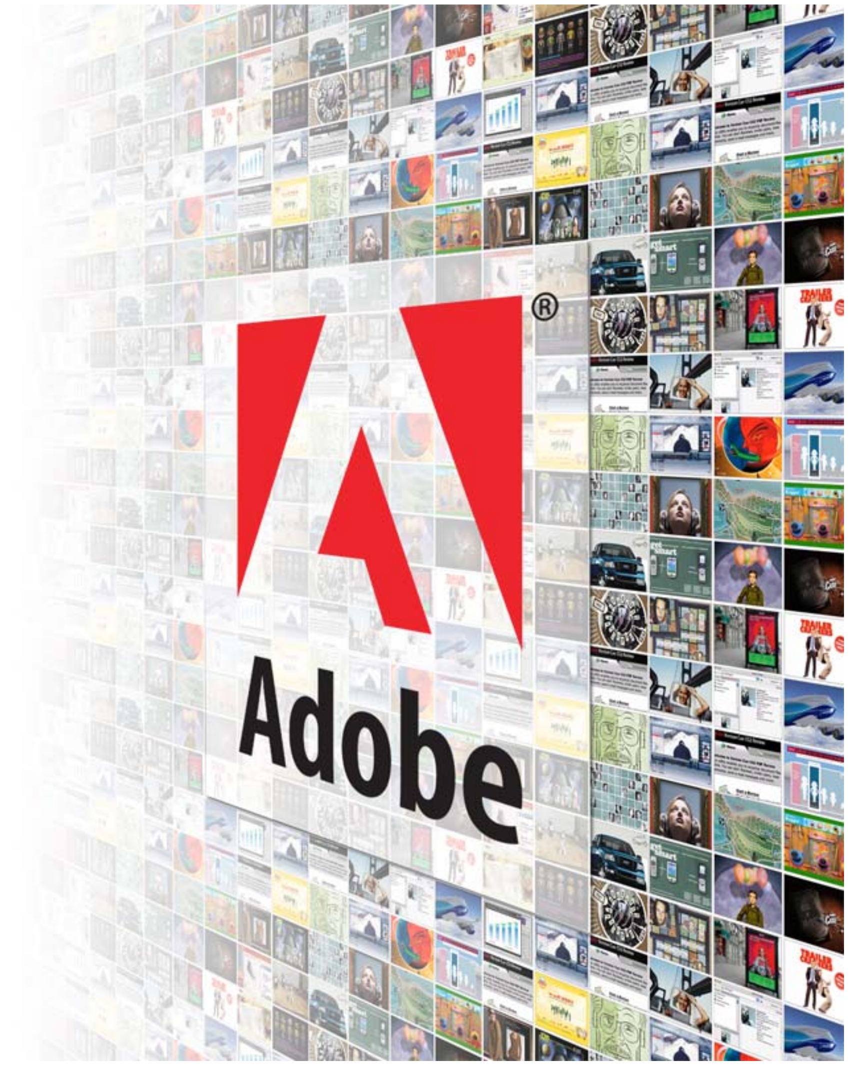
Adobe Source Libraries Overview & Philosophy

Sean Parent

Principal Scientist & Engineering Manager
Adobe Software Technology Lab

http://stlab.adobe.com

03 April 2008



Adobe Source Libraries

- A collection of libraries to support application development
- Research artifacts of the Adobe Software Technology Lab
- Open Source: http://stlab.adobe.com/
- Used by many Adobe products

Outline

- **Regular Types – libraries for e□ciently handling regular types**
- **Forest – advantages of explicit data structures**

- **Layout Library – a library for placing / aligning items in an interface and a language to express layouts**
- **Property Model Library – describing and solving inter-related proprerties**

Goal of ASL

- Express entire applications using a combination of generic and declarative techniques
  - 2 orders of magnitude reduction in code
  - Greater than corresponding reduction in defects
- We are still a long way from our goal
  - perhaps not as far as it would appear

Approach

- **Generic Algorithms**
  - **Write algorithms with minimal requirements – maximum reuse**
- **Generic Data Structures (Containers)**
  - **Containers support algorithm requirements (including complexity)**
- **Declarative Architecture**
  - **Identify “patterns” of how components are assembled and learn to express/solve these pattern with algorithms and data structures**

Challenges

- Build a Strong Foundation
  - See http://stepanovpapers.com/eop/lecture_all.pdf
  - Our work here has a strong impact on all aspects of ASL
- Combine Runtime Polymorphism and Generic Programming
  - See http://www.emarcus.org/papers/gpce2007f-authors-version.pdf
  - See http://www.emarcus.org/papers/MPOOL2007-marcus.pdf
  - See Poly and Any Regular Libraries
- Make Implicit Structure Explicit
  - Work ongoing – see Forest, Property Model, and Layout Libraries
- Discovering the Rules that Govern Large Systems
  - Work ongoing – see Property Model Library and initial work on Sequence Models

Adobe Source Libraries – Regular Types

- Definition: Regular
- Move Library
    - How RVO works
- Creating Polymorphic Regular Types and Poly Library
- Copy On Write Library

De nition of Regular

- The requirements of Regular are based on equaltional reasoning
- They assure regularity of behavior and interoperability
- Types which model these requirements are ***regular types***

- The properties of Regular are inherent in the machine model
- Regular types exist in any correct system but formalizing the requirements and normalizing the syntax is what enables interoperability

- All types are inherently regular

Basic Requirements of Regular Type

Requirement	Syntax Example	Axioms & Postconditions

Copy	`T x = y;`
	`~x();`
		`x == y`
		`if (is_defined(modify, x)`
		`   then modify(x); x != y`

Assignment	`x = y;`	`x == y`
		`if (is_defined(modify, x)`
		`   then modify(x); x != y`

Equality	`x == y;`
	`x != y;`
		`a == b && b == c => a == c`
		`a == b ⇔ b == a`
		`a == a`

Identity	`&x;`	`&a == &b => a == b`
		`given &x == &y`
		`if (is_defined(modify, x)`
		`    then modify(x); x == y;`

Size	`sizeof(T);`	`size of local part of T`

Swap	`swap(x, y);`	`x' == y; y' == x;`
		`O(sizeof(T)); nothrow;`

Extended Requirements of Regular Type

Requirement	Syntax Example	Axioms & Postconditions
Default Construction	`T x;`	`T x; x = y;` is equivalent `T x = y;`
Default Comparison	`std::less<T>()(x, y);`	`!op(x, y) && !op(y, x) => x == y`
Movable	`x = f();` `x = move(y);`	`O(sizeof(T)); nothrow;` `T x = y; z = move(x); => z == y;`
Area	`area(x);`	Copy and Assignment are `O(area(x));` Equality is worst case `O(area(x));`
Alignment	`alignment(T);`	alignment size for type
Underlying Type	`underlying(T)`	type which can be copied to/from T in `O(size(T))`

Importance of Move

- Allows transfer of ownership of remote parts in small constant time
- Will not throw an exception
- Move does not refine Copy and Copy does not refine Move
- When the source will not be used after a copy, copy can be replaced with move
- An object which has been moved from is still Regular

- Reference Semantics provide move for “free”
  - But there are other costs

Quiz: What will the following code print?

```
struct object_t
{
    object_t()
        { cout << "construct" << endl; }
    object_t(const object_t&)
        { cout << "copy" << endl; }
    object_t& operator=(const object_t&)
        { cout << "assign" << endl; return *this; }
};

object_t function()
    { object_t result; return result; }

int main()
    { object_t x = function(); return 0; }
```

Answer: Return Value Optimization Eliminates Copies

```
struct object_t
{
    object_t()
        { cout << "construct" << endl; }
    object_t(const object_t&)
        { cout << "copy" << endl; }
    object_t& operator=(const object_t&)
        { cout << "assign" << endl; return *this; }
};

object_t function()
    { object_t result; return result; }

int main()
    { object_t x = function(); return 0; }
```

```
construct
```

Adobe

Quiz: What will the following code print?

```
struct object_t
{
    object_t()
        { cout << "construct" << endl; }
    object_t(const object_t&)
        { cout << "copy" << endl; }
    object_t& operator=(const object_t&)
        { cout << "assign" << endl; return *this; }
};

object_t function()
    { object_t result; return result; }

void sink(object_t) { }

int main()
    { sink(function()); return 0; }
```

Adobe

Answer: RVO Works for Parameters Also

```
struct object_t
{
    object_t()
        { cout << "construct" << endl; }
    object_t(const object_t&)
        { cout << "copy" << endl; }
    object_t& operator=(const object_t&)
        { cout << "assign" << endl; return *this; }
};

object_t function()
    { object_t result; return result; }

void sink(object_t) { }

int main()
    { sink(function()); return 0; }
```

```
construct
```

Sink Functions

- A sink function is any function which consumes one or more arguments by storing them or by returning them
- By passing the argument by value and moving it into position we allow the compiler to avoid a copy
- Assignment is a sink function

Typical Assignment

```
struct object_t{
    object_t() : object_m(new int(0)) { }
    object_t(const object_t& x) : object_m(new int(*x.object_m))
        { cout << "copy" << endl; }
    object_t& operator=(const object_t& x)
        { object_t tmp = x; swap(tmp, *this); return *this; }
    ~object_t() { delete object_m; }

    friend inline void swap(object_t& x, object_t& y)
        { swap(x.object_m, y.object_m); }
 private:
    int* object_m;
};

object_t function()
    { object_t result; return result; }

int main()
    { object_t x; x = function(); return 0; }
```

```
copy
```

Better Assignment

```
struct object_t{
    object_t() : object_m(new int(0)) { }
    object_t(const object_t& x) : object_m(new int(*x.object_m))
        { cout << "copy" << endl; }
    object_t& operator=(object_t x)
        { swap(x, *this); return *this; }
    ~object_t() { delete object_m; }

    friend inline void swap(object_t& x, object_t& y)
        { swap(x.object_m, y.object_m); }
 private:
    int* object_m;
};

object_t function()
    { object_t result; return result; }

int main()
    { object_t x; x = function(); return 0; }
```

~~copy~~

Better Assignment

```
struct object_t{
    object_t() : object_m(new int(0)) { }
    object_t(const object_t& x) : object_m(new int(*x.object_m))
        { cout << "copy" << endl; }
    object_t& operator=(object_t x)
        { swap(x, *this); return *this; }
    ~object_t() { delete object_m; }

    friend inline void swap(object_t& x, object_t& y)
        { swap(x.object_m, y.object_m); }
 private:
    int* object_m;
};

object_t function()
    { object_t result; return result; }

int main()
    { object_t x; x = function(); return 0; }
```

Explicit Move

```
struct object_t{
    object_t(move_from<object_t> x) : object_m(0)
        { swap(*this, x.source); }

    int& get() { return *object_m; }

    //…
};

object_t function()
    { object_t result; return result; }

object_t sink(object_t x)
    { x.get() += 5; return move(x); }

int main()
     { object_t x = sink(function()); return 0; }
```

Polymorphism and Regular Types

- Current pattern:
  - polymorphism => inheritance => specialized classes => limited code sharing
  - polymorphism => variable size => heap allocation => pointer management
  - polymorphism => virtual functions => slower dispatch
- The requirement for polymorphism comes from the need to handle heterogeneous types which satisfy a common set of requirement in a homogeneous manner
- Requirement is driven by the use of the type, there is nothing inherently polymorphic about a type

Creating a Polymorphic Regular Type

```
struct object_t
{
    template <typename T> // T models Drawable
    explicit object_t(T x) : object_m(new model_t<T>(move(x))) { }

    object_t(move_from<object_t> x) : object_m(0)
        { swap(*this, x.source); }
    object_t(const object_t& x) : object_m(x.object_m->copy_()) { }
    object_t& operator=(object_t x) { swap(x, *this); return *this; }
    ~object_t() { delete object_m; }

    friend inline void swap(object_t& x, object_t& y)
        { using std::swap; swap(x.object_m, y.object_m); }

    friend inline void draw(const object_t& x)
        { x.object_m->draw_(); }

 private:
    // …fill in here…
    concept_t* object_m;
};
```

Adobe

Creating a Polymorphic Regular Type

```
struct concept_t
{
    virtual ~concept_t() { }
    virtual concept_t* copy_() const = 0;
    virtual void draw_() const = 0;
};

template <typename T>
struct model_t : concept_t
{
    explicit model_t(T x) : value_m(move(x)) { }
    concept_t* copy_() const { return new model_t(*this); }
    void draw_() const { draw(value_m); }

    T value_m;
};
```

Adobe

Using our Poly Drawable Type

```
template <typename T> void draw(const T& x) { cout << x << endl; }

template <typename T> void draw(const vector<T>& x) {
    typedef typename vector<T>::const_iterator iterator_t;
    cout << "<vector>" << endl;
    for (iterator_t f(x.begin()), l(x.end()); f != l; ++f)
        { draw(*f); }
    cout << "</vector>" << endl;
}

int main() {
    vector<object_t> x;

    x.push_back(object_t(10));
    x.push_back(object_t(string_t("Hello World!")));
    x.push_back(object_t(x));
    x.push_back(object_t(string_t("Another String!")));

    draw(x);
    return 0;
}
```

Adobe

Results

```
<vector>
  10
  Hello World!
  <vector>
    10
    Hello World!
  </vector>
  Another String!
</vector>
```

Indenting Added for clarity

Summary

- Non-Intrusive – client need only satisfy requirements
- Existing types can be used in a polymorphic fashion without wrapping
- Cost of virtual dispatch the same – but only required when object used in a polymorphic setting
- Client isn't burdened by managing pointers – can use e□ciently with containers and algorithms

- The Poly Library provides facilities for:
  - Virtualization of the properties of Regular
  - Re□nement
  - Dynamic Type Information

Adobe

One Final Change...

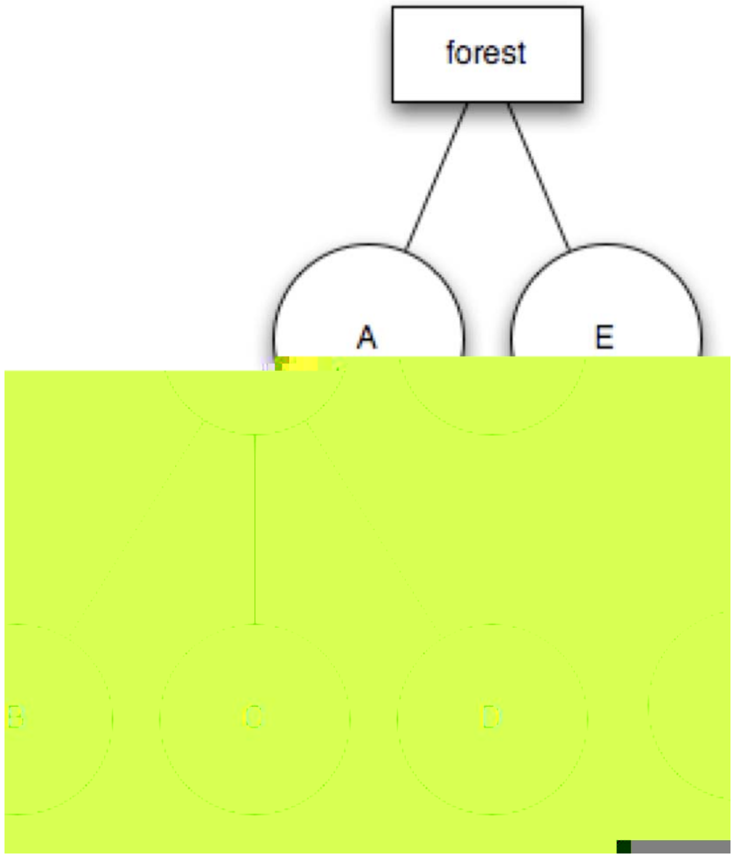
```
template <typename T>
void draw(const copy_on_write<T>& x) { draw(x.read()); }

int main(){
    typedef copy_on_write<object_t> cow_t;

    vector<cow_t> x;

    x.push_back(cow_t(object_t(10)));
    x.push_back(cow_t(object_t(string_t("Hello World!"))));
    x.push_back(cow_t(object_t(x)));
    x.push_back(cow_t(object_t(string_t("Another String!"))));

    draw(x);

    return 0;
}
```

Adobe

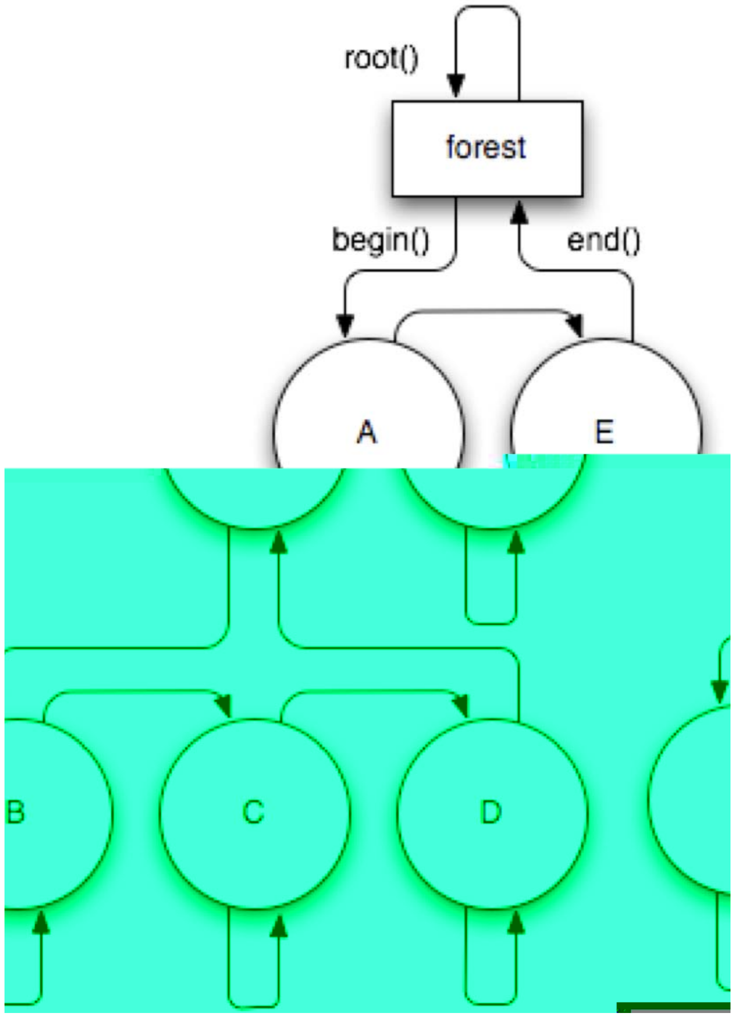
Forest Library

- STL provides sequence and associative containers and algorithms
- Because the STL data types are Regular they can be composed to create new structures
- Not all structures are best represented by composition
- Hierarchies can be represented through containment
  - as we saw with object_t
- Other representations provide other advantages

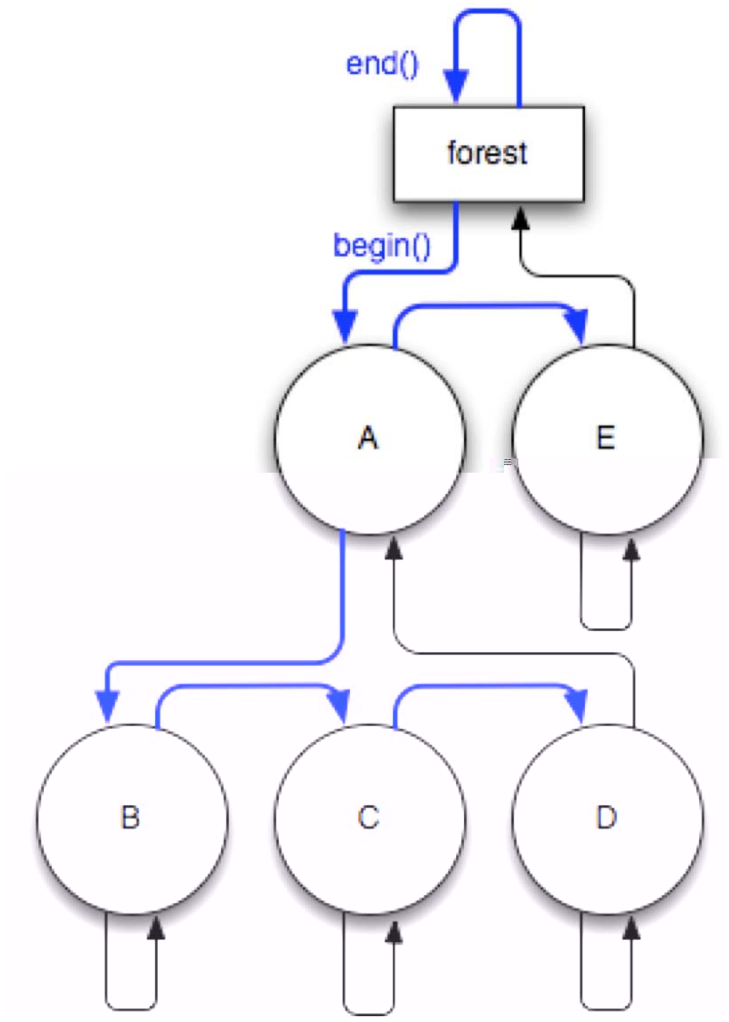
Forest



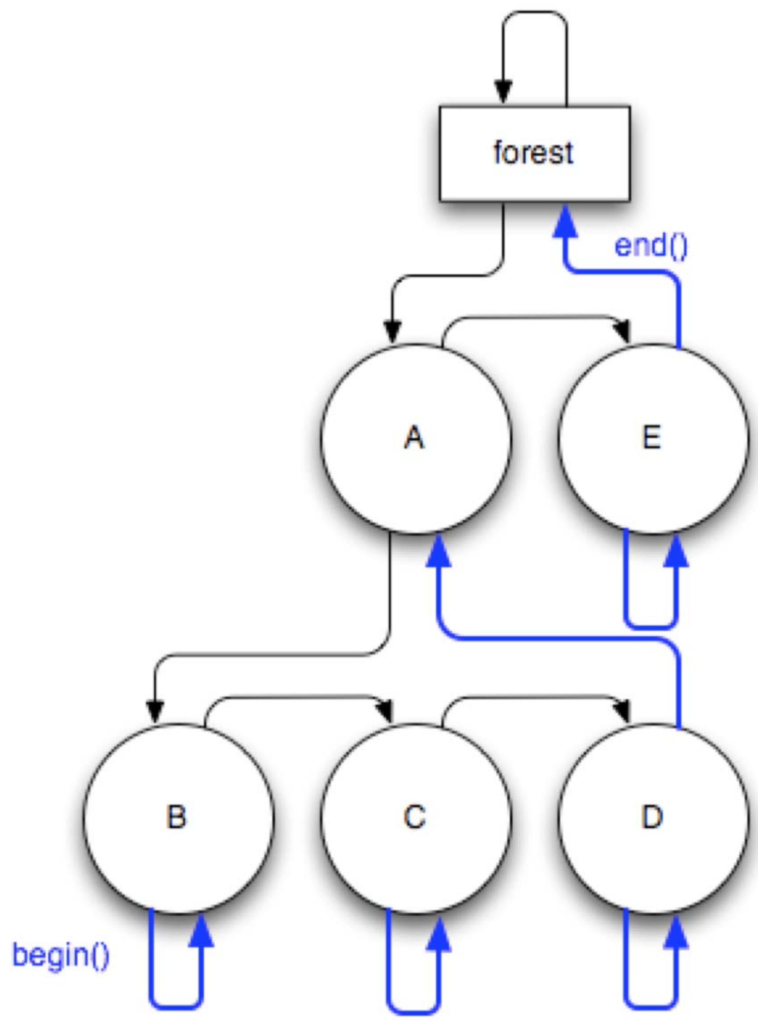
Forest (full-order traversal)



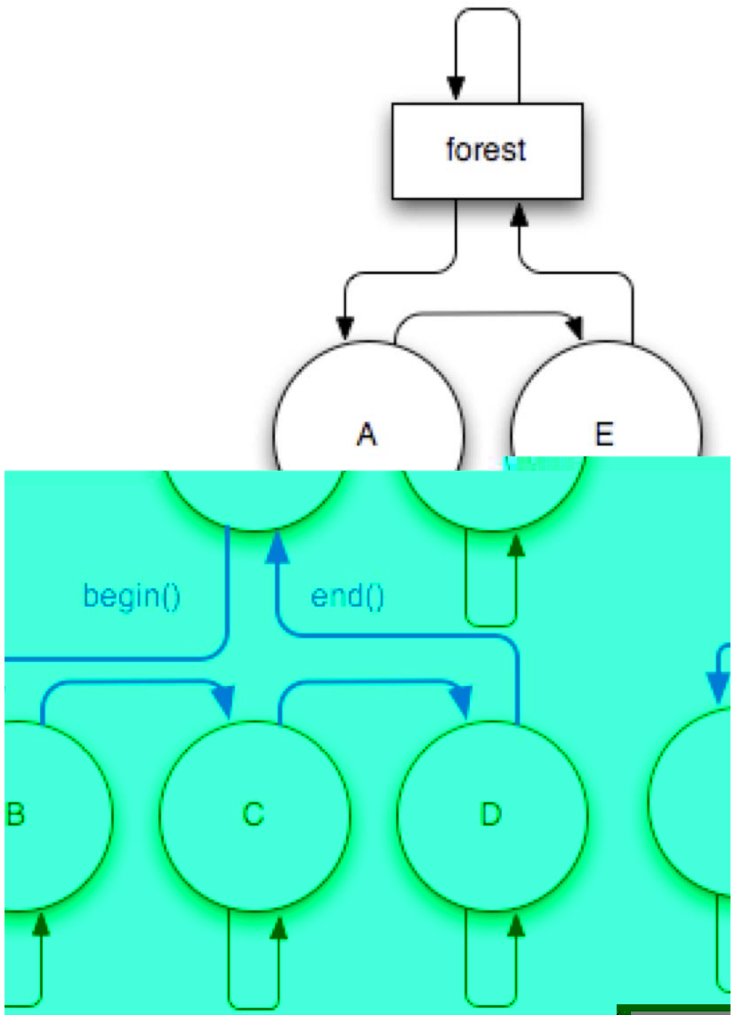
Forest (pre-order traversal)



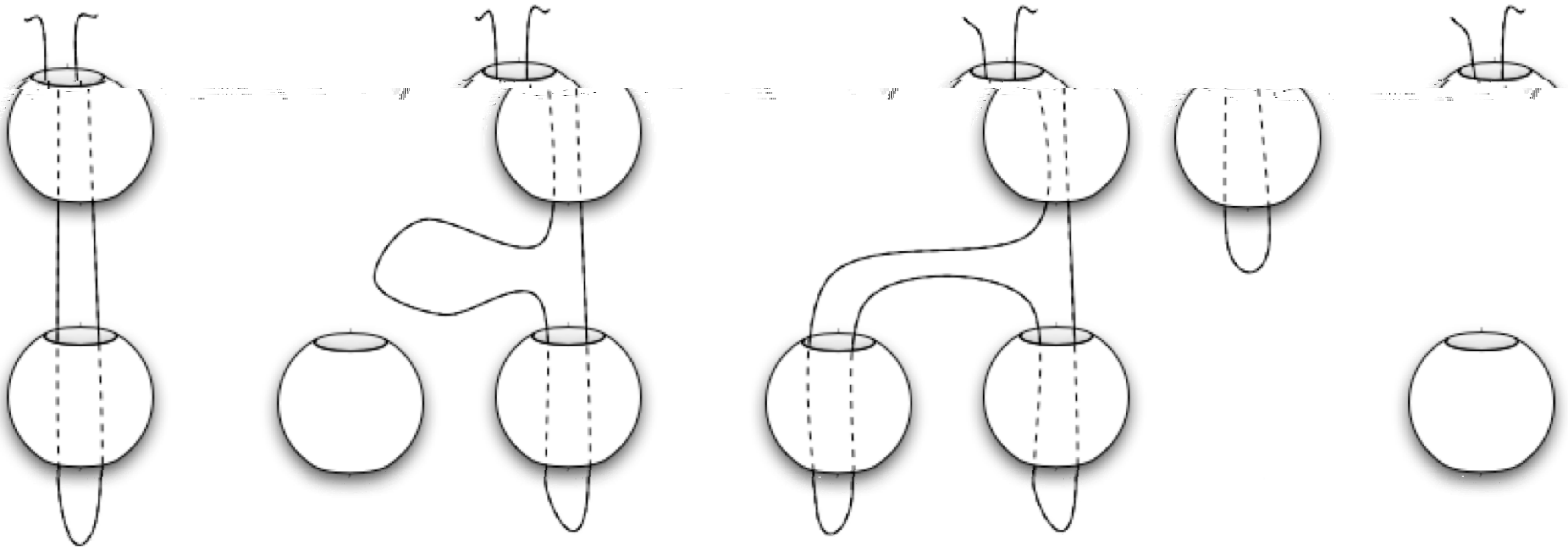
Forest (post-order traversal)



Forest (child traversal)



Forest (insert and erase)



Print as XML

```
template <typename T> // T models Regular
ostream& operator<<(ostream& stream, const forest<T>& x)
{
    typedef typename forest<T>::const_iterator      iterator_t;
    typedef depth_fullorder_iterator<iterator_t>    depth_iterator_t;

    for (depth_iterator_t f(begin(x)), l(end(x)); f != l; ++f)
    {
        for (size_t n(f.depth()); n != 0; --n) stream << "\t";
        stream << (f.edge() ? "<" : "</") << *f << ">" << endl;
    }

    return stream;
}
```

Adobe

Example

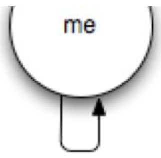
```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```

Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```

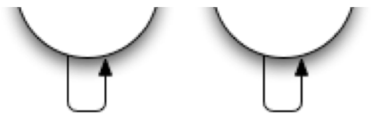
Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```



Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```

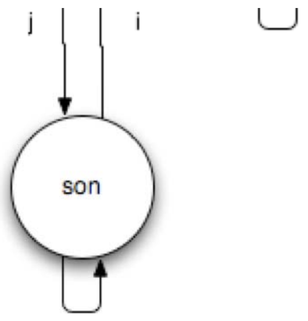


Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```

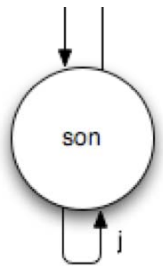
Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```



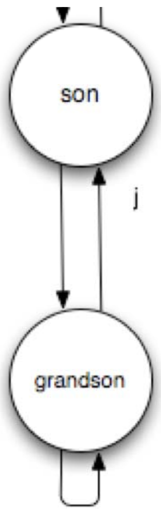
Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```



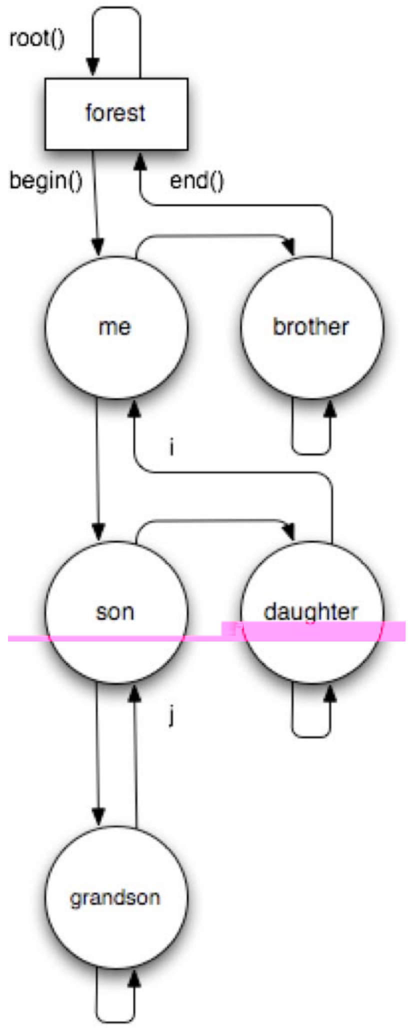
Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```



Example

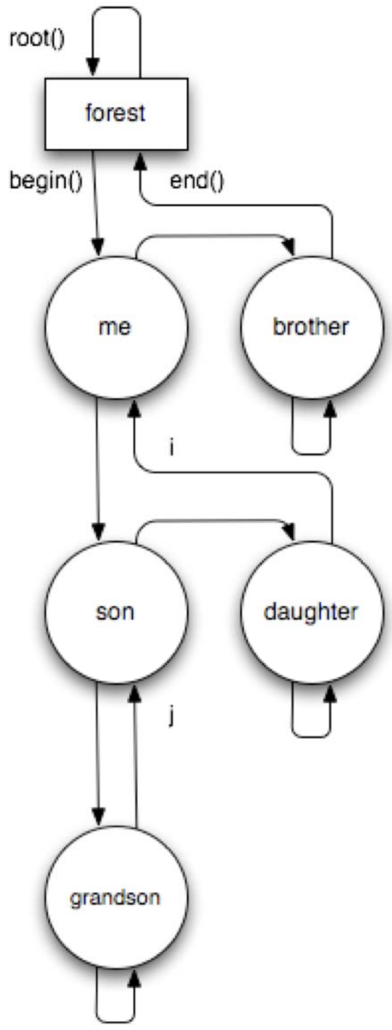
```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```



Example

```
int main()
{
    typedef forest<const char*> forest_t;
    typedef forest_t::iterator  iterator_t;

    forest_t x;

    iterator_t i = x.insert(x.end(), "me");
    x.insert(x.end(), "brother");
    ++i;
    iterator_t j = x.insert(i, "son");
    ++j;
    x.insert(j, "grandson");
    x.insert(i, "daughter");

    cout << x;

    return 0;
}
```

```
<me>
  <son>
    <grandson>
    </grandson>
  </son>
  <daughter>
  </daughter>
</me>
<brother>
</brother>
```



Declarative UI with ASL

- Introduction
  - What a User Interface Is
  - Identifying UI Mechanisms
  - What MVC Is
  - Property Models and Layouts Libraries
  - Modeling the Form
  - Presenting the Form
- Property Model Basics
  - An Overview of The Property Model Syntax
  - CEL expression and the Begin Inspector
  - Invariants & Dependency Tracking
  - Relationships & Logic
- Layout Library Basics
  - An Overview of the Layout Library Syntax
  - Placement and Alignment
  - Spacing, Margins, and Indenting
  - Guides
  - Optional and Panel
- Advanced Topics
  - Scripting and Localization
  - How Layouts Work
    - What you can't do
  - How Property Models Work
    - What you can't do

Adobe

What is a User Interface?

Discussion

What a User Interface Is

- De nition: A ***User Interface*** **(UI) is a system for assisting a user in selecting a function and providing a valid set of parameters to the function.**
- De nition: A ***Graphical User Interface*** **(GUI) is a visual and interactive UI.**

Mechanisms to Assist the User

Discussion

Adobe

UI Mechanisms

- Context
  - Current Document, Selection, Tools, Modal Dialogs
  - Context Provides a Function or One or More parameters to the Function
    - The current item is referred to as the subject
    - The selected function is the verb
- Sentences
  - subject-verb(function)-[object]
  - Drag and Drop, Cut/Copy/Paste
- Constraints
  - Disabled Options, Rejecting Invalid Input, Modality
- Consistency

UI Mechanisms (Continued)

- Interactivity

Tracking:	≈1/30 s
Acknowledge:	≈1/5 s
Confirmation:	≈1 s

- Precognition
  - Specifying Parameters in Terms of Desired Results:
    - Compress this movie to fit on a DVD
    - Scale this image to fit the Page
- Time-Travel
  - Undo, Preview, Non-Destructive Editing
- Metaphors
  - Using knowledge transference

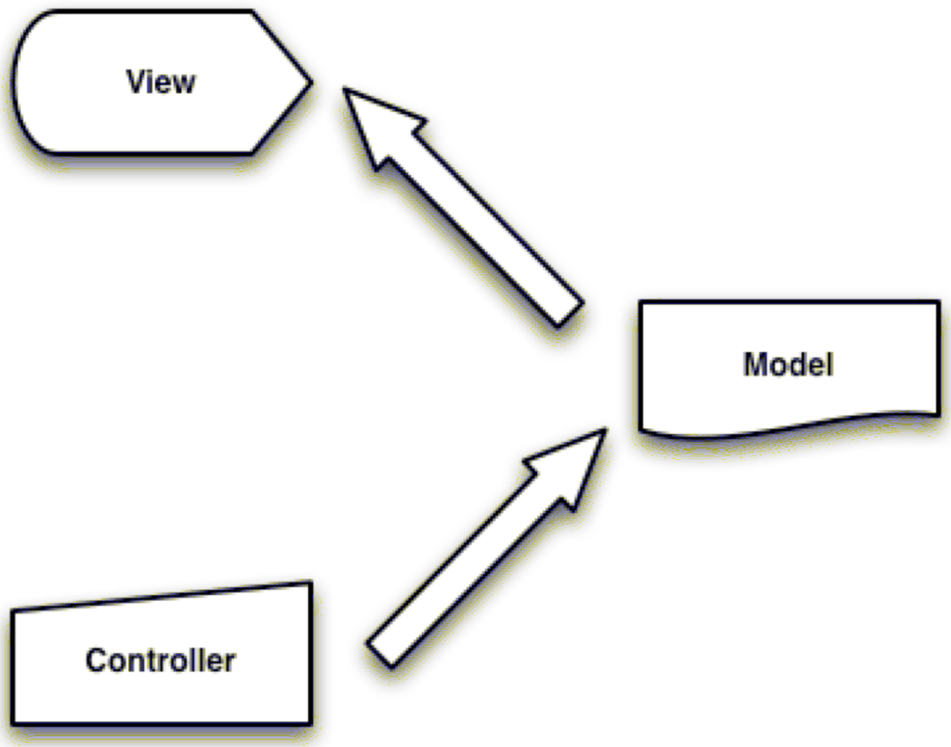
Adobe

Introduction

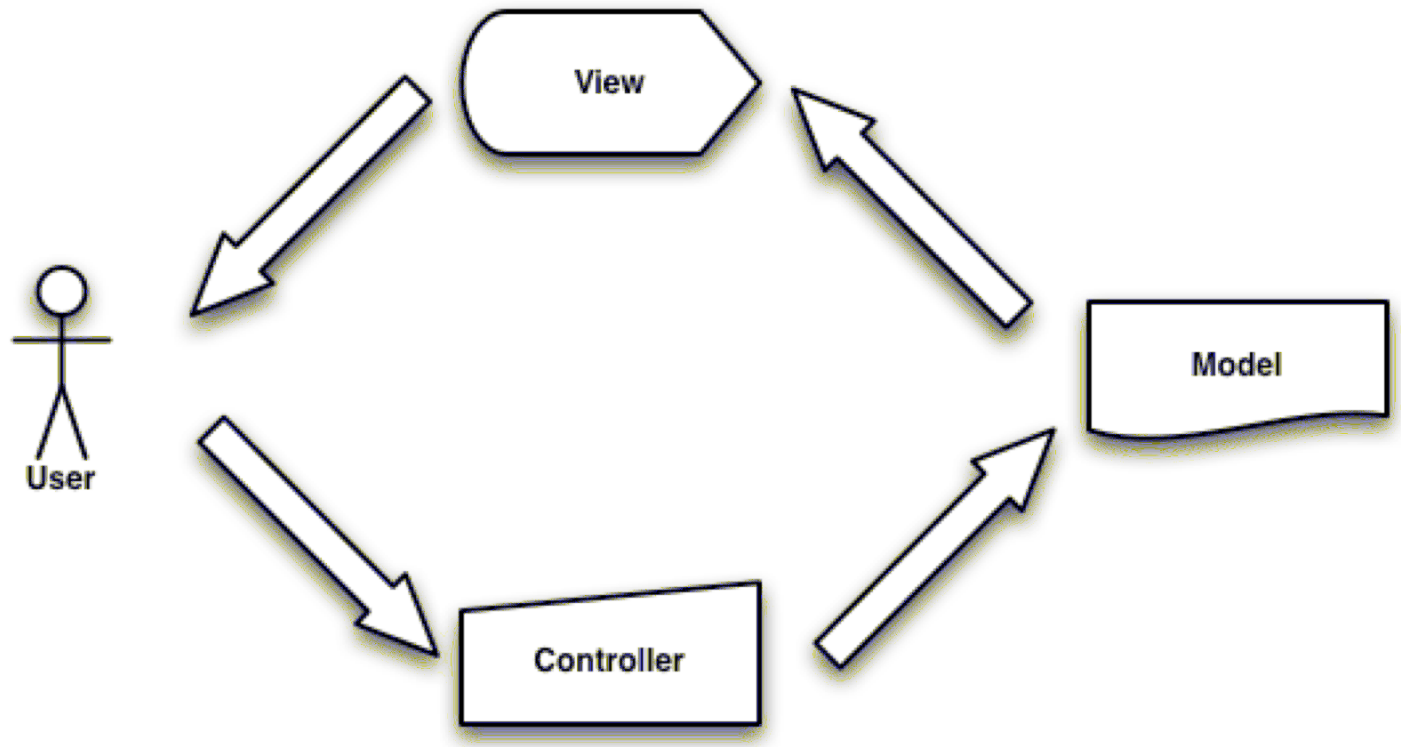
Demo

Model-View-Controller

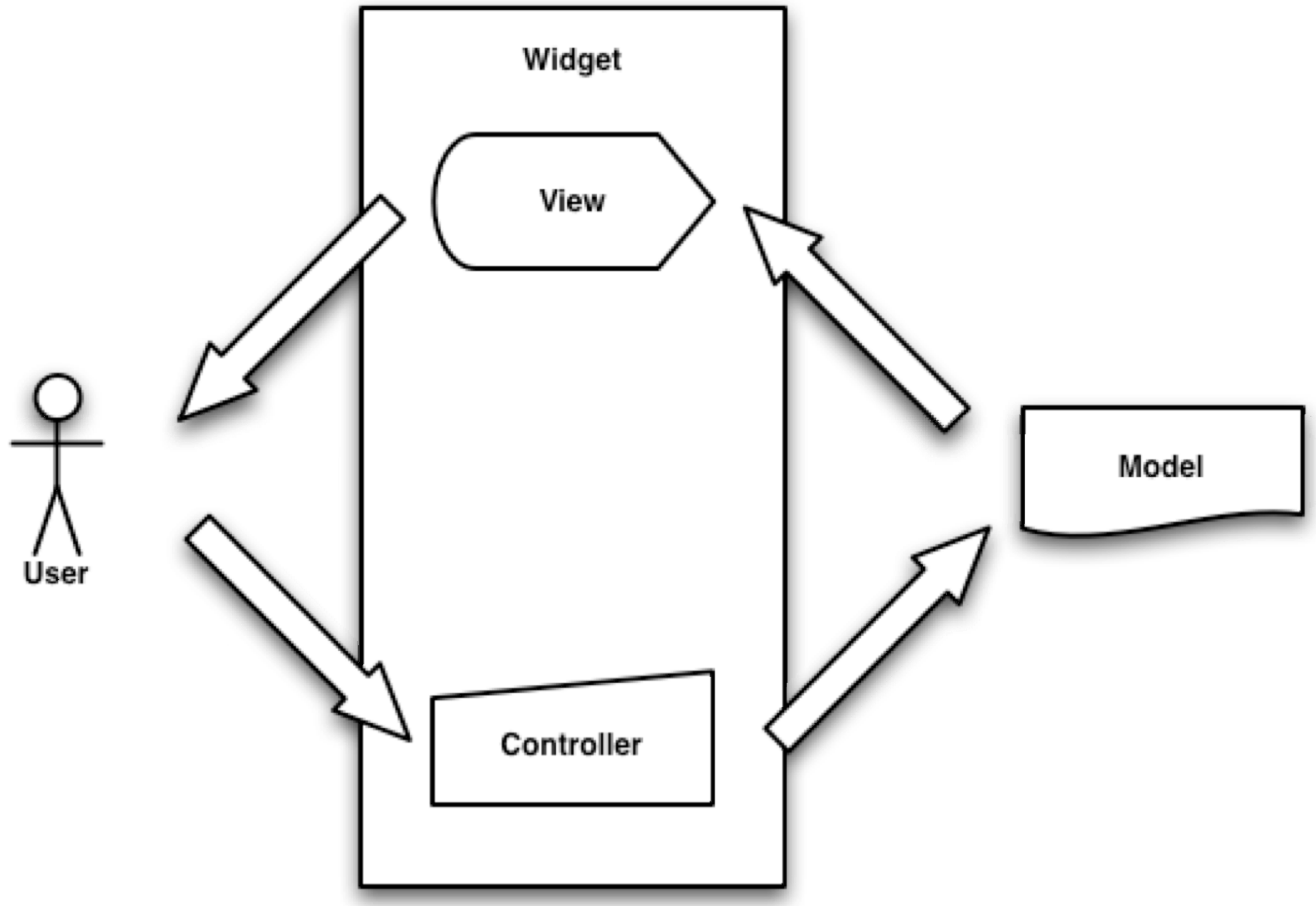
- View & Controller Logically Separate
- Most Descriptions get MVC Wrong - see Design Patterns or Smalltalk, not Apple or Microsoft.
- CMV Would be a Better Term



Model View Controller



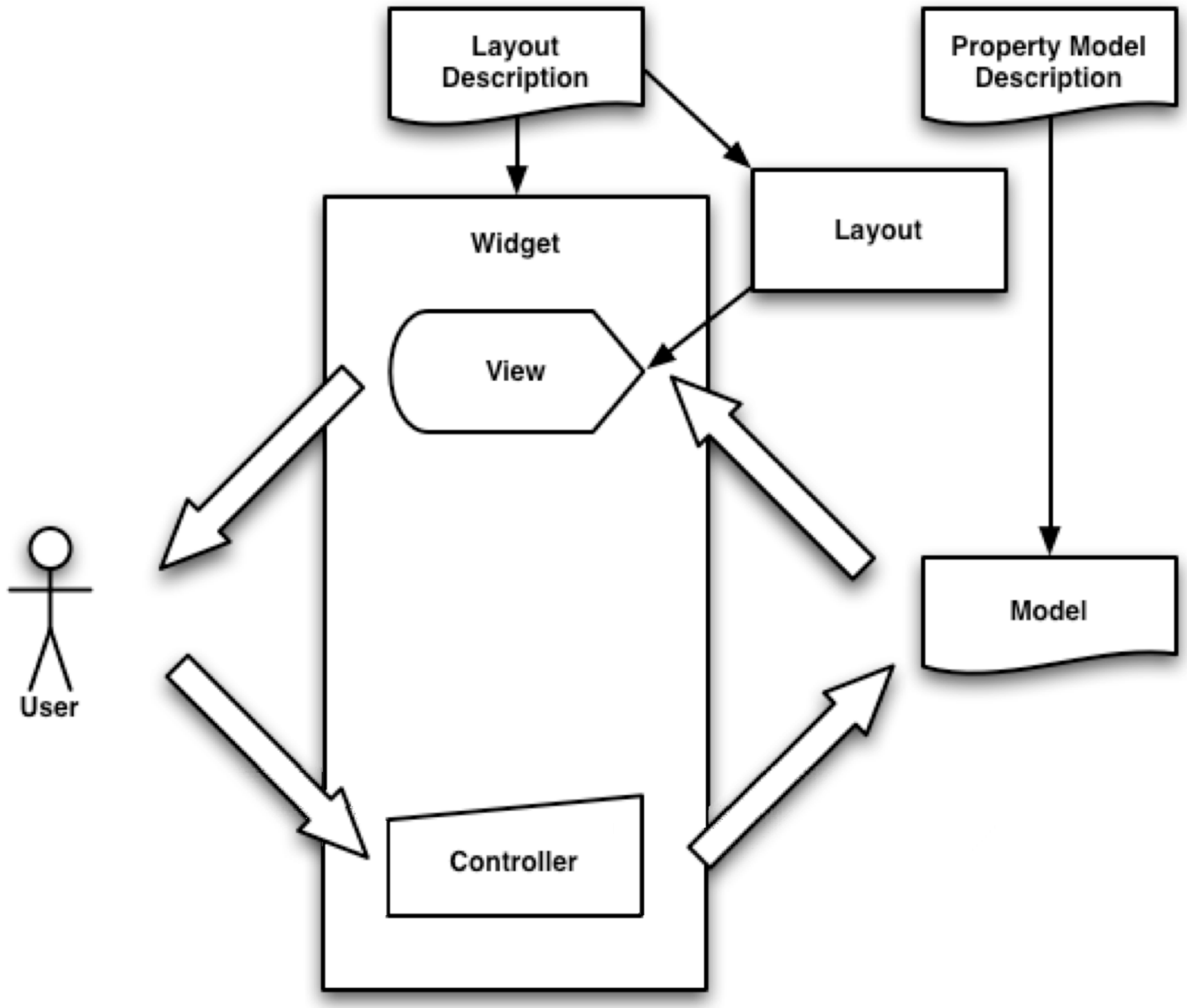
Model-View-Controller



Property Models and Layouts Libraries

- Property Model Library is ***only*** concerned with the model portion
  - It is not the only way to construct a model
- Layout Library is ***only*** concerned with how the view portions are positioned in a coordinate space
- Within our Layout Descriptions we'll also providing ***binding*** to connect the widgets to the model
  - It is important to note that the layout library does not have any built in knowledge about the widgets - we provide a sample set of widgets but they are not complete implementations.

Relation to MVC



Property Model Basics

Property Model Descriptions

```
sheet my_sheet
{
 interface:
    team_1: "Giants";
    team_2: "Patriots";
    score_1: 0;
    score_2: 0;

 output:
    result <== {
        team_1: team_1, team_2: team_2,
        score_1: score_1, score_2: score_2 };
 }
```

Adobe

Property Model Descriptions

- **Interface Cells**
  - **Optional Initializer and Expression**

```
score_1: 0 <== score_2 * 2;
```

- **Output Cells**
  - **Require Expression**

```
result <== [score_1, score_2];
```

CEL Expressions

- **Built-In Data Types**

number:	`-17.3`
string:	`"Hello" ' world!'`
name:	`@identifier`
boolean:	`true`
array:	`[false, "Test", @key]`
dictionary:	`{key_1: "Value", key_2: 10}`
empty:	`empty`

- **Variables and Function**

variable:	`score_1`
function:	`max(10, score_1)`
	`scale(m: base, x: 10, b: offset)`

Adobe

CEL Expressions

- **Operators**

number:	`*, /, +, -`
number:	`<, >, <=, >=`
boolean:	`!, &&, ||`
any:	`==, !=`
array:	`[`*number_expression*`]`
dictionary:	`[`*name_expression*`], .`
any:	*expression* `?` *expression* `:` *expression*
empty:	`empty`

- **C order of Precedence**
- **Example**

```
{ width: 10, height: 20 }[ p ? @width : @height]
```

Property Model Descriptions

- **Invariant Cells**
  - **Requires Boolean Expression**

```
invariant:
    check <== a < b;
```

- **The pre-conditions to a function are an invariant of the functions arguments**

- **Cells that contribute to an invariant are *poison***

- **Cells derived from poison are *invalid***

Adobe

Property Model Descriptions

- **Logic Cells**
  - **Requires Expression**

```
logic:
    rate <== a * b;
```

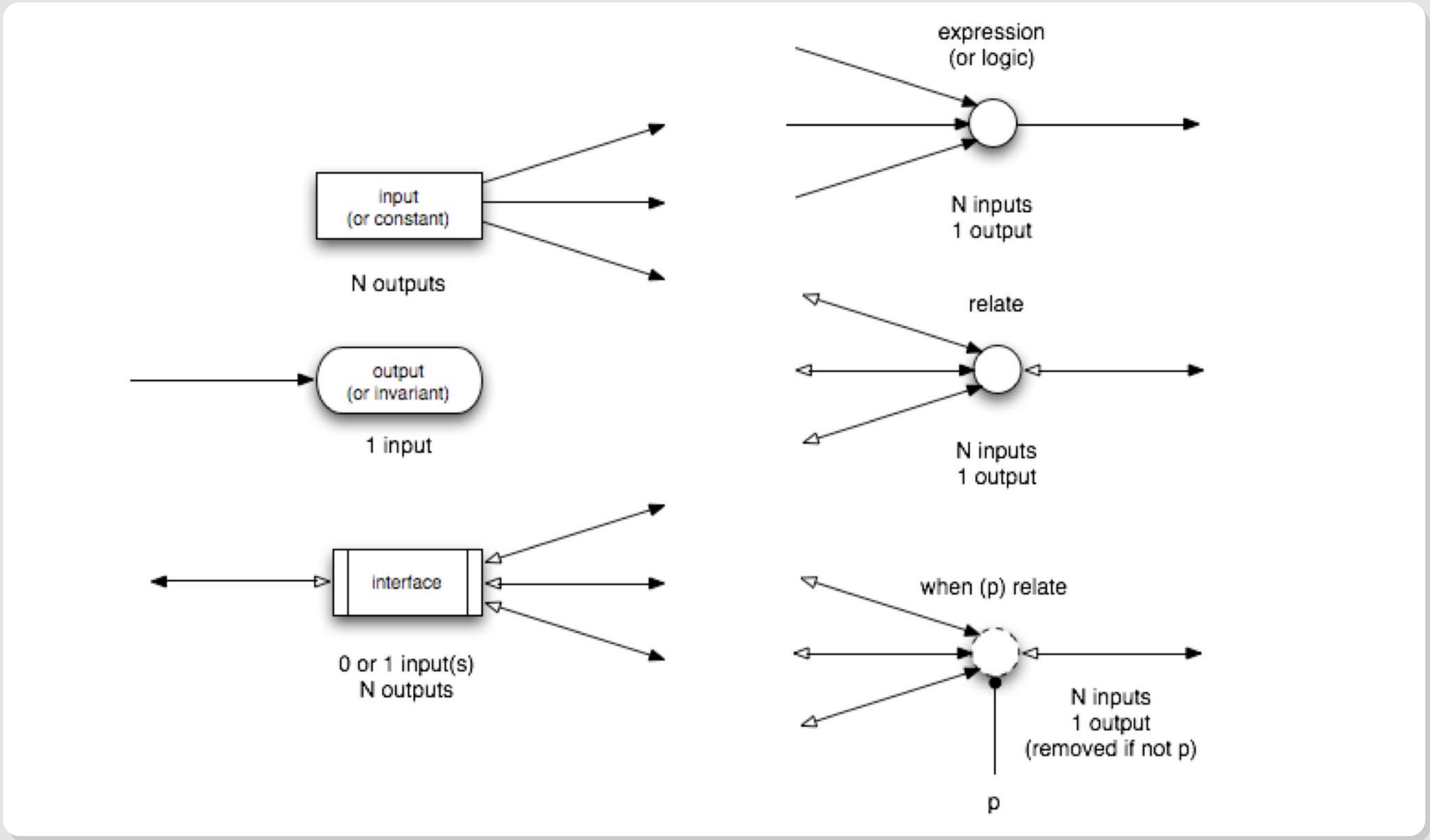
- **A logic cell is simply a named expression**

- **Relate Expression**

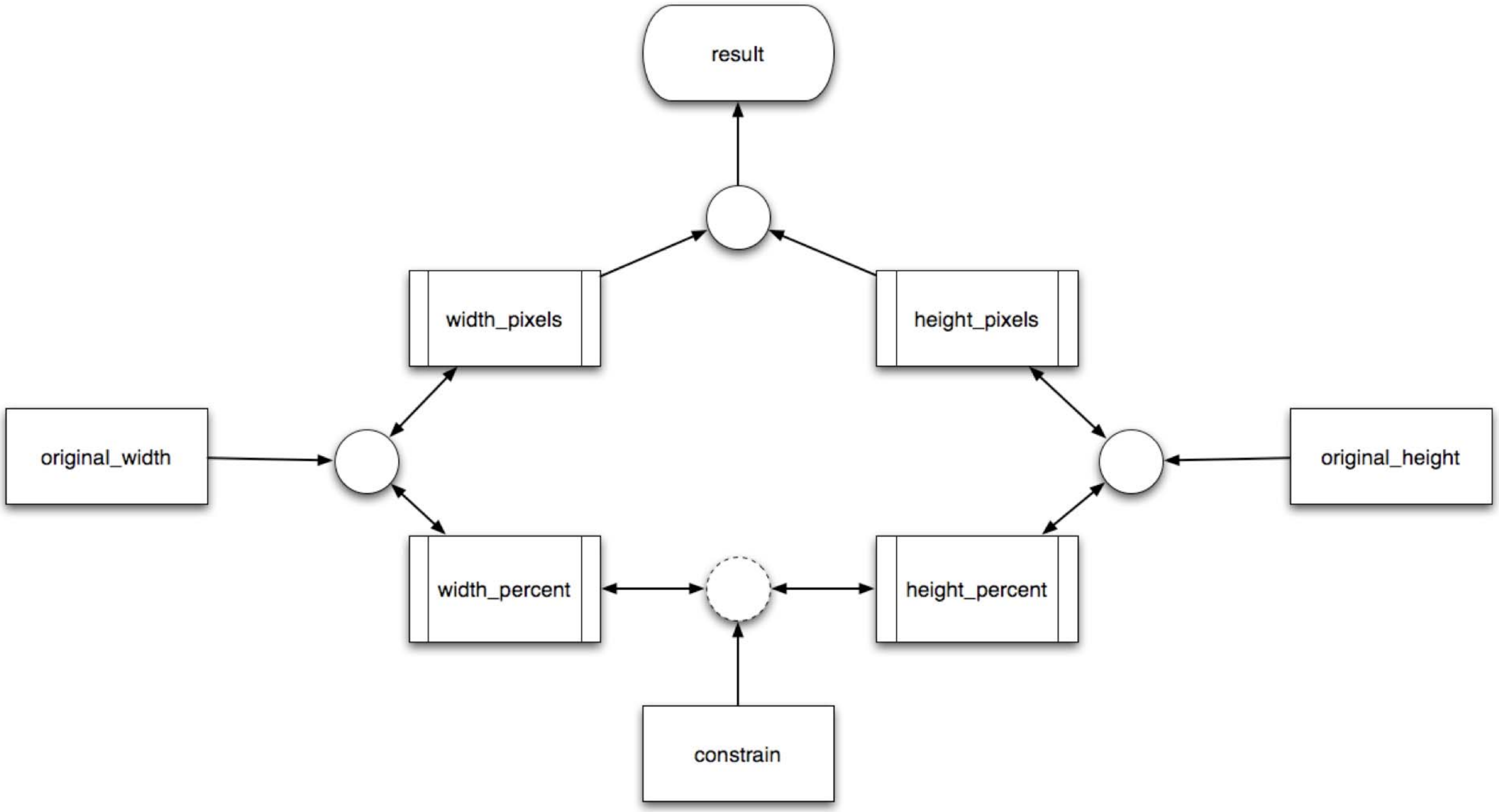
```
logic:
    relate {
        a <== b * c;
        b <== a / c;
        c <== a / b;
    }
```

- **N-Way, Exactly One Expression Is Executed For A Given State**

Visualizing Property Models



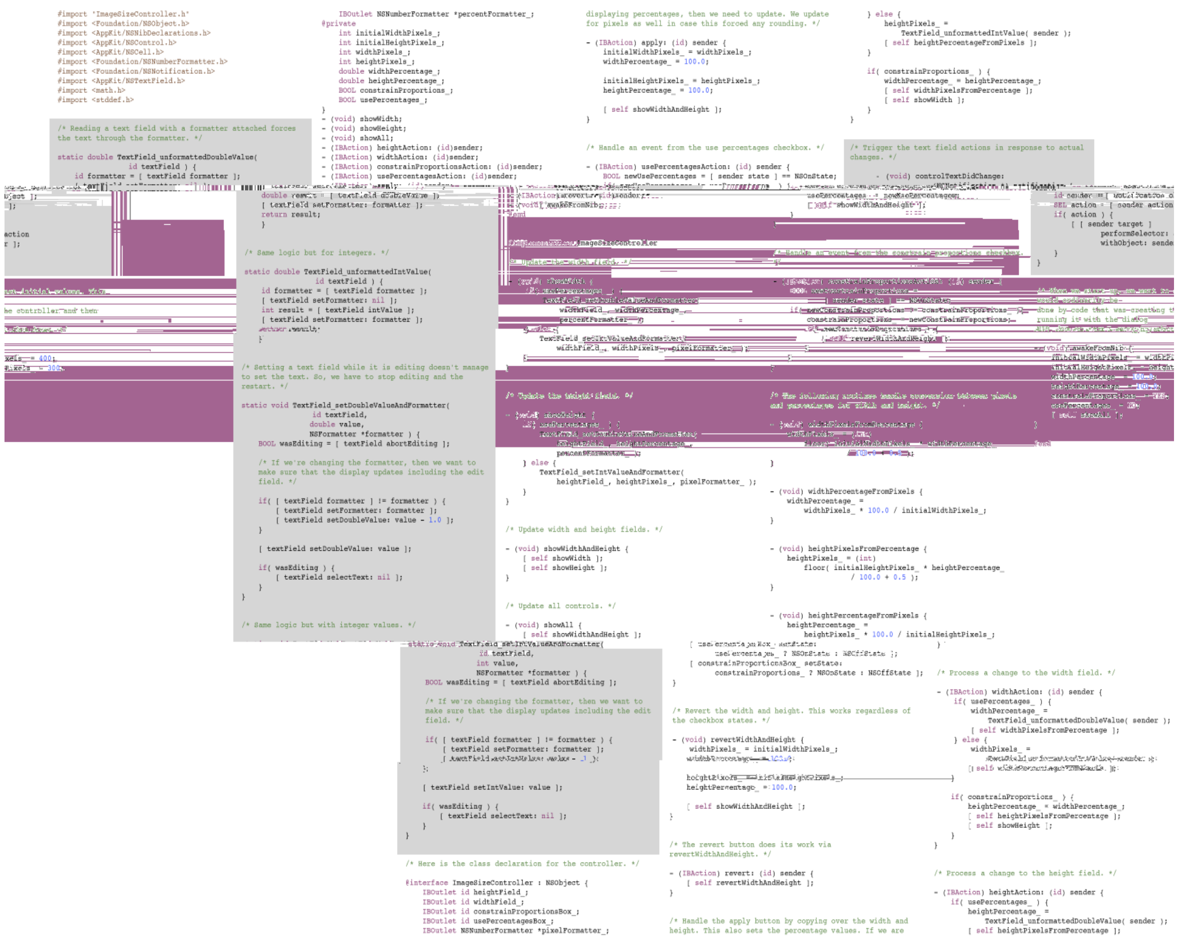
Mini-Image Size Example



Declarative Solution using the Property Model Library

```
sheet mini_image_size
{
 input:
    original_width      : 5 * 300;
    original_height     : 7 * 300;
 interface:
    constrain           : true;
    width_pixels        : original_width     <== round(width_pixels);
    height_pixels       : original_height    <== round(height_pixels);
    width_percent;
    height_percent;
 logic:
    relate {
        width_pixels        <== round(width_percent * original_width / 100);
        width_percent       <== width_pixels * 100 / original_width;
    }
    relate {
        height_pixels       <== round(height_percent * original_height / 100);
        height_percent      <== height_pixels * 100 / original_height;
    }
    when (constrain) relate {
        width_percent       <== height_percent;
        height_percent      <== width_percent;
    }
 output:
    result <== { height: height_pixels, width: width_pixels };
}
```

Imperative Solution to Mini-Image Size



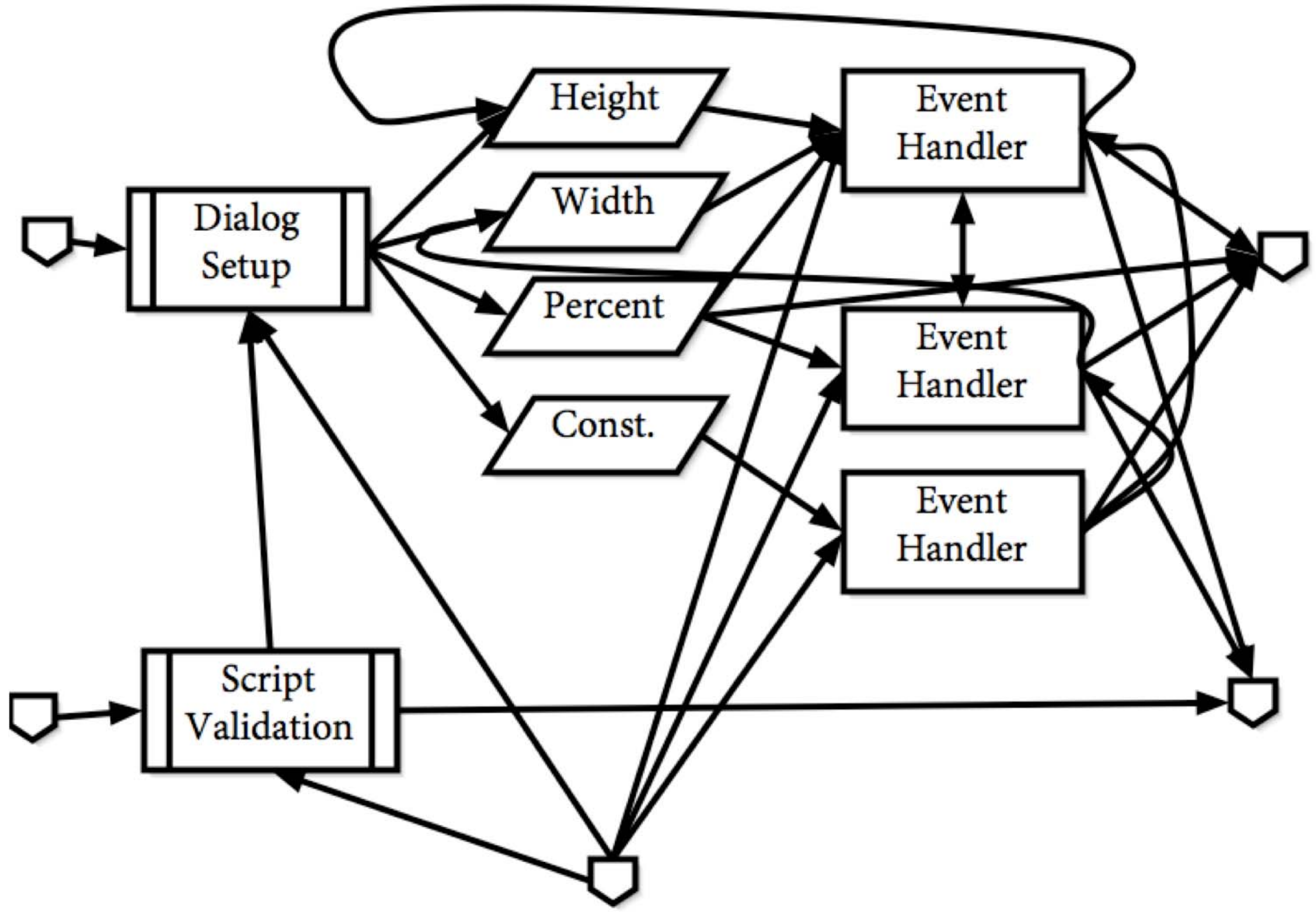
```
#import "ImageSizeController.h"
#import <Foundation/NSObject.h>
#import <AppKit/NSNibDeclarations.h>
#import <AppKit/NSControl.h>
#import <AppKit/NSCell.h>
#import <Foundation/NSNumberFormatter.h>
#import <Foundation/NSNotification.h>
#import <AppKit/NSTextField.h>
#import <math.h>
#import <stddef.h>
```

```
/* Reading a text field with a formatter attached forces
the text through the formatter. */

static double TextField_unformattedDoubleValue(
                id textField ) {
    id formatter = [ textField formatter ];
[illegible]
    double result = [ textField doubleValue ];
    [ textField setFormatter: formatter ];
    return result;
    }


/* Same logic but for integers. */

static double TextField_unformattedIntValue(
                id textField ) {
    id formatter = [ textField formatter ];
    [ textField setFormatter: nil ];
    int result = [ textField intValue ];
    [ textField setFormatter: formatter ];
    return result;
    }


/* Setting a text field while it is editing doesn't manage
to set the text. So, we have to stop editing and the
restart. */

static void TextField_setDoubleValueAndFormatter(
                id textField,
                double value,
                NSFormatter *formatter ) {
    BOOL wasEditing = [ textField abortEditing ];

    /* If we're changing the formatter, then we want to
    make sure that the display updates including the edit
    field. */

    if( [ textField formatter ] != formatter ) {
        [ textField setFormatter: formatter ];
        [ textField setDoubleValue: value - 1.0 ];
    }

    [ textField setDoubleValue: value ];

    if( wasEditing ) {
        [ textField selectText: nil ];
    }
}


/* Same logic but with integer values. */

static void TextField_setIntValueAndFormatter(
                id textField,
                int value,
                NSFormatter *formatter ) {
    BOOL wasEditing = [ textField abortEditing ];

    /* If we're changing the formatter, then we want to
    make sure that the display updates including the edit
    field. */

    if( [ textField formatter ] != formatter ) {
        [ textField setFormatter: formatter ];
        [ textField setIntValue: value - 1 ];
    }

    [ textField setIntValue: value ];

    if( wasEditing ) {
        [ textField selectText: nil ];
    }
}

/* Here is the class declaration for the controller. */

@interface ImageSizeController : NSObject {
    IBOutlet id heightField_;
    IBOutlet id widthField_;
    IBOutlet id constrainProportionsBox_;
    IBOutlet id usePercentagesBox_;
    IBOutlet NSNumberFormatter *pixelFormatter_;
    IBOutlet NSNumberFormatter *percentFormatter_;
@private
    int initialWidthPixels_;
    int initialHeightPixels_;
    int widthPixels_;
    int heightPixels_;
    double widthPercentage_;
    double heightPercentage_;
    BOOL constrainProportions_;
    BOOL usePercentages_;
}
- (void) showWidth;
- (void) showHeight;
- (void) showAll;
- (IBAction) heightAction: (id)sender;
- (IBAction) widthAction: (id)sender;
- (IBAction) constrainProportionsAction: (id)sender;
- (IBAction) usePercentagesAction: (id)sender;
[illegible]
- (IBAction) revert: (id)sender;
- (void) awakeFromNib;
@end
```

```
@implementation ImageSizeController

/* Update the width field. */
[illegible]

/* Update the height field. */

- (void) showHeight {
    if( usePercentages_ ) {
        TextField_setDoubleValueAndFormatter(
            heightField_, heightPercentage_,
            percentFormatter_ );
    } else {
        TextField_setIntValueAndFormatter(
            heightField_, heightPixels_, pixelFormatter_ );
    }
}


/* Update width and height fields. */

- (void) showWidthAndHeight {
    [ self showWidth ];
    [ self showHeight ];
}


/* Update all controls. */

- (void) showAll {
    [ self showWidthAndHeight ];
    [ usePercentagesBox_ setState:
        usePercentages_ ? NSOnState : NSOffState ];
    [ constrainProportionsBox_ setState:
        constrainProportions_ ? NSOnState : NSOffState ];
}


/* Revert the width and height. This works regardless of
the checkbox states. */

- (void) revertWidthAndHeight {
    widthPixels_ = initialWidthPixels_;
    widthPercentage_ = 100.0;

    heightPixels_ = initialHeightPixels_;
    heightPercentage_ = 100.0;

    [ self showWidthAndHeight ];
}


/* The revert button does its work via
revertWidthAndHeight. */

- (IBAction) revert: (id) sender {
    [ self revertWidthAndHeight ];
}


/* Handle the apply button by copying over the width and
height. This also sets the percentage values. If we are
displaying percentages, then we need to update. We update
for pixels as well in case this forced any rounding. */

- (IBAction) apply: (id) sender {
    initialWidthPixels_ = widthPixels_;
    widthPercentage_ = 100.0;

    initialHeightPixels_ = heightPixels_;
    heightPercentage_ = 100.0;

    [ self showWidthAndHeight ];
}


/* Handle an event from the use percentages checkbox. */

- (IBAction) usePercentagesAction: (id) sender {
    BOOL newUsePercentages = [ sender state ] == NSOnState;
[illegible]
        usePercentages_ = newUsePercentages;
        [ self showWidthAndHeight ];
    }
}

/* Handle an event from the constrain proportions checkbox.
[illegible]
```

```
/* The following routines handle conversion between pixels
and percentages for width and height. */

- (void) widthPixelsFromPercentage {
    widthPixels_ = (int)
        floor( initialWidthPixels_ * widthPercentage_
            / 100.0 + 0.5 );
}


- (void) widthPercentageFromPixels {
    widthPercentage_ =
        widthPixels_ * 100.0 / initialWidthPixels_;
}


- (void) heightPixelsFromPercentage {
    heightPixels_ = (int)
        floor( initialHeightPixels_ * heightPercentage_
            / 100.0 + 0.5 );
}


- (void) heightPercentageFromPixels {
    heightPercentage_ =
        heightPixels_ * 100.0 / initialHeightPixels_;
}


/* Process a change to the width field. */

- (IBAction) widthAction: (id) sender {
    if( usePercentages_ ) {
        widthPercentage_ =
            TextField_unformattedDoubleValue( sender );
        [ self widthPixelsFromPercentage ];
    } else {
        widthPixels_ =
            TextField_unformattedIntValue( sender );
        [ self widthPercentageFromPixels ];
    }

    if( constrainProportions_ ) {
        heightPercentage_ = widthPercentage_;
        [ self heightPixelsFromPercentage ];
        [ self showHeight ];
    }
}


/* Process a change to the height field. */

- (IBAction) heightAction: (id) sender {
    if( usePercentages_ ) {
        heightPercentage_ =
            TextField_unformattedDoubleValue( sender );
        [ self heightPixelsFromPercentage ];
    } else {
        heightPixels_ =
            TextField_unformattedIntValue( sender );
        [ self heightPercentageFromPixels ];
    }

    if( constrainProportions_ ) {
        widthPercentage_ = heightPercentage_;
        [ self widthPixelsFromPercentage ];
        [ self showWidth ];
    }
}


/* Trigger the text field actions in response to actual
changes. */

    - (void) controlTextDidChange:
[illegible]
        id sender = [ notification object ];
        SEL action = [ sender action ];
        if( action ) {
            [ [ sender target ]
                performSelector: action
                withObject: sender ];
        }
    }
[illegible]
```

Event Flow in a Simple User Interface



Layout Library Basics

Layout Description

```
layout my_dialog
{
 interface:
   display : true;
 constant:
   dialog_name : "My Dialog";

   view dialog(name: dialog_name) {
      reveal(name: "Display", bind: @display);
      optional(bind: @display) {
         button(name: "OK");
      }
   }
 }
```

Adobe

Placement and Alignment

- **Placement is a container property**
  - placement: place_row, place_column, place_overlay
  - The containers row(), column(), and overlay() are ***non-creating*** containers with the corresponding placement.
- **Alignment is a general property that applies to horizontal and vertical**
  - horizontal: align_left, align_right, align_center, align_proportional, align_□ll
  - vertical: align_top, align_bottom, align_center, align_proportional, align_□ll
- **Alignment of children can be imposed from container**
  - child_horizontal:
  - child_vertical:
- ***Tip: If widgets are stuck top/left, it is likely because the container they are in isn't using align_fill.***

Adobe

Spacing, Margins, Indenting

- Spacing is a container property
  - spacing: number
  - spacing: array
  - The spacing between each element in the container
- Margin is a container property
  - margin: number
  - margin: [top, left, bottom, right]
- Indent is a general property
  - Indent: number
  - The indent applies to the horizontal position of an item in a column and vertical position of an item in a row and is relative to the left or right alignment
- ***Tip: Define meaningful constants for these elements - don't use raw values and don't use to "fake" alignment.***

Guides

- Guides are De□ned By Widgets (Currently)
- There are (Currently) Two Guide Types: @guide_baseline, @guide_label
- Guides Propagation Can Be Suppressed:
  - guide_mask: [@guide_xxxx]
  - The default mask for columns is [@guide_baseline]
- Guides Can Also Be Balanced Within A Container
  - guide_balance: [@guide_xxxx]
- Guides only apply to items which are aligned left/right or top/bottom or □lled. Fill left or right is determined by widget (and may vary by local).
- *Tip: Guides can be allowed to propagate from overlays to get consistent column widths on tab panels.*

Adobe

Optional and Panel

- optional() and panel() are containers whose visibility can be bound
- An optional() container is removed from the layout when hidden
- A panel() remains part of the layout when hidden

- ***Tip: Use panel() with a tab_group(). A tab_group() is like a popup but is also a container that defaults to place_overlay.***

```
tab_group(bind: @x,
          item: [{name: "tab 1", value: @tab_1},
                 {name: "tab 2", value: @tab_2}]) {
   panel(bind: @x, value: @tab_1) { /*…*/ }
   panel(bind: @x, value: @tab_2) { /*…*/ }
}
```

Adobe

Scripting and Localization

- **Contributing values form the basis for intelligent recording**
  - **Di□erence between "□xed" values and contributing captures "intent"**
- **Same model is used for playback - handling all script validation**
- **Model assists script writers in the same way it assists users - letting them specify the parameters in terms they understand**

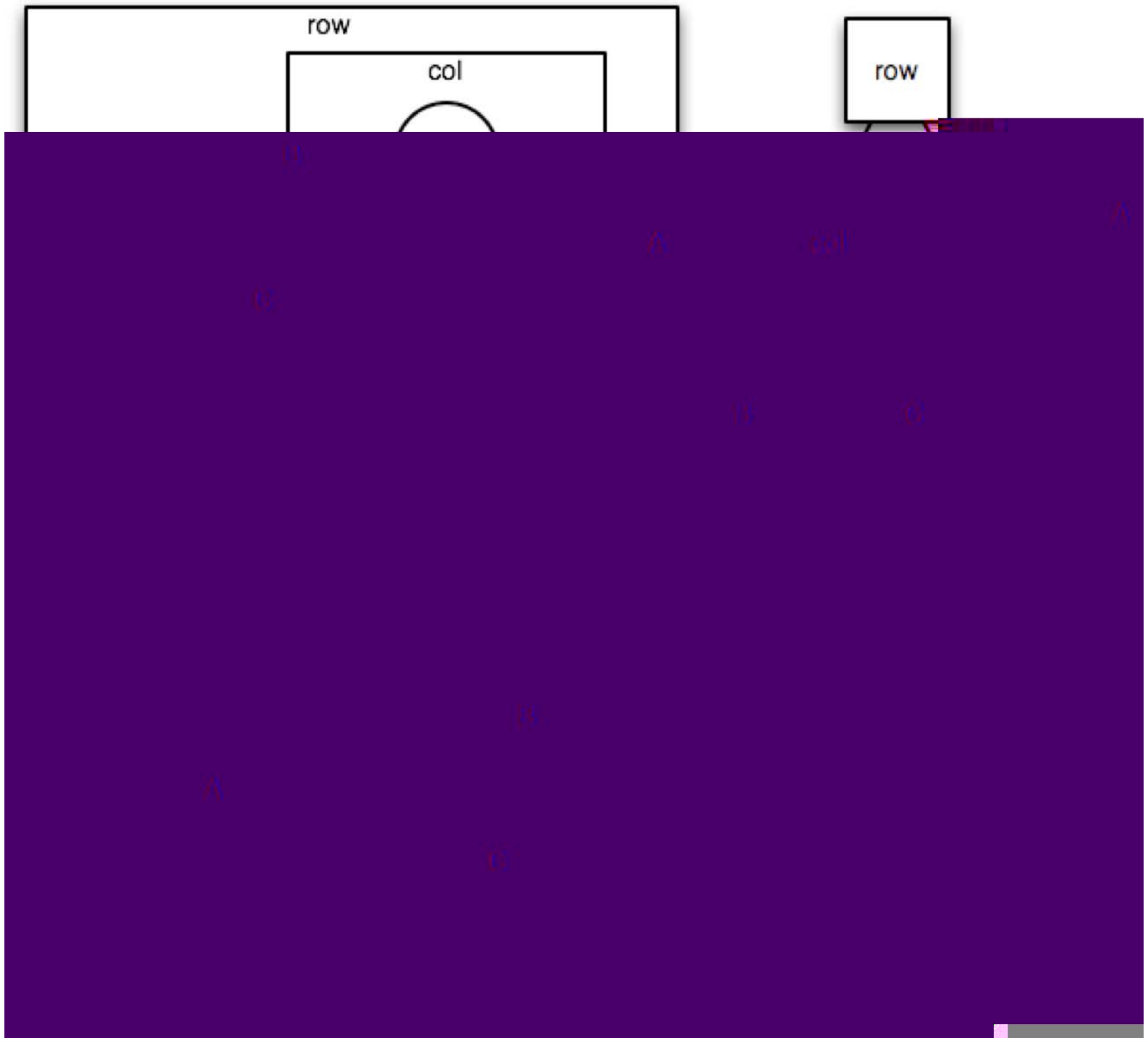
- **ASL contains an experimental xstring library:**

```
button(name: localize("<xstr id='ok'>OK</xstr>"));
```

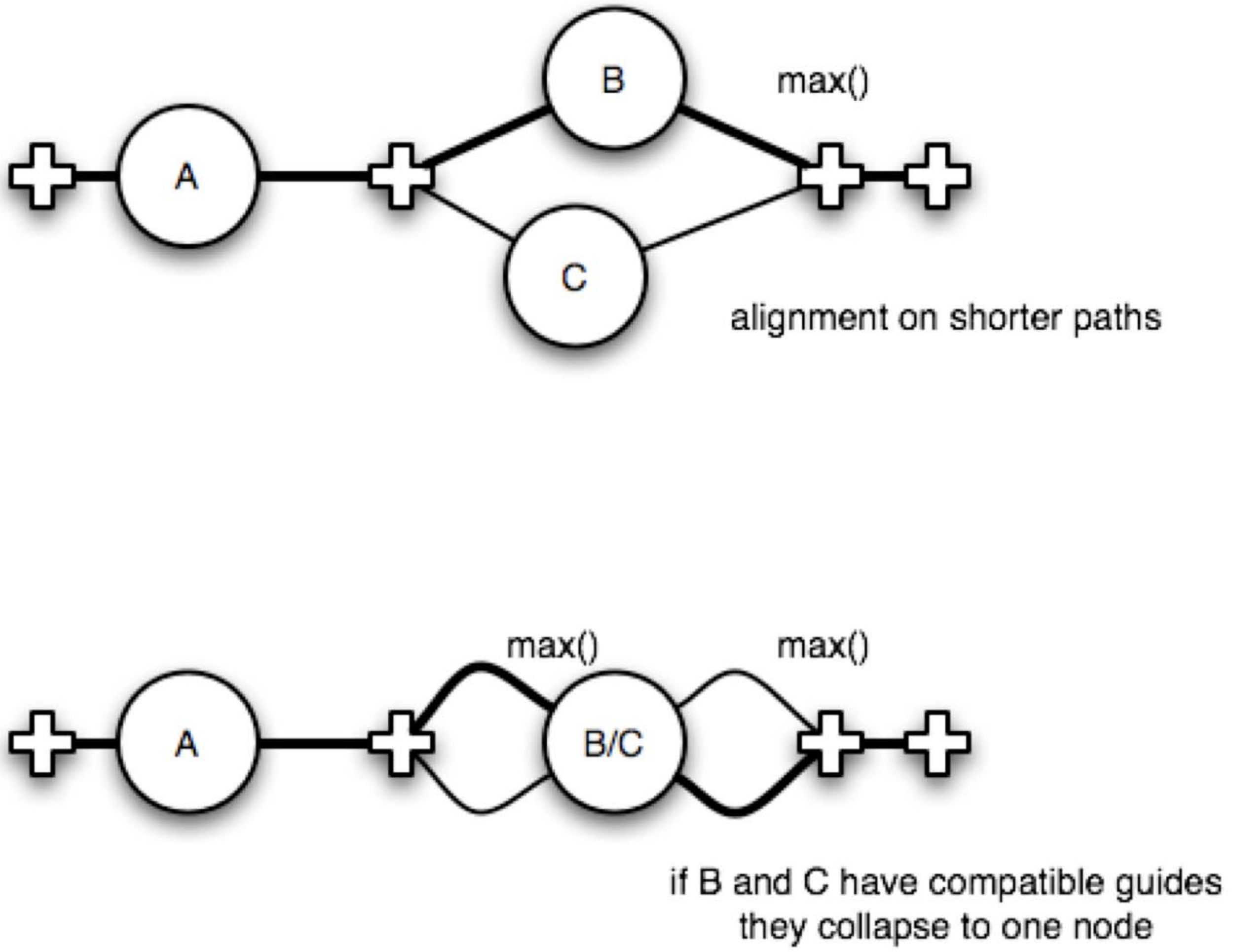
How Layouts Work

- A layout is a container of ***placeable*** objects
- When a description is parsed a hierarchy of placeable objects is stored in the layout
- The basic algorithm is:
  - Gather horizontal metrics of each item in the hierarchy, depth first post order
  - Solve the horizontal layout
  - Gather vertical metrics - providing final horizontal metrics
  - Solve the vertical layout
  - Place each item

How Layouts Work



How Layouts Work


B
max()
A
C
alignment on shorter paths
max()
max()
A
B/C
if B and C have compatible guides
they collapse to one node

How Property Models Work

- A property model is a container of cells, relationships, views and controllers
- When the description is parsed, cells and relationships are added.
- Views and controller are added from the layout description
- Each cell attached to a relationship has a priority as well as a value, priority is usually based on how recently the element changed

How Property Models Work

- The basic algorithm is:
  - Calculate the predicates for any conditional relate clauses
    - Predicates cannot be involved in relate clauses
  - Flow the active relate clauses using the priority on the cells
    - After this point, the □ow will be use to direct calculations
    - Flow and calculate run in opposite directions on the graph.
  - Calculate the invariants
    - If an invariant is false, any reached source is marked as poison
  - Calculate the output expressions
    - Reached sources are marked enabled
    - If a reached source is poison result is marked invalid
  - Calculate any remaining interface cells to which a view is attached

What you can't do

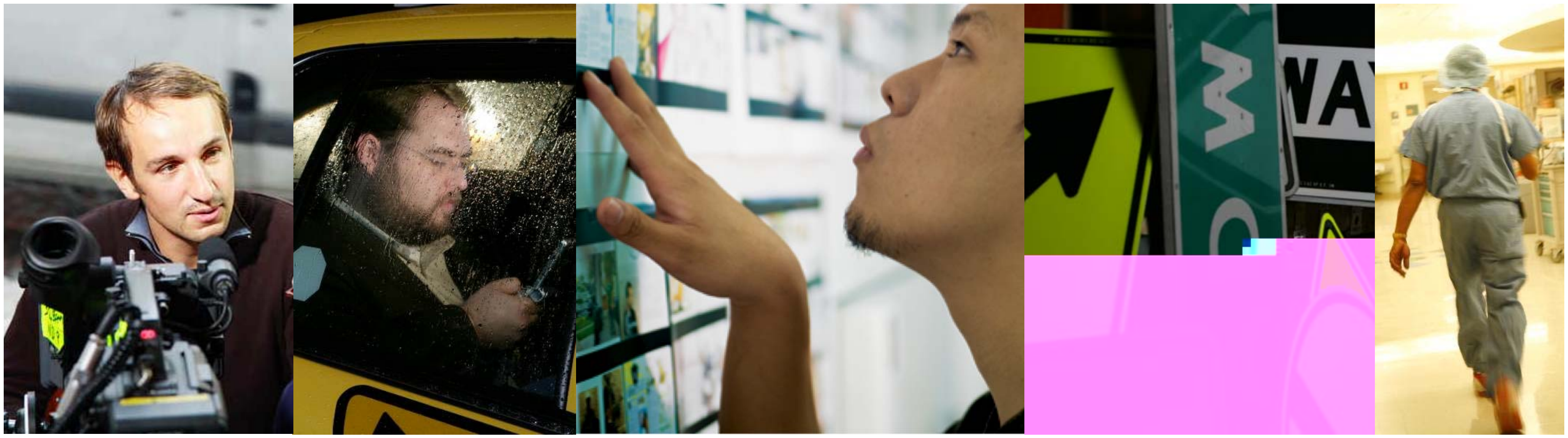
- There are many other types of models that the property model library can't handle - some of the more common ones:
  - Sequences (manipulating lists of elements)
    - Although the property model can describe invariants on the sequence and pre- and post- conditions on the functions that manipulate it.
  - Grammars
    - The property model library is not a parser
  - Triggers - imperative actions
    - There is no way to say "when this ***happens*** do this"
- The property model library cannot handle distributing values (yet)
  - From our exercise - there is no way to construct a UI which given a final score calculates how many tds, field goals, and extra points are needed to reach it.

Adobe

Closing Comments

- **Website http://stlab.adobe.com**
- **Don't be afraid to ask questions - subscribe to our mailing list**
- **Please contribute to ASL - our charter is to improve how software is written - by contributing you will learn and help others**
  - **We prefer *small* contributions - contribute the big functions when they become small functions leveraging the rest of the library**

Adobe



Revolutionizing
how the world engages
with ideas and information

Adobe