Formal Methods in the Enterprise

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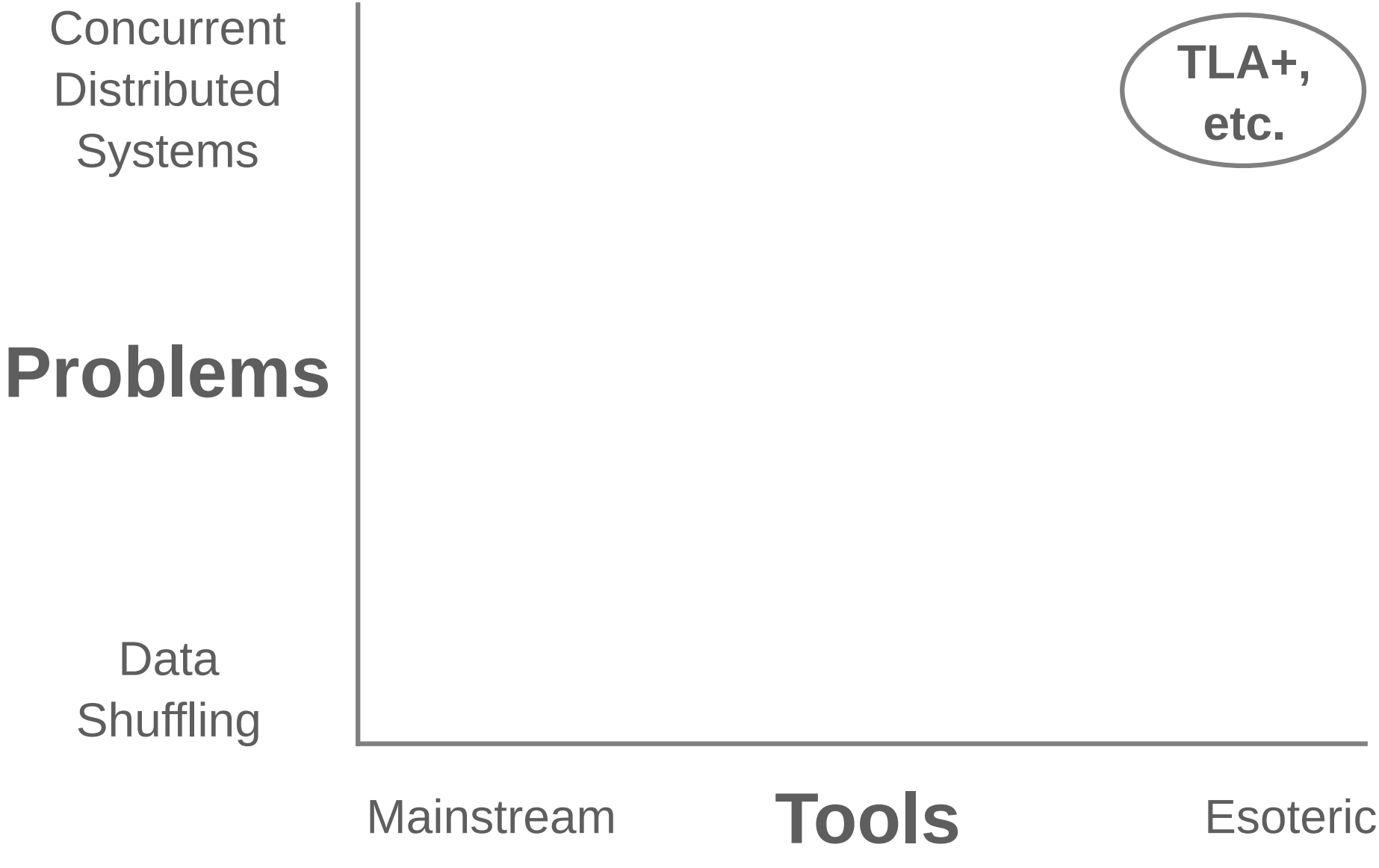
TLA+ Conf 2024
Monday, April 15, 2024
Seattle, USA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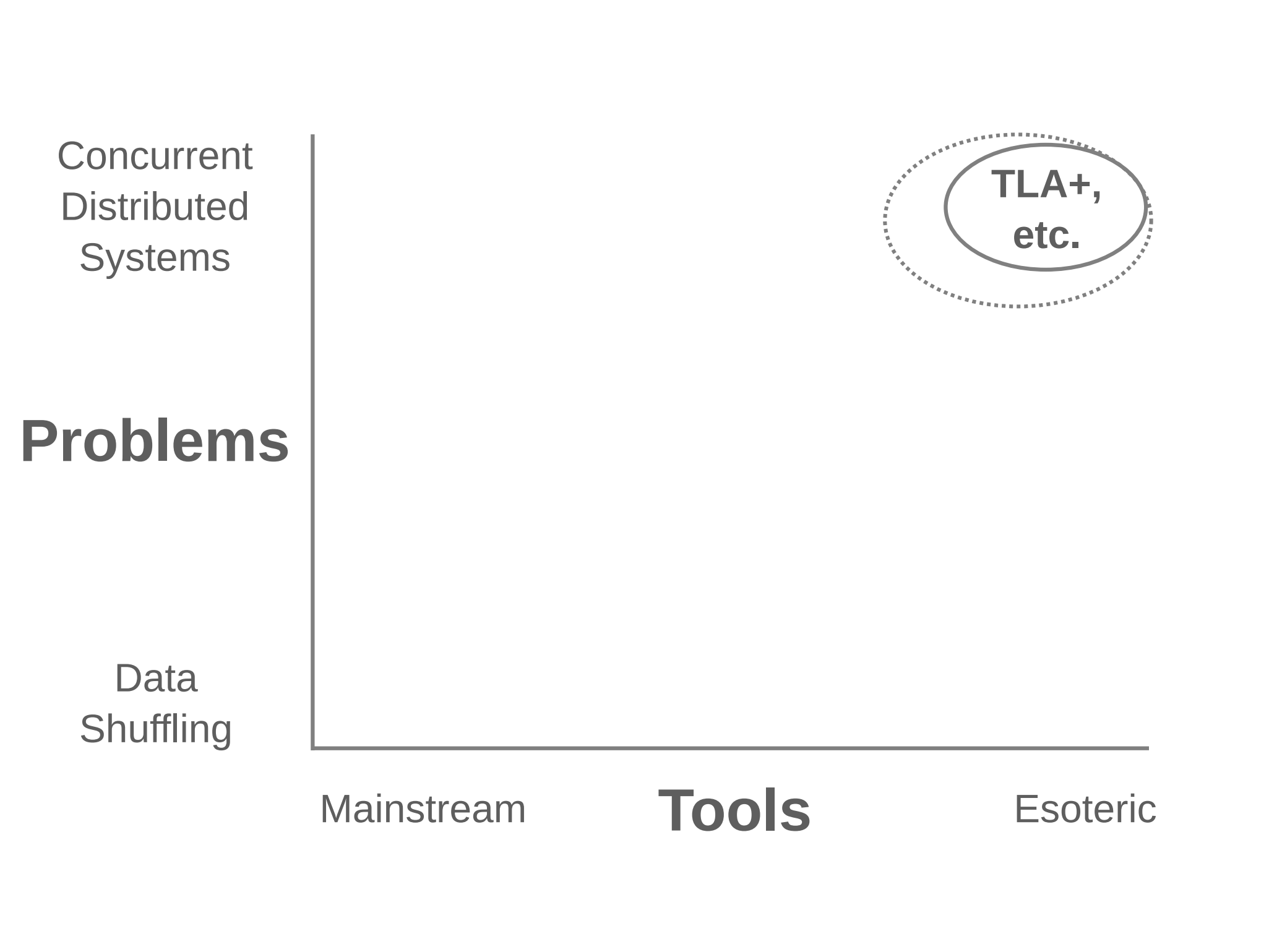
Concurrent
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Tools
Esoteric

What is Halite?

Collaboration features

Enterprise collaboration

Developer workflows

Summary

halite

Public

forked from Viasat/halite

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This branch is up to date with `Viasat/halite:main`. Contribute Sync fork

david-mcneil and **Repo Extractor** bom-user: allow ranges to be 'open' on on… aa4923a · 7 months ago 1,272 Commits

doc	project.clj: upgrade clojure, upgrade libraries, trim some u…	8 months ago
resources/com/viasat	jadeite: move up a level in the namespace structure since …	2 years ago
src/com/viasat	bom-user: allow ranges to be 'open' on one end	7 months ago
test	analysis: bug fix for analyzing top-level 'every?' expressions	7 months ago
.gitignore	halite: typing/evaluation of literals	2 years ago
LICENSE	halite: typing/evaluation of literals	2 years ago
README.md	halite: typing/evaluation of literals	2 years ago
project.clj	upgrade to latest clojure	last year

README License

Halite

The successor to Salt.

Halite Documentation

Please note this is a pre-release version and the API is unstable.

About

Halite provides a LISP-like constraint expression language built on top of open source formal modelling tools such as the Choco constraint programming library

Readme

MIT license

Activity

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Clojure 100.0%

Halite specs have fields

```
{:spec/Dog$v4 {:fields {:age :Integer,
                        :colors [:Vec :String],
                        :name :String}}}
```

```
{:spec/Dog$v4 {:fields {:age :Integer,
                        :colors [:Vec :String],
                        :name :String}}}
```

Halite instances must structurally match specs

```
{:name "Rex",
 :$type :spec/Dog$v4,
 :age 3,
 :colors ["brown" "white"]}
```

Halite specs have constraints

```
{:tutorials.vending/State$v1
   {:fields {:balance [:Decimal 2],
             :beverageCount :Integer,
             :snackCount :Integer},
    :constraints #{'{:name "balance_not_negative",
                     :expr (>= balance #d "0.00")}
                   '{:name "counts_below_capacity",
                     :expr (and (<= beverageCount 20) (<= snackCount 20))}
                   '{:name "counts_not_negative",
                     :expr (and (>= beverageCount 0) (>= snackCount 0))}}}}
```

```
{:tutorials.vending/State$v1
   {:fields {:balance [:Decimal 2],
             :beverageCount :Integer,
             :snackCount :Integer},
    :constraints #{'{:name "balance_not_negative",
                     :expr (>= balance #d "0.00")}
                   '{:name "counts_below_capacity",
                     :expr (and (<= beverageCount 20) (<= snackCount 20))}
                   '{:name "counts_not_negative",
                     :expr (and (>= beverageCount 0) (>= snackCount 0))}}}}
```

Halite instances must satisfy spec constraints

```
{:$type :tutorials.vending/State$v1,
 :balance #d "0.00",
 :beverageCount 10,
 :snackCount 15}
```

Halite specs can model state machines

```
{:tutorials.vending/Transition$v1
   {:fields {:current :tutorials.vending/State$v1,
             :next :tutorials.vending/State$v1},
    :constraints
      #{'{:name "state_transitions",
          :expr
            (or
              (and (contains? #{#d "0.10" #d "0.25" #d "0.05"}
                              (- (get next :balance) (get current :balance)))
                   (= (get next :beverageCount) (get current :beverageCount))
                   (= (get next :snackCount) (get current :snackCount)))
              (and (= #d "0.50" (- (get current :balance) (get next :balance)))
                   (= (get next :beverageCount) (get current :beverageCount))
                   (= (get next :snackCount) (dec (get current :snackCount))))
              (and (= #d "1.00" (- (get current :balance) (get next :balance)))
                   (= (get next :beverageCount)
                      (dec (get current :beverageCount)))
                   (= (get next :snackCount) (get current :snackCount)))
              (= current next))}}}}
```

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Halite specs are versioned

```
{:spec/Dog$v4 {:fields {:age :Integer,
                        :colors [:Vec :String],
                        :name :String}}}
```

Halite specs are namespaced

```
{:tutorials.vending/State$v1
   {:fields {:balance [:Decimal 2],
             :beverageCount :Integer,
             :snackCount :Integer},
    :constraints #{'{:name "balance_not_negative",
                     :expr (>= balance #d "0.00")}
                   '{:name "counts_below_capacity",
                     :expr (and (<= beverageCount 20) (<= snackCount 20))}
                   '{:name "counts_not_negative",
                     :expr (and (>= beverageCount 0) (>= snackCount 0))}}}}
```

Halite specs can refine other specs

```
{:spec/A$v4 {:fields {:b :Integer,
                      :c :Integer,
                      :d :String},
             :refines-to {:spec/X$v4 {:name "refine_to_X",
                                      :expr '{:$type :spec/X$v4,
                                              :x (+ b c),
                                              :y 12,
                                              :z (if (= "medium" d) 5 10)}}}},
 :spec/X$v4 {:fields {:x :Integer,
                      :y :Integer,
                      :z :Integer}}}
```

```
{:spec/A$v4 {:fields {:b :Integer,
                      :c :Integer,
                      :d :String},
             :refines-to {:spec/X$v4 {:name "refine_to_X",
                                      :expr '{:$type :spec/X$v4,
                                              :x (+ b c),
                                              :y 12,
                                              :z (if (= "medium" d) 5 10)}}}},
 :spec/X$v4 {:fields {:x :Integer,
                      :y :Integer,
                      :z :Integer}}}
```

```
(let [a {:$type :spec/A$v4,
         :b 1,
         :c 2,
         :d "large"}]
  (refine-to a :spec/X$v4))


;-- result --
{:$type :spec/X$v4,
 :x 3,
 :y 12,
 :z 10}
```

Halite specs compose

```
{:spec/A$v1 {:fields {:b :spec/B$v1}},
 :spec/B$v1 {:fields {:c :Integer}}}
```

```
{:spec/A$v1 {:fields {:b :spec/B$v1}},
 :spec/B$v1 {:fields {:c :Integer}}}
```

Halite instances compose

```
{:$type :spec/A$v1,
 :b {:$type :spec/B$v1,
     :c 1}}
```

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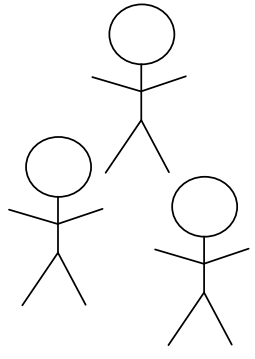
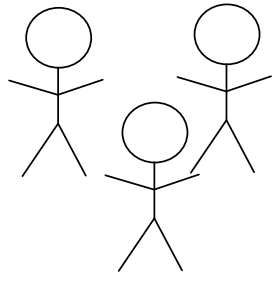
Enterprise Collaboration

Hierachical namespace



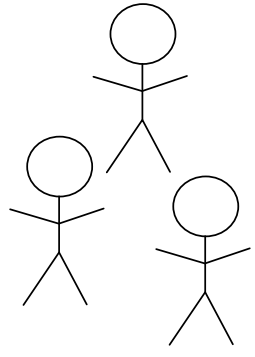


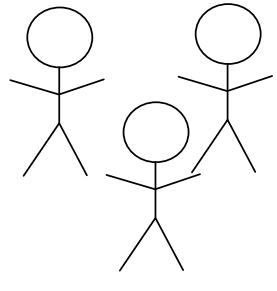
Enterprise Collaboration

Hierachical namespace

```
{:groupA/X$v1 ...}
```

immutable,
versioned specs



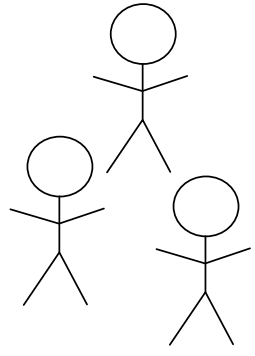


Enterprise Collaboration

Hierachical namespace

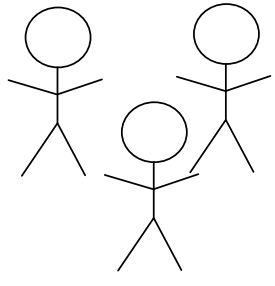
`{:groupA/X$v1 ...}`

immutable,
versioned specs



spec refinement
& composition

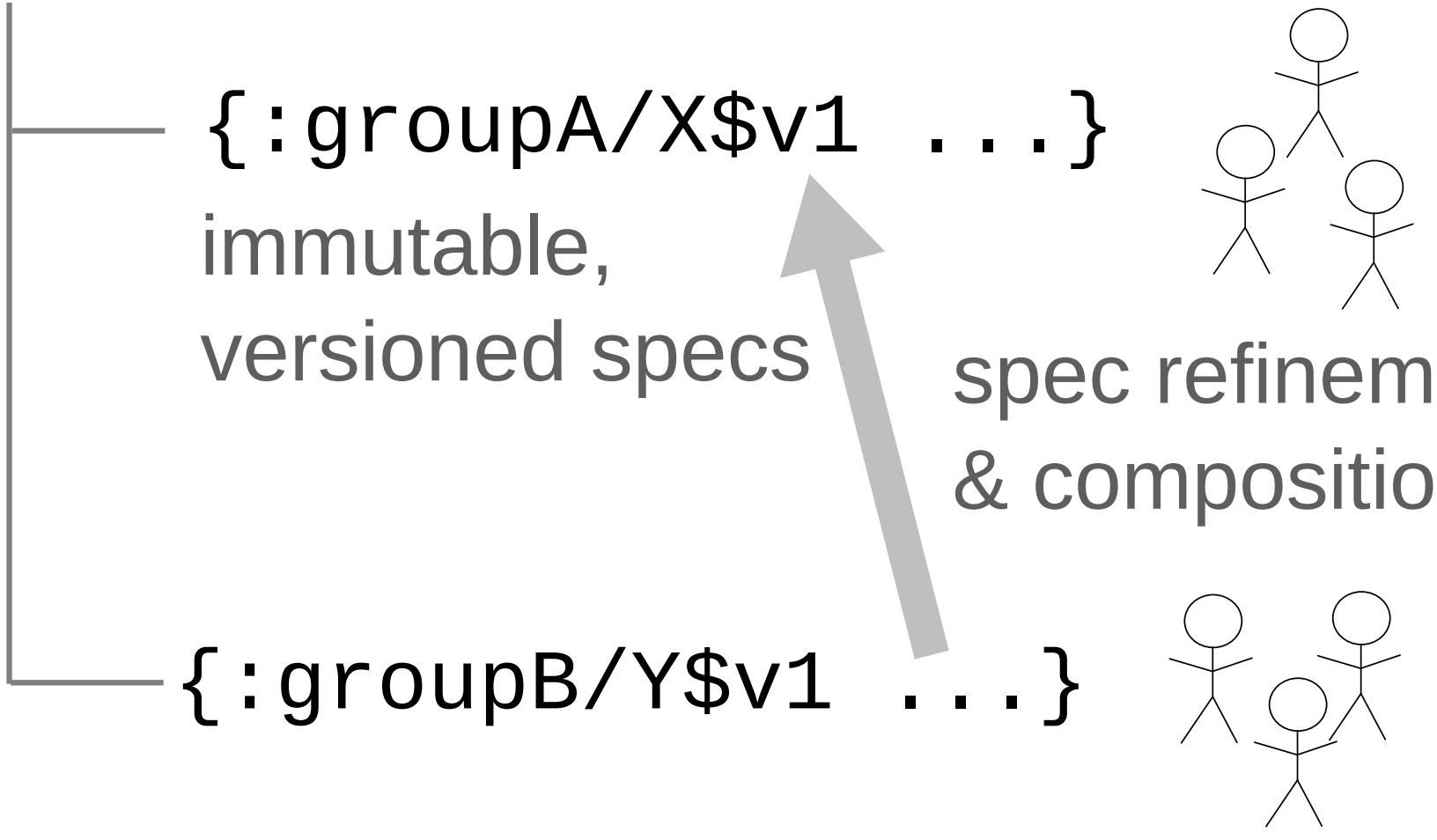
`{:groupB/Y$v1 ...}`



Enterprise Collaboration

Concurrent, distributed spec authoring

Hierachical namespace



What is Halite?
Collaboration features
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Halite expressions can be evaluated

```
(let [a {:$type :spec/A$v4,
         :b 1,
         :c 2,
         :d "large"}]
  (refine-to a :spec/X$v4))


;-- result --
{:$type :spec/X$v4,
 :x 3,
 :y 12,
 :z 10}
```

Literate Specs

How to model data fields in specifications.

It is possible to define a spec that does not have any fields.

```
{:spec/Dog$v1 {}}
```

Instances of this spec could be created as:

```
{:$type :spec/Dog$v1}
```

It is more interesting to define data fields on specs that define the structure of instances of the spec

```
{:spec/Dog$v2 {:fields {:age :Integer}}}
```

This spec can be instantiated as:

```
{:$type :spec/Dog$v2,
 :age 3}
```

A spec can have multiple fields

```
{:spec/Dog$v4 {:fields {:age :Integer,
                        :colors [:Vec :String],
                        :name :String}}}
```

```
{:name "Rex",
 :$type :spec/Dog$v4,
 :age 3,
 :colors ["brown" "white"]}
```

Literate Specs

A valid transition representing a dime being dropped into the machine.

```
{:$type :tutorials.vending/Transition$v1,
 :current {:$type :tutorials.vending/State$v1,
           :balance #d "0.00",
           :beverageCount 10,
           :snackCount 15},
 :next {:$type :tutorials.vending/State$v1,
        :balance #d "0.10",
        :beverageCount 10,
        :snackCount 15}}
```

An invalid transition, because the balance cannot increase by $0.07

```
{:$type :tutorials.vending/Transition$v1,
 :current {:$type :tutorials.vending/State$v1,
           :balance #d "0.00",
           :beverageCount 10,
           :snackCount 15},
 :next {:$type :tutorials.vending/State$v1,
        :balance #d "0.07",
        :beverageCount 10,
        :snackCount 15}}
```

```
;-- result --
[:throws
 "h-err/invalid-instance 0-0 : Invalid instance of 'tutorials.vending/Transition$v1', violates constraints \"tu
 :h-err/invalid-instance]
```

Constraint Propagation

```
(propagate {:ws/A$v1 {:fields {:x :Boolean,
                               :y :Boolean},
                      :constraints [["c1" '(if x true y)]]}}

           {:$instance-of :ws/A$v1,
            :x false})

;-- result --
{:$instance-of :ws/A$v1,
 :x false,
 :y true}
```

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Documentation / Modeling / Declaring variables

Declaring variables

How to declare variables?

A variable is an *unknown*, mathematically speaking. The goal of a resolution is to *assign* a *value* to each variable. The *domain* of a variable –(super)set of values it may take– must be defined in the model.

Choco-solver includes several types of variables: `BoolVar`, `IntVar`, `SetVar` and `RealVar`. Variables are created using the `Model` object. When creating a variable, the user can specify a name to help reading the output.

Integer variables

An integer variable is an unknown whose value should be an integer. Therefore, the domain of an integer variable is a set of integers (representing possible values). To create an integer variable, the `Model` should be used:

Java Python

```java
// Create a constant variable equal to 42
IntVar v0 = model.intVar("v0", 42);
// Create a variable taking its value in [1, 3] (the value is 1, 2 or 3)
IntVar v1 = model.intVar("v1", 1, 3);
// Create a variable taking its value in {1, 3} (the value is 1 or 3)
IntVar v2 = model.intVar("v2", new int[]{1, 3});
```

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Enterprise coordination
Spec relationships
Immutable versions
Executable specs
Literate specs
Incremental adoption

Problems

Data
Shuffling

Mainstream **Tools** Esoteric

Thank you!