Once Upon a Time in CS 581 …

Abstract syntax
Denotational semantics
Types
Lambda calculus

Tools for Language Definition
Domain Analysis
Beacon of Simplicity
Context for this Class

Design a language at least once in your life!

Project focused (very unlike CS 581)

DSLs: evolving, unstructured area

Syntax/Tools vs. Semantics

Modelware vs. Grammarware
1 Introduction

\[ F = ma \]
\[ E = mc^2 \]
I Introduction

What is a DSL?

How to Develop a DSL?

Course Content
PL Concept Hierarchy

Set

Elements: strings over alphabet

Formal Language

Structured Language

Elements: typed trees

Function

Domain: Structured Language

Representations

Domain & Range:

Range: Structured Language

+ Semantics

Domain of Semantics:

Computation

Programming Language

CS 321

CS 521

CS 589

Domain-Specific Languages

CS 581
What is a DSL?

<table>
<thead>
<tr>
<th>L</th>
<th>Formal Language</th>
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<tbody>
<tr>
<td>S</td>
<td>Structured Language</td>
</tr>
<tr>
<td>D</td>
<td>Semantic Domain</td>
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<tr>
<td>[·]</td>
<td>Semantic Function</td>
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</tbody>
</table>

... of strings
... of trees

Set

$S \rightarrow D$

(Turing-complete computation)
Other computation
Non-computation

Semantic Language

$S \oplus [\cdot] : S \rightarrow D$

(General-Purpose) PL

DSL

Short form
Two Notions of Domain-Specificity

Methodological DSLs
- Spreadsheets
- Venn Diagrams
- Dataflow

Topical DSLs
- SQL
- Social Computation

Computation

Structure
- LaTeX
- Haskore
- PFP

Application Domain
- QuickCheck
- Chemical Reactions

Introduction
Example Domain: Chess

Introduction

Many Notations ...

Algebraic
1. e4 e5
2. Nf3 Nf6
3. Bb5 a6
4. Bxc6 dxc6

Descriptive
1. P-K4 P-K4
2. N-KB3 N-QB3
3. B-N5 P-QR3
4. BxN QPxB

ICCF
1. 5254 5755
2. 7163 2836
3. 6125 1716
4. 2536 4736
Example Domain: Music

Many Notations ...
I Introduction

What is a DSL?
How to Develop a DSL?
Course Content
Syntax & Semantics

Many different notations for one domain

Syntax A

Syntax B

Syntax C

Semantic Domain

Most DSL research focuses on notation

What we say to dogs
Okay Ginger! I've had it! You stay out of the garbage! Understand Ginger? Stay out of the garbage, or eat!

What they hear
bleh bleh GINGER bleh bleh bleh bleh bleh bleh
3 Methodological Levels

Topical
- Understanding
- Modeling
- Implementing

Technical

- Interview experts, Collect examples, Identify goals, Study existing notations, ...
- Syntax vs. Semantics First
- Metalanguage
- Degree of Completeness, External vs. Internal DSL, Shallow vs. Deep Embedding, ...

Haskell
Introduction

Elegance
Expressiveness
Usability

Interview experts,
Collect examples,
Identify goals,
Study existing notations, ...

Modeling

Creation

Understanding

Implementing

Evaluation

Elegance
Expressiveness
Usability

Semantics First in Haskell
Prototype as a Shallow Internal DSL
I Introduction

What is a DSL?

How to Develop a DSL?

Course Content
Class Topics

Understanding

Domain Analysis
- Domain Decomposition
- Domain Modeling

Semantics First
- Micro DSL & Domain Integration Syntax
- Language Operators
- Deep/Shallow Embedding
- Monadic DSLs
- Bindings
- Data Types, Type Classes, Monads

Modeling/Implementing

Midterm

Evaluation

Cognitive Dimensions

Usability

Examples

Introduction