

# **axle**

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# Typical CS Abstractions

Set, Relation, Graph

Chomsky Hierarchy (Regex, CFG, ...)

...

Lattice

...

Monad

Category

# Monoids

Scalaz's Nick Partridge derives  
Monoid, Foldable, and more at  
[vimeo.com/10482466](https://vimeo.com/10482466)



[learnyouahaskell.com](http://learnyouahaskell.com)

# Post-Monoid

Nov 12, 2012 Oscar Boykin and Sam Ritchie took questions about Algebird at [Cascading meetup](#) (Twitter)

February 2013 “Life After Monoids” Tom Switzer (NE Scala) [youtube.com/watch?v=xO9AoZNSOH4](https://youtube.com/watch?v=xO9AoZNSOH4)

August 2014 “Reasoning with Types” Adelbert Chang (Scala by the Bay) [youtube.com/watch?v=TbASMeJSh9s](https://youtube.com/watch?v=TbASMeJSh9s)

# Algebra: MacLane & Birkhoff

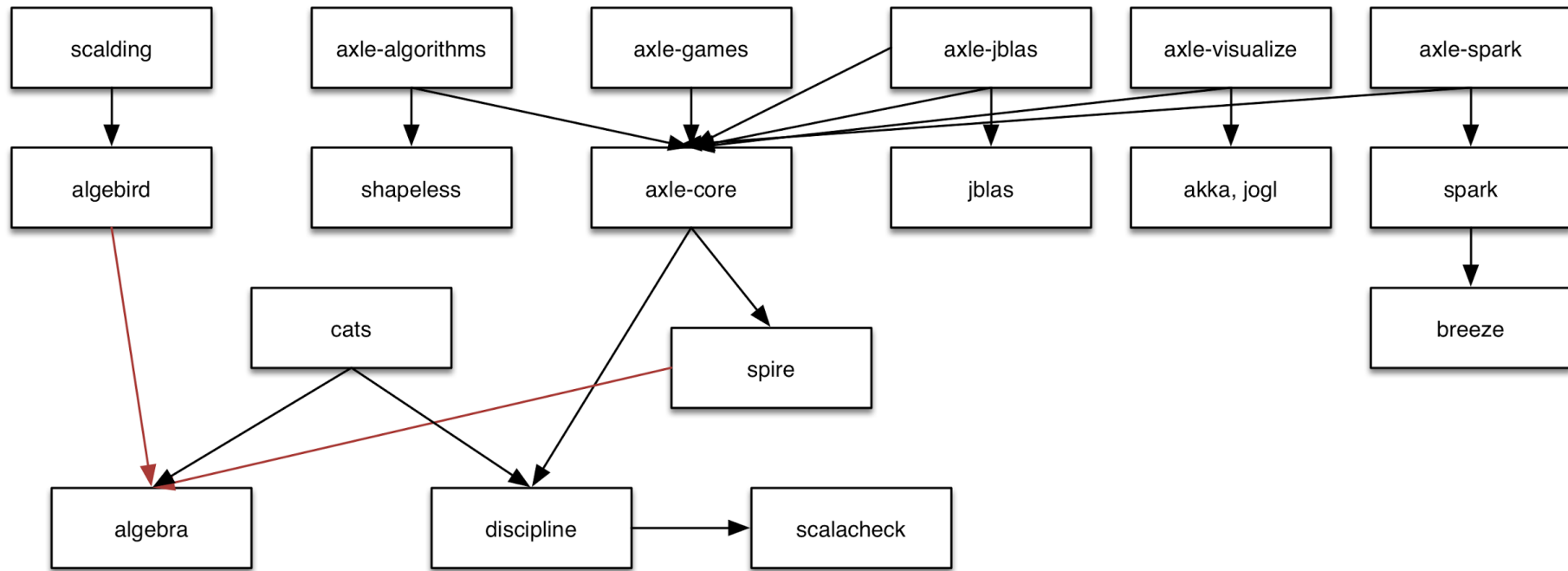
- I. Sets, Functions, and Integers
- II. Groups
- III. Rings
- IV. Universal Constructions
- V. Modules
- VI. Vector Spaces
- VII. Matrices
- VIII. Special Fields
- IX. Determinants and Tensor Products
- X. Bilinear and Quadratic Forms
- XI. Similar Matrices and Finite Abelian Groups
- XII. Structure of Groups
- XIII. Galois Theory
- XIV. Lattices
- XV. Categories and Adjoint Functors
- XVI. Multilinear Algebra

Structure	Composed of	Examples
Semigroup	an associative binary operator	Integer +, string concat
Monoid	a semigroup with identity element	(+, 0), (*, 1), (concat, "")
Group	a <b>set</b> of <b>elements</b> together with an <b>operation</b> that combines any two elements to form a third element. The operation satisfies <b>closure</b> , <b>associativity</b> , <b>identity</b> and <b>invertibility</b> .	Integer + Rubik's Cube group
Abelian Group	a <b>group</b> in which the result of applying the group <b>operation</b> to two group elements does not depend on their order	Integer +
Ring	an <b>abelian group</b> with a second <b>binary operation</b> that is associative, is <b>distributive</b> over the abelian group operation and has an identity element	2x2 matrix + and *
Field	a <b>nonzero commutative ring</b> that contains a <b>multiplicative inverse</b> for every <b>nonzero</b> element	(+, -, *, /) for $\mathbb{R}$ , $\mathbb{C}$ , and $\mathbb{Q}$
Vector Space	a collection of objects called <b>vectors</b> , which may be <b>added</b> together and <b>multiplied</b> ("scaled") by numbers, called <b>scalars</b> in this context	$\mathbb{R}^2$

# Diverse Algorithms

Units of Measurement	Algebra
Machine Learning	Games
Visualization	Statistics
Probabilistic Graphical Models	Bioinformatics
Natural Language Processing	...

# Diverse Platform





# Docs (axle-lang.org)

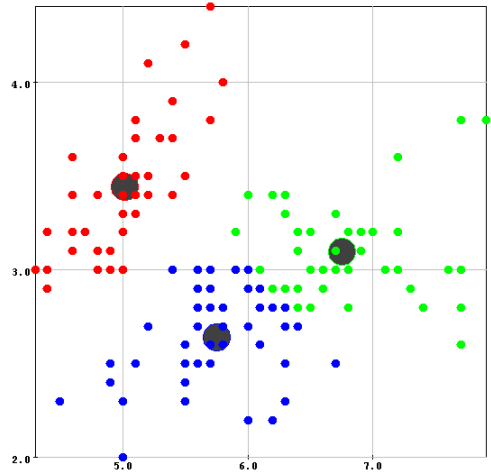
```
6 val classifier = KMeans[Iris, List, DoubleMatrix](
7   irises,
8   2,
9   (iris: Iris) => List((iris.sepalLength in cm).magnitude.toDouble, (iris.sepalWidth in cm).magnitude.),
10  (PCAFeatureNormalizer[DoubleMatrix] _).curried.apply(0.98),
11  (features: Seq[Double]) => Iris(1 *: cm, 1 *: cm, 1 *: cm, 1 *: cm, ""),
12  K = 3,
13  iterations = 20)
```

Produce a "confusion matrix"

```
1 import axle.ml.ConfusionMatrix
2 import spire.implicit.IntAlgebra
3
4 val confusion = ConfusionMatrix[Iris, Int, String, Vector, DoubleMatrix](classifier, irises.toVector, _
5
6 string(confusion)
```

```
1 49 0 : 50 Iris-setosa
34 0 16 : 50 Iris-versicolor
16 0 34 : 50 Iris-virginica

51 49 50
```



# ... and ...

Correct	Some ScalaCheck properties (to be organized with Discipline)
Complete	20k lines of code, but lots of “???” yet
Fast	No benchmarking yet
Diverse Data	A few small datasets available in axle.data

# Feedback welcome!

@axlelang

axle-lang.org

@pingel

gitter.im/axlelang/axle

github.com/axlelang/axle

“org.axle-lang” %% “axle-core” % “0.2.0-SNAPSHOT”