Anatomy of Lisp

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The Considered life

“The unconsidered life is not worth living.”

— Socrates

“That language is an instrument of human reason, and not merely a medium for the expression of thought, is a truth generally admitted.”

— George Boole
What Is The Right Tool?

1. **Memory management**: garbage collection
2. **Object oriented**: modularity and encapsulation
3. **Egalitarianism**: first class everything
4. **Libraries**: great stdlib, powerful third-party facilities
5. **Introspection**: program available as data
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The Bottom Line

1. Lisp is a dynamic language as it grows to meet your needs
2. Lisp is a programmable programming language
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2. Lisp is a programmable programming language.
3. Lisp is for doing what you’ve been told is impossible.
“Lisp is the greatest single programming language ever designed.”

— Alan Kay
**Question:** What is XML?

XML is standardized syntax used to express arbitrary hierarchical data.

To-do lists, web pages, medical records and config files are all examples of XML use.
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To-do lists, web pages, medical records and dconfig files are all examples of XML use.
Let’s use an example to-do list:

```xml
<todo name="housework">
  <item priority="high">Clean the house.</item>
  <item priority="medium">Wash the dishes.</item>
  <item priority="medium">Buy more soap.</item>
</todo>
```
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What happens if we submit this list to an XML parser? ... Once the data is parsed, how is it represented in memory?

The most natural representation is as a tree.

Anything that can be represented as a tree, can be represented in XML, and vice-versa.
A To-do List

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**Question:** What other type of data is often represented as a tree?

Any compiler inevitably parses the source code into an abstract syntax tree.

This shouldn’t surprise you: source code is hierarchical.
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This shouldn’t surprise you: source code is hierarchical.
If all source code is a tree, and any tree can be represented as XML:

```c
An example ‘add’ function

```int add(int arg1, int arg2)
{
    return arg1 + arg2;
}
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XML ‘add’ function

Can you convert that function to an XML equivalent?

An example ‘add’ function

```xml
<define-function return-type="int" name="add">
  <arguments>
    <argument type="int">arg1</argument>
    <argument type="int">arg2</argument>
  </arguments>
  <body>
    <return>
      <add value1="arg1" value2="arg2"/>
    </return>
  </body>
</define-function>
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Classify our XML ‘add’ function: is it **data**? **code**?

We could easily write a small interpreter for this XML code and we could execute it directly.

It’s data . . . and code.
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It’s data . . . and code.
We’ve arrived at the following interesting point:

We now know that code is always data.
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XML Is Flexible

Ant takes an XML file with specific build instructions and interprets them.

A simple XML instruction causes a Java class to be executed:

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<copy todir="../new/dir">
  <fileset dir="src_dir"/>
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XML Is Powerful

That snippet copies a source directory to a destination directory.

Ant acts as an interpreter for a language that uses XML as its syntax.

Ant translates XML elements to appropriate Java instructions.
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What is the **advantage** of using interpreted XML over simple Java code?

XML has the property of being flexible when introducing semantic constructs.
Why XML?

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XML has the property of being flexible when introducing **semantic constructs**.
A Semantic Construct

Can we represent the ‘copy’ example above in Java?

An Ant instruction

CopyTask copy = new CopyTask();
Fileset fileset = new Fileset();

fileset.setDir("src_dir");
copy.setToDir("../new/dir");
copy.setFileset(fileset);

copy.execute();
An Ant instruction

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Fileset fileset = new Fileset();

fileset.setDir("src_dir");
copy.setToDir("../new/dir");
copy.setFileset(fileset);

copy.execute();
That code was almost the same as the original XML.

**Question:** What's different?

**Answer:** the XML snippet introduces a special semantic construct for copying.
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A Special Operator

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Hypothetical Java

If we could do it in Java, it would look like this:

```java
This Java Isn't Feasible

copy("..\new\dir")
{
    fileset("src_dir");
}
```
Hypothetical Java

If we could do it in Java, it would look like this:

```java
copy("../new/dir")
{
    fileset("src_dir");
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About That Implementation

We could extend the Java language to introduce an operator for copying files.

We would do this by modifying the AST grammar that the Java compiler accepts.

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Why not extend Ant, in Ant itself?

If Ant provided constructs to develop tasks in Ant itself we’d reach a higher level of abstraction.
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Consider the possibility:

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```xml
<task name="Test">
  <echo message="Hello World!">
  </echo>
</task>
<Test />
```

If we could write a “task” task in Java and make Ant able to extend itself using Ant-XML!
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Ant Tasks

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If we could write a “task” task in Java and make Ant able to extend itself using Ant-XML!
Oh, by the way, you’re looking at Lisp code.
Self-extending Ant wouldn’t be useful.

The reason for this is XML’s verbosity.

The solution to this problem involves using a less verbose alternative to XML.
Why Not XML

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Symbolic Expressions

We don’t have to use XML’s angle brackets to represented trees.

We could use other formats.

One such format is called a symbolic expression.

S-expressions accomplish the same goals as XML.
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lisp implementation of 'copy'

(copy
  (todir "../new/dir")
  (fileset (dir "src_dir")))
Lisp ‘copy’

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Lisp Representation

What’s different with our Lisp representation?

- angled brackets seem to be replaced by parens
- dispense of unnecessary ‘(/element)’
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- angled brackets seem to be replaced by parens
- dispense of unnecessary ‘/element’
Let’s look at our ‘task’ code in something that looks like Lisp:

```lisp
(task (name "Test")
  (echo (message "Hello World!")))
(Test)
```
A Lisp ‘task’

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(task (name "Test")
  (echo (message "Hello World!")))
```

(Test)
Welcome To Lisp

S-expressions are called lists in Lisp lingo.

The Lisp code above is a tree, implemented via a Lisp list.

Welcome to Lisp, you’ll enjoy your stay.