        name("dentist");
        from(fourPM);
        to(fivePM);
        at("123 main street");
    }});

    calendar.add(new Appointment() {{
        name("birthday party");
        at(fourPM);
    }});

    displayAppointments(calendar);
}
```



support for DSLs

dynamic typing

closures for context

two different open class techniques:

- categories
- expando metaclass

groovy calendars

```
def calendar = new AppointmentCalendar()

use (IntegerWithTimeSupport) {
  calendar.add new Appointment("Dentist")
               .from(4.pm)
  calendar.add new Appointment("Conference call")
               .from(5.pm)
               .to(6.pm)
               .at("555-123-4321")
}
```

categories

```
class IntegerWithTimeSupport {
  static Integer getAm(Integer self) {
    self == 12 ? 0 : self
  }

  static Integer getPm(Integer self) {
    self == 12 ? 12 : self + 12
  }

  static Calendar getFromToday(Integer self) {
    def target = Calendar.instance
    target.roll(Calendar.DAY_OF_MONTH, self)
    return target
  }
}
```

am/pm

```
@Test void am_returns_number() {
  use (IntegerWithTimeSupport) {
    1.upto(11) { i ->
      assertThat(i.am, is(i))
    }
    assertThat(12.am, is(0))
  }
}

@Test void pm_returns_correct_number() {
  use (IntegerWithTimeSupport) {
    1.upto(11) { i ->
      assertThat i.pm, is(i + 12)
    }
    assertThat 12.pm, is(12)
  }
}
```

categories

```
class IntegerWithTimeSupport {
  static Integer getAm(Integer self) {
    self == 12 ? 0 : self
  }

  static Integer getPm(Integer self) {
    self == 12 ? 12 : self + 12
  }

  static Calendar getFromToday(Integer self) {
    def target = Calendar.instance
    target.roll(Calendar.DAY_OF_MONTH, self)
    return target
  }
}
```

fromToday

```
@Test void from_today_gets_correct_date() {
  use (IntegerWithTimeSupport) {
    def expected = Calendar.instance
    expected.roll(Calendar.DAY_OF_MONTH, 4)
    assertThat 4.fromToday.DAY_OF_MONTH, is(expected.DAY_OF_MONTH)
  }
}

@Test void from_today_responds_to_negative_days() {
  use (IntegerWithTimeSupport) {
    def expected = Calendar.instance
    expected.roll(Calendar.DAY_OF_MONTH, -4)
    assertThat((-4).fromToday.DAY_OF_MONTH, is(expected.DAY_OF_MONTH))
  }
}
```

categories

```
class IntegerWithTimeSupport {
  static Integer getAm(Integer self) {
    self == 12 ? 0 : self
  }

  static Integer getPm(Integer self) {
    self == 12 ? 12 : self + 12
  }

  static Calendar getFromToday(Integer self) {
    def target = Calendar.instance
    target.roll(Calendar.DAY_OF_MONTH, self)
    return target
  }
}
```

expando target syntax

```
def calendar = new AppointmentCalendar()

calendar.add new Appointment("Dentist")
             .from(4.pm)
calendar.add new Appointment("Conference call")
             .from(5.pm)
             .to(6.pm)
             .at("555-123-4321")

calendar.print()
```

expando metaclass

```
Integer.metaClass.getAm = { ->
  delegate == 12 ? 0 : delegate
}

Integer.metaClass.getPm = { ->
  delegate == 12 ? 12 : delegate + 12
}

Integer.metaClass.getFromToday = { ->
  def target = Calendar.instance
  target.roll(Calendar.DAY_OF_MONTH, delegate)
  target
}
```

expando tests

```
class TestIntegerMeta  {

  @Test void am() {
    0.upto(11) {
      assertThat it, is(it.am)
    }
  }

  @Test void pm() {
    0.upto(11) {
      assertThat it+12, is(it.pm)
    }
  }

  @Test void from_today() {
    0.upto(100) {
      def c = Calendar.instance
      c.roll(Calendar.DAY_OF_MONTH, it)
      assertThat it.fromToday.DAY_OF_MONTH, is(c.DAY_OF_MONTH)
    }
  }
}
```

category vs. expando

```
def calendar = new AppointmentCalendar()

use (IntegerWithTimeSupport) {
    calendar.add new Appointment("Dentist")
                 .from(4.pm)
    calendar.add new Appointment("Conference call")
                 .from(5.pm)
                 .to(7.pm)
                 .at("555-123-4321")
}

calendar.print()
```

```
def calendar = new AppointmentCalendar()


calendar.add new Appointment("Dentist")
             .from(4.pm)
calendar.add new Appointment("Conference call")
             .from(5.pm)
             .to(6.pm)
             .at("555-123-4321")


calendar.print()
```

the goal

```
recipe = Recipe.new "Spicy bread"
recipe.add 200.grams.of Flour
recipe.add 1.lb.of Nutmeg
```

open classes

```
class Numeric
  def gram
    self
  end
  alias_method :grams, :gram

  def pound
    self * 453.59237
  end
  alias_method :pounds, :pound
  alias_method :lb, :pound
  alias_method :lbs, :pound
end
```

recipe redux

```
recipe = Recipe.new "Spicy bread"
recipe.add 200.grams.of Flour
recipe.add 1.lb.of Nutmeg
```

of

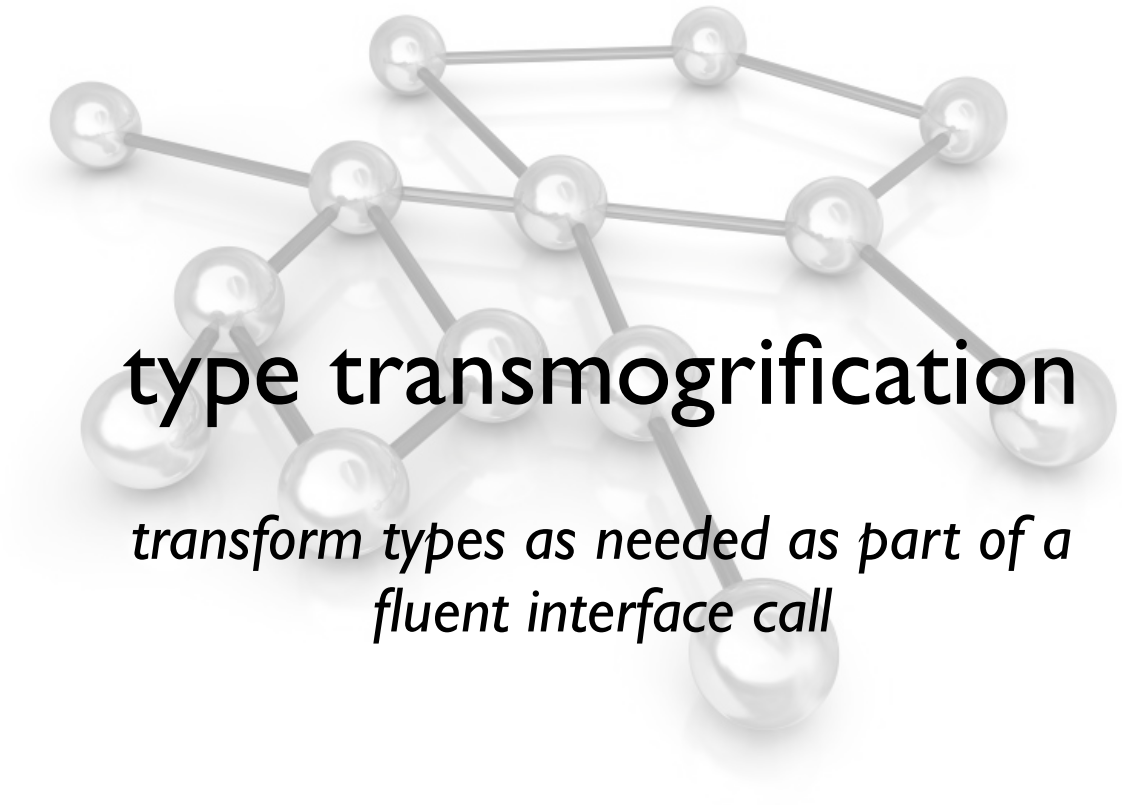
```
class Numeric
  def of ingredient
    if ingredient.kind_of? String
      ingredient = Ingredient.new(ingredient)
    end
    ingredient.quantity = self
    ingredient
  end
end
```

who returns what?

Numeric Ingredient

```
1.pound.of("Flour")
```

Integer Ingredient



type transmogrification

transform types as needed as part of a fluent interface call

killing noise characters

```
recipe.add 200.grams.of Flour
recipe.add 1.lb.of Nutmeg
```

const_missing

```
class Object
  def self.const_missing(sym)
    eval "Ingredient.new(sym.to_s)"
  end
end
```

constant_missing factory

using "missings" as factories to create types

ingredient factory

yikes!

```
class Object
  def self.const_missing(sym)
    Ingredient.new(sym.to_s)
  end
end
```

mix it in

```
module IngredientBuilder
  def self.append_features(target)
    def target.const_missing(name)
      Ingredient.new(name.to_s)
    end
    super
  end
end
```

safer `const` factories

```
class TestIngredients < Test::Unit::TestCase
  include IngredientBuilder

  def test_ingredient_factory
    i = Flour
    assert i.kind_of? Ingredient
    assert_equal(i.name, "Flour")
  end
```

smarter `const` factories

```
module SmartIngredientBuilder
  @@INGREDIENTS = {
    "Flour" => "Flour", "Fluor" => "Flour", "Flower" => "Flour",
    "Flur" => "Flour", "Nutmeg" => "Nutmeg", "Knutmeg" => "Nutmeg"
  }
  def self.append_features(target)
    def target.const_missing(name)
      i = @@INGREDIENTS.keys.find do |val|
        name.to_s ==  val
      end
      return Ingredient.new(@@INGREDIENTS[i]) unless i.nil?
      raise "No such ingredient"
    end
    super
  end
end
```

```
class TestSmartIngredients < Test::Unit::TestCase
  include SmartIngredientBuilder

  def test_correct_spelling
    i = Flour
    assert i.kind_of? Ingredient
    assert_equal(i.name, "Flour")
  end

  def test_misspelling
    i = Flower
    assert i.kind_of? Ingredient
    assert_equal(i.name, "Flour")
  end

  def test_missing_ingredient
    assert_raise(RuntimeError) {
      i = BakingSoda
    }
  end
end
```

shotgun approach to open classes

*don't provide universe-wide access to the whacky stuff you've implemented for your **dsl***

control your context

context

implicit context tersifies **dsl**'s

context

```
def test_verbose_syntax
  recipe = Recipe.new "Milky Gravy"
  recipe.add 1.lb.of Flour
  recipe.add 200.grams.of Milk
  recipe.add 1.gram.of Nutmeg
  assert_equal 3, recipe.ingredients.size
end
```

```
def test_consists_of
  recipe = Recipe.new "Milky Gravy"
  recipe.consists_of {
    add 1.lb.of Flour
    add 200.grams.of Milk
    add 1.gram.of Nutmeg
  }
  assert_equal 3, recipe.ingredients.size
end
```

add context

```
def consists_of &block
  instance_eval &block
end
```

evaluates ruby code by switching *self* to the instance of the object calling instance_eval

context

```
def test_consists_of
  recipe = Recipe.new "Milky Gravy"
  recipe.consists_of {
    add 1.lb.of Flour
    add 200.grams.of Milk
    add 1.gram.of Nutmeg
  }
  assert_equal 3, recipe.ingredients.size
end
```

expression builder

building a simple language for recipes allows you to build other stuff underneath

for example, a nutrition profile

recipe nutrition profile

```
def nutrition_profile
  profile = NutritionProfile.new
  ingredients.each { |i|
    foo = NutritionProfileDatabase.get_profile_for(i)
    add_to profile, NutritionProfileDatabase.get_profile_for(i)
  }
  profile
end
```

nutrition profile

```
class NutritionProfile
  attr_accessor :protein, :lipid, :sugars, :calcium, :sodium

  def initialize(protein=0, lipid=0, sugars=0, calcium=0, sodium=0)
    @protein, @lipid, @sugars =  protein, lipid, sugars
    @calcium, @sodium = calcium, sodium
  end

  def to_s()
    "\tProtein: " +   @protein.to_s       +
    "\n\tLipid: " +   @lipid.to_s         +
    "\n\tSugars: " +  @sugars.to_s        +
    "\n\tCalcium: " + @calcium.to_s       +
    "\n\tSodium: " +  @sodium.to_s
  end

end
```

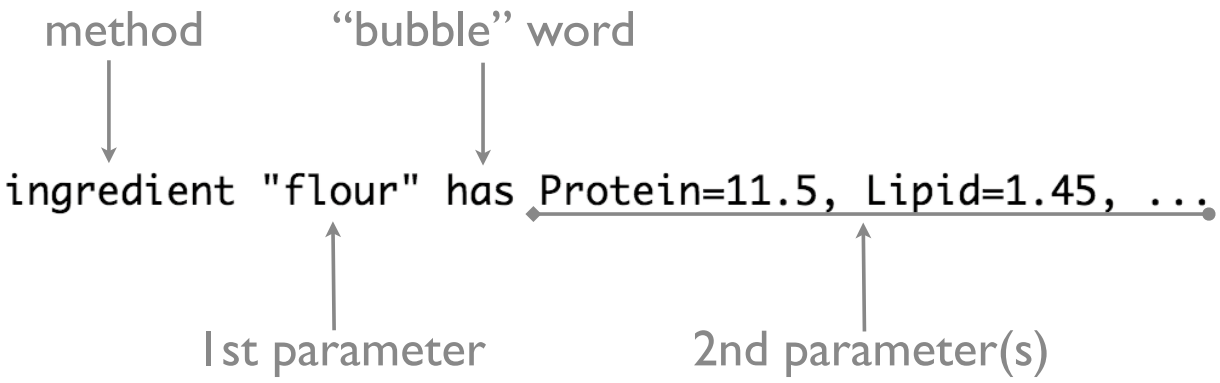
testing profile

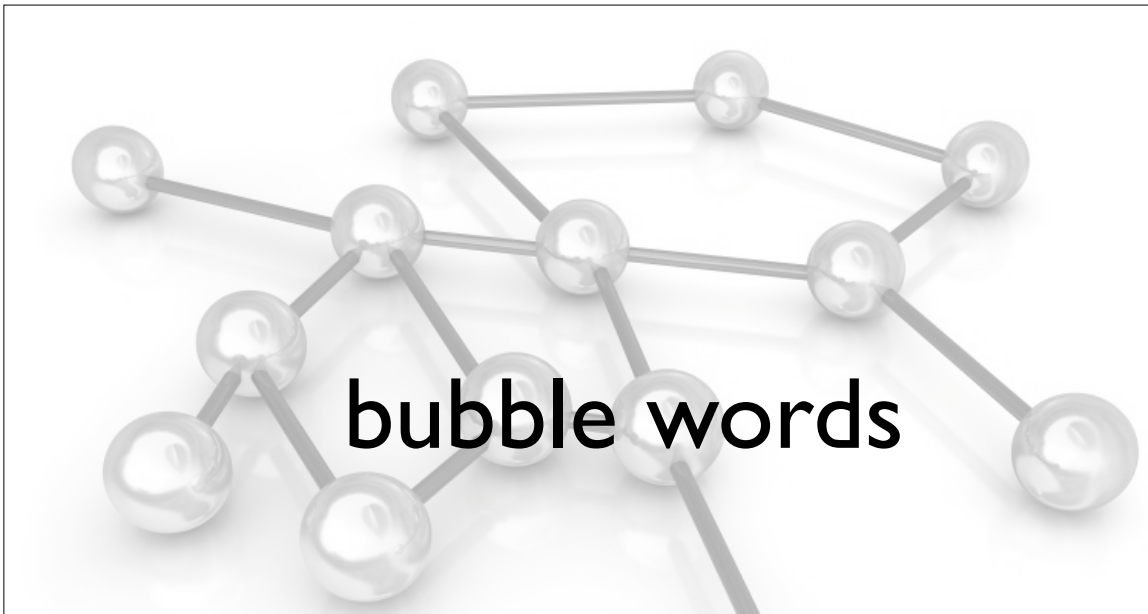
```
def test_nutrition_profile_for_recipe
  recipe = Recipe.new
  expected = [] << 2.lbs.of(Flour) << 1.gram.of(Nutmeg)
  expected.each {|i| recipe.add i}
  protein = 11.5 + 5.84
  lipid = 1.45 + 36.31
  sugar = 1.12 + 28.49
  calcium = 20 + 184
  sodium = 2 + 16
  expected_profile = recipe.nutrition_profile
  assert_equal expected_profile.protein, protein
  assert_equal expected_profile.lipid, lipid
  assert_equal expected_profile.sugars, sugar
  assert_equal expected_profile.calcium, calcium
  assert_equal expected_profile.sodium, sodium
end
```

profile target

```
ingredient "flour" has Protein=11.5, Lipid=1.45, Sugars=1.12, Calcium=20, Sodium=0
ingredient "nutmeg" has Protein=5.84, Lipid=36.31, Sugars=28.49, Calcium=184, Sodium=16
ingredient "milk" has Protein=3.22, Lipid=3.25, Sugars=5.26, Calcium=113, Sodium=40
```

what is this?





bubble words

terms in a dsl that don't contribute to the definition but rather to the readability

```
class NutritionProfileDefinition
  class << self
    def const_missing(sym)
      sym.to_s.downcase
    end
  end

  def ingredient(name, ingredients)
    NutritionProfile.create_from_hash name, ingredients
  end

  def process_definition(definition)
    t = polish_text(definition)
    instance_eval polish_text(definition)
  end

  def polish_text(definition_line)
    polished_text = definition_line.clone
    polished_text.gsub!(/=/, '=>')
    polished_text.sub!(/and /, '')
    polished_text.sub!(/has /, ',')
    polished_text
  end

end
```

```
def test_polish_text
  test_text = "ingredient \"flour\" has Protein=11.5, Lipid=1.45, Sugars=1.12, Calcium=20, and Sodium=0"
  expected = 'ingredient "flour" ,Protein=>11.5, Lipid=>1.45, Sugars=>1.12, Calcium=>20, Sodium=>0'
  assert_equal expected, NutritionProfileDefinition.new.polish_text(test_text)
end
```

```
def polish_text(definition_line)
  polished_text = definition_line.clone
  polished_text.gsub!(/=/, '=>')
  polished_text.sub!(/and /, '')
  polished_text.sub!(/has /, ',')
  polished_text
end
```

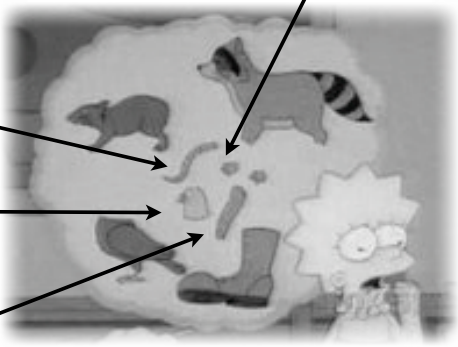
```
def process_definition(definition)
  instance_eval polish_text(definition)
end
```

```
'ingredient "flour" ,Protein=>11.5, Lipid=>1.45,
```

```
def ingredient(name, ingredients)
  NutritionProfile.create_from_hash name, ingredients
end
```

polish vs. preprocess vs. parse

=

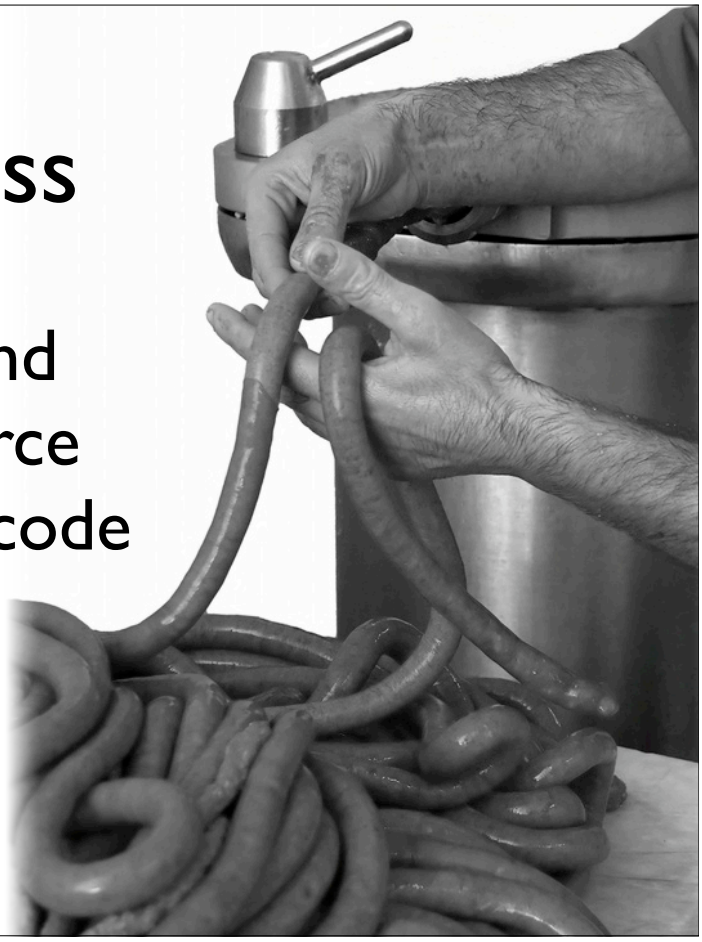


polish

simple string substitutions to convert *nearly* ruby to *actual* ruby

pre-process

load strings and modify to coerce them into ruby code



business natural languages

term defined by jay fields (www.jayfields.com)

use natural language to represent business logic

bnl is a **dsl**, but not all **dsl**'s are **bnl**'s

example

```
employee John Jones

compensate $2500 for each deal closed in the past 30 days
compensate $500 for each active deal that closed more than 365 days ago
compensate 5% of gross profits if gross profits are greater than $1,000,000
compensate 3% of gross profits if gross profits are greater than $2,000,000
compensate 1% of gross profits if gross profits are greater than $3,000,000
```

process_payroll.rb

```
Dir[File.dirname(__FILE__) + "/*.bnl"].each do |bnl_file|

  vocabulary = CompensationVocabulary.new(File.basename(bnl_file, '.bnl'))

  compensation = CompensationParser.parse(File.read(bnl_file), vocabulary)

  puts "#{compensation.name} compensation: #{compensation.amount}"

end
```

vocabulary.rb

```
module Vocabulary

  def phrase(name, &block)
    define_method :"_#{name.to_s.gsub(" ","_")}", block
  end

end
```

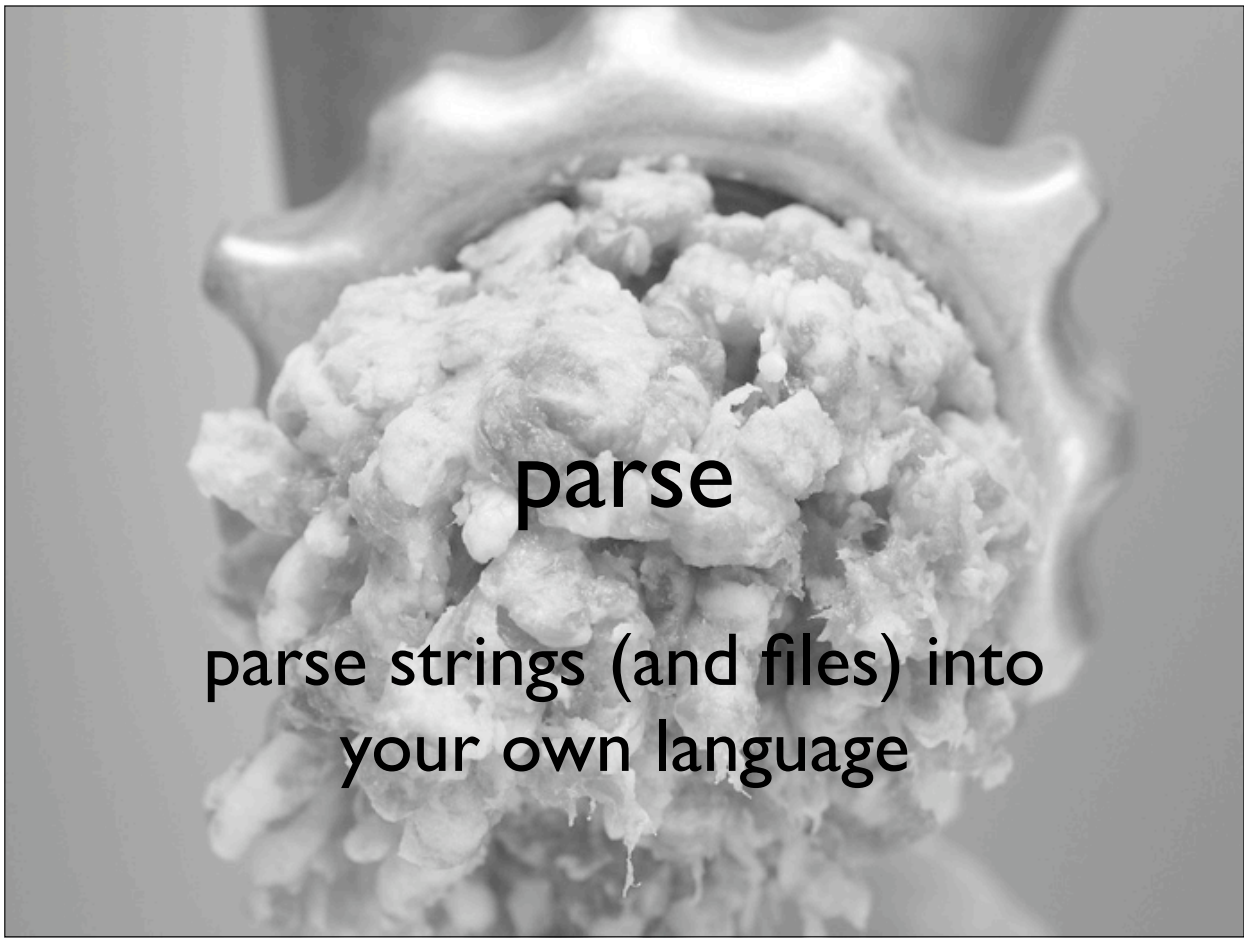
compensation_vocabulary.rb

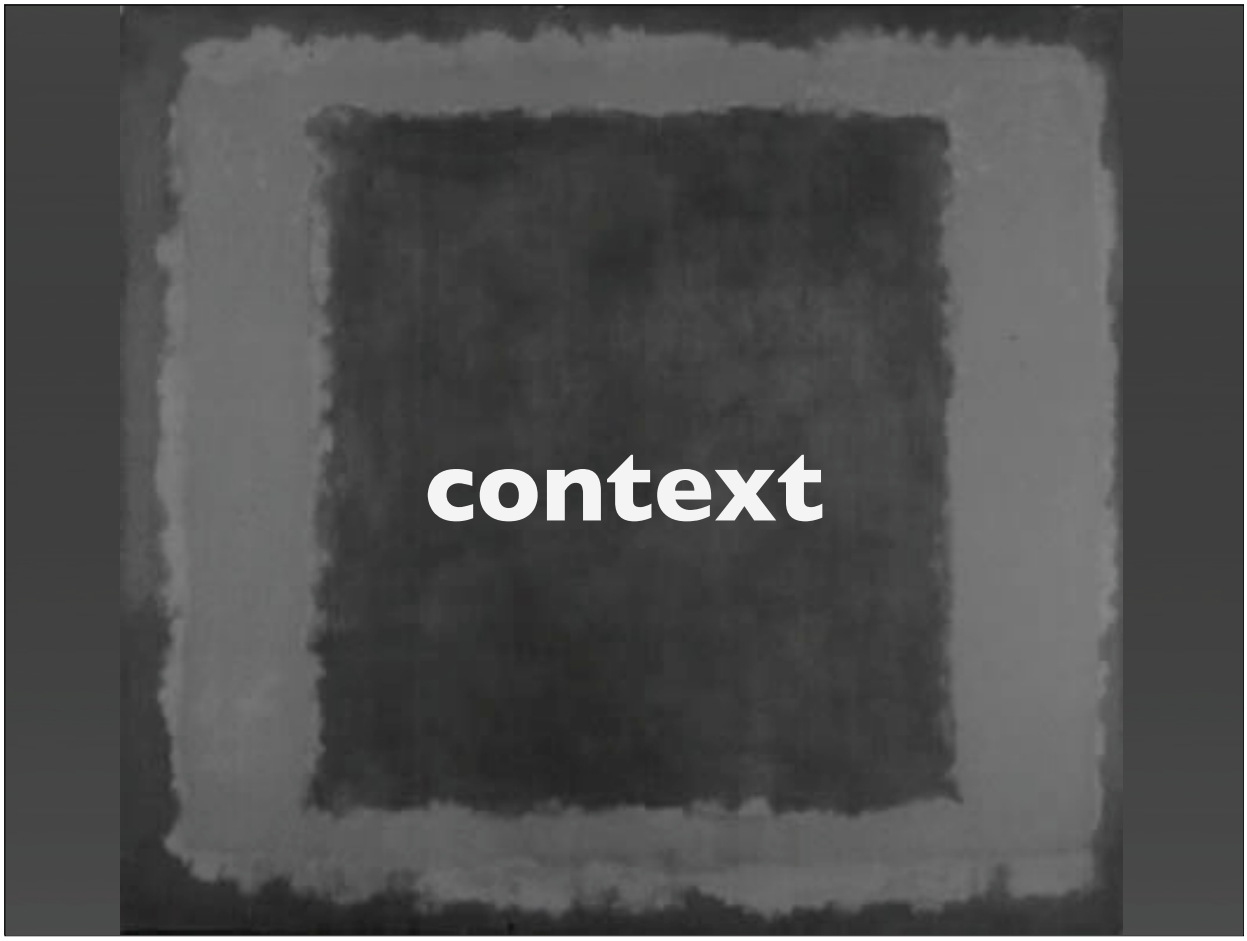
```
class CompensationVocabulary
  extend Vocabulary

  def initialize(data_for)
    @data_for = data_for
  end

  phrase "active deal that closed more than 365 days ago!" do
    SalesInfo.send(@data_for).year_old_deals.to_s
  end

  phrase "are greater than" do
    " > "
  end

  phrase "deal closed in the past 30 days!" do
    SalesInfo.send(@data_for).deals_this_month.to_s
  end

  phrase "for each"  do
    "*"
  end
```

compensation_parser.rb

```
class CompensationParser

  class << self
    def parse(script, vocabulary)
      root = Root.new(vocabulary)
      script.split(/\n/).each { |line| root.process(preprocess(line)) }
      root
    end

    def preprocess(line)
      line.chomp!
      line.delete!('$,')
      line.gsub!(/(\d+)%/, '\1percent')
      line.gsub!(/\s/, '._')
      "_#{line.downcase}!"
    end
  end
end
```

```ruby
class Compensation

  def initialize(vocabulary)
    @phrase, @compensation_logic = '', ''
    @vocabulary = vocabulary
  end

  def method_missing(sym, *args)
    @phrase = reduce(@phrase + sym.to_s)
    if @phrase.any? && sym.to_s =~ /!$/
      raise NoMethodError.new("#{@phrase} not found")
    end
    self
  end

  def reduce(phrase)
    case
      when phrase =~ /^_\d+[(percent)!]*$/
        append(extract_number(phrase))
      when @vocabulary.respond_to?(phrase)
        append(@vocabulary.send(phrase))
      else phrase
    end
  end

  def append(piece)
    @compensation_logic += piece
    ""
  end

  def extract_number(string)
    string.gsub(/(\d+)percent$/, '0.0\1').delete('_!')
  end

  def amount
    instance_eval(@compensation_logic) || 0
  end

end
```





context wrapping

nested parameters

method chaining

functional sequence

- context blocks
- sticky attributes

annotations for context

```
public class Country {
    private List<Region> regions = new ArrayList<Region
    private String name;

    public Country(String name){
        this.name = name;
    }

    @MaxLength(length = 10)
    public String getName(){
        return name;
    }

    public void addRegion(Region region){
        regions.add(region);
    }

    public List<Region> getRegions(){
        return regions;
    }
}
```

validator

```
public abstract class Validator {

    public void validate(Object obj) throws ValidationException {
        Class clss = obj.getClass();
        for(Method method : clss.getMethods()){
            if (method.isAnnotationPresent(getAnnotationType()))
                validateMethod(obj, method, method.getAnnotation(getAnnotationType()));
        }
    }

    protected abstract Class getAnnotationType();
    protected abstract void validateMethod(Object obj,
            Method method, Annotation annotation);
}
```

```
@Retention(RetentionPolicy.RUNTIME)
public @interface Unique {
    Class scope() default Unique.class;
}
```

Unique
Validator

```
public class UniqueValidator extends Validator{

    @Override
    protected void validateMethod(Object obj, Method method, Annotation annotation) {
        Unique unique = (Unique) annotation;
        try {
            Method scopeMethod = obj.getClass().getMethod("get" + unique.scope().getSimpleName());
            Object scopeObj = scopeMethod.invoke(obj, new Object[0]);

            Method collectionMethod = scopeObj.getClass().getMethod("get" + obj.getClass().getSimpleName() + "s");
            List collection = (List)collectionMethod.invoke(scopeObj, new Object[0]);
            Object returnValue = method.invoke(obj, new Object[0]);
            for(Object otherObj: collection){
                Object otherReturnValue = otherObj.getClass().
                        getMethod(method.getName()).invoke(otherObj, new Object[0]);
                if (!otherObj.equals(obj) && otherReturnValue.equals(returnValue))
                    throw new ValidationException(method.getName() + " on " +
                        obj.getClass().getSimpleName() + " should be unique but is not since");
            }
        } catch (Exception e) {
            System.out.println(e.getMessage());
            throw new ValidationException(e.getMessage());
        }
    }

    @Override
    protected Class getAnnotationType() {
        return Unique.class;
    }
}
```

limiting testing

```
require 'test/unit'
class CalculatorTest<Test::Unit::TestCase

  def test_some_complex_calculation
    assert_equal 2, Calculator.new(4).complex_calculation
  end

end
```

conditional method definition

```
class CalculatorTest<Test::Unit::TestCase

  if ENV["BUILD"] == "ACCEPTANCE"

    def test_some_complex_calculation
      assert_equal 2, Calculator.new(4).complex_calculation
    end

  end

end
```

attribute

```
class CalculatorTest<Test::Unit::TestCase
  extend TestDirectives

  acceptance_only
  def test_some_complex_calculation
    assert_equal 2, Calculator.new(4).complex_calculation
  end

end
```

using hook methods

```
module TestDirectives

  def acceptance_only
    @acceptance_build = ENV["BUILD"] == "ACCEPTANCE"
  end

  def method_added(method_name)
    remove_method(method_name) unless @acceptance_build
    @acceptance_build = false
  end

end
```

delineating blocks

```
class CalculatorTest<Test::Unit::TestCase
  extend TestDirectives

  acceptance_only do

    def test_some_complex_calculation
      assert_equal 2, Calculator.new(4).complex_calculation
    end

  end

end
```

building block container

```
module TestDirectives

  def acceptance_only &block
    block.call if ENV["BUILD"] == "ACCEPTANCE"
  end

end
```

named blocks

```
class CalculatorTest<Test::Unit::TestCase
  extend TestDirectives

  acceptance_only :test_some_complex_calculation do

    assert_equal 2, Calculator.new(4).complex_calculation

  end

end
```

implementing named blocks

```
module TestDirectives

  def acceptance_only(method_name, &method_body)
    if ENV["BUILD"] == "ACCEPTANCE"
      define_method method_name, method_body
    end
  end

end
```

attributes for cross-cutting concerns

```
class Approval
  extend Loggable

  logged
  def decline(approver, comment)
    #implementation
  end

end
```

```
module Loggable
  def logged
    @logged = true
  end

  def method_added(method_name)
    logged_method = @logged
    @logged = false

    if logged_method
      original_method = :"unlogged_#{method_name.to_s}"
      alias_method original_method, method_name

      define_method(method_name) do |*args|
        arg_string = args.collect{ |arg| arg.inspect + " " } unless args.empty?
        log_message = "called #{method_name}"
        log_message << " with #{arg_string}" if arg_string
        Logger.log log_message
        self.send(original_method, *args)
      end
    end
  end
end
```

summarizing DSLs

limited computer languages

used for:

- configuration
- fluent interfaces
- “little” languages

summarizing DSLs

context is king!

readability matters...a lot

build solutions by composition, not elaboration

start with the end

evolutionary, not revolutionary

? ' s

please fill out the session evaluations
samples at **`github.com/nealford`**

NEAL FORD software architect / meme wrangler

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resources

http://martinfowler.com/bliki/DomainSpecificLanguage.html

http://martinfowler.com/articles/languageWorkbench.html

http://www.theserverside.com/news/thread.tss?thread_id=46674

http://homepages.cwi.nl/~arie/papers/dslbib/