Knowledge Representation using Dependent Type Theory

Nick Harley
njharley@ai.vub.ac.be
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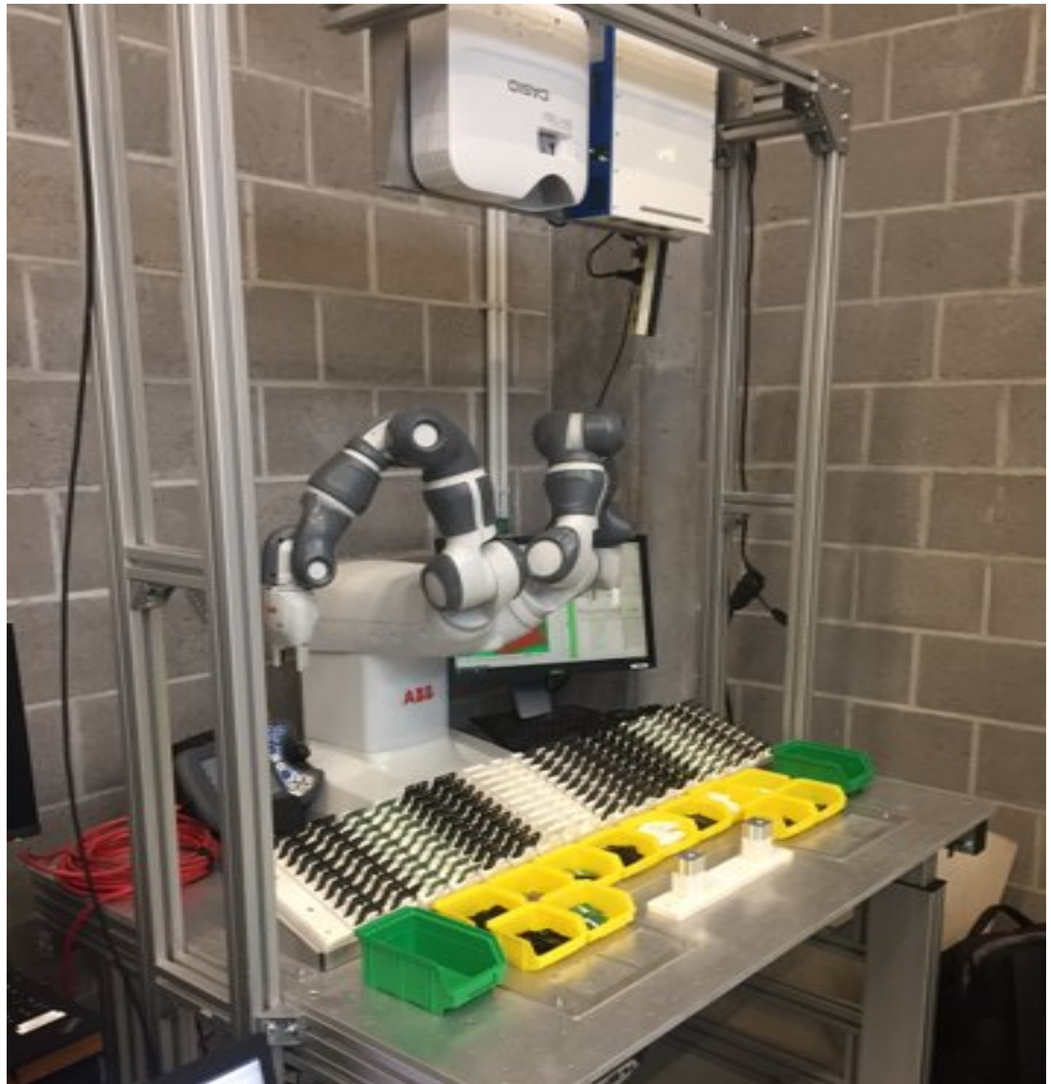
Application: AI Assisted Operator

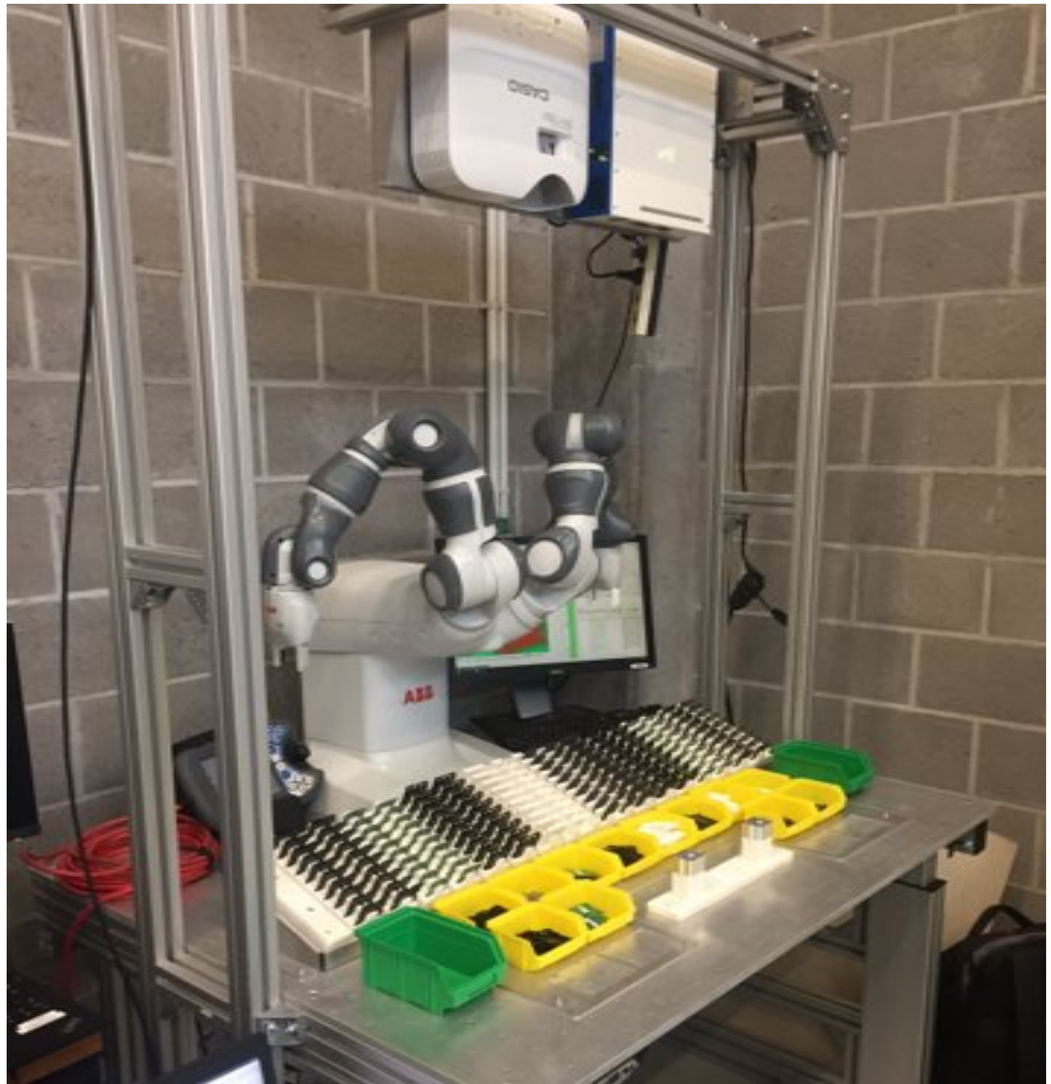


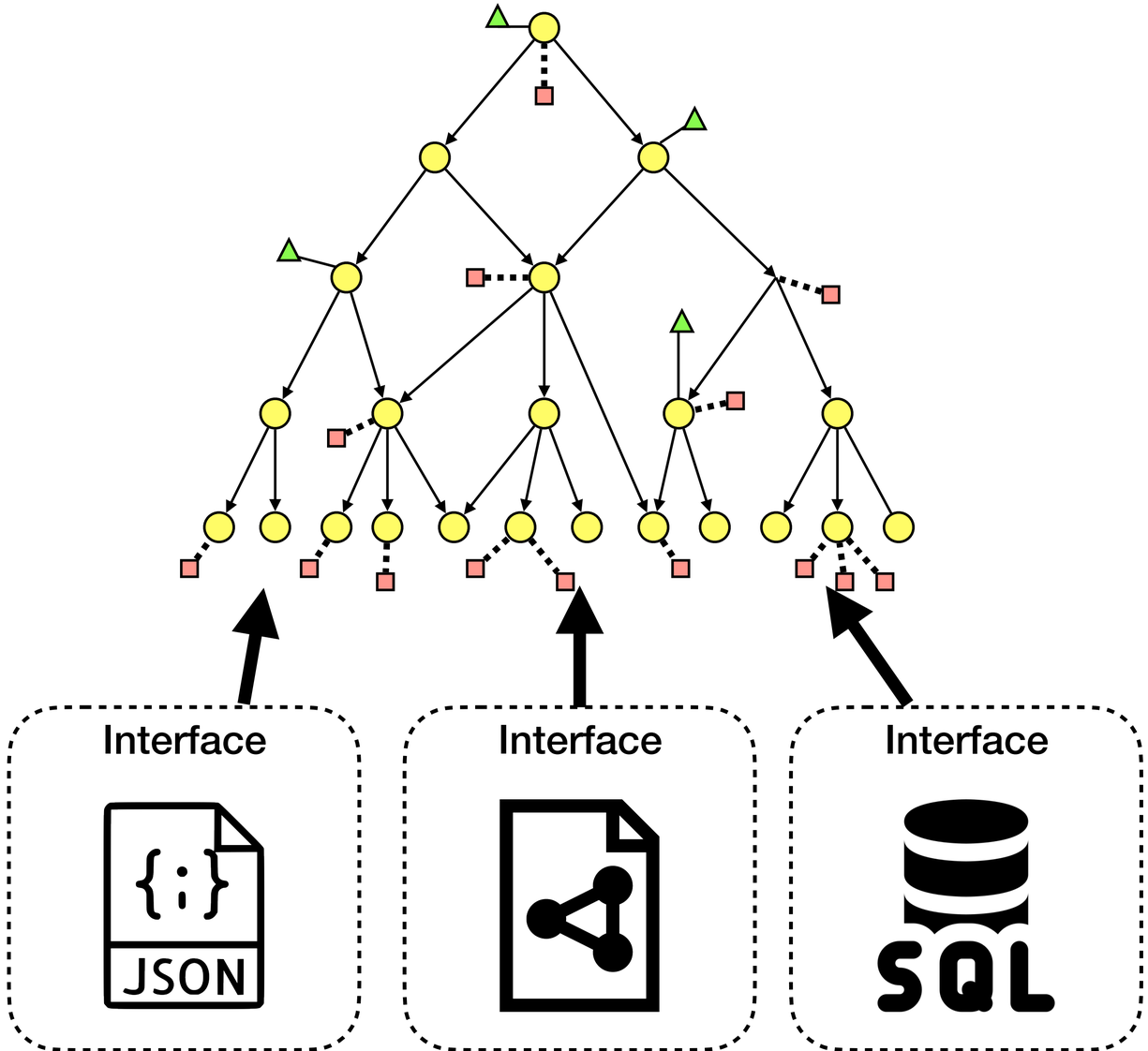
- Historical execution data (SQL)
- Robot world model (RDF)
- Execution plans (PDDL)
- Assembly instructions (JSON)

Knowledge Representation: CHAKRA

FLANDERS MAKE
DRIVING INNOVATION IN MANUFACTURING

Common **H**ierarchical **A**bstract **K**nowledge **R**epresentation for **A**nything

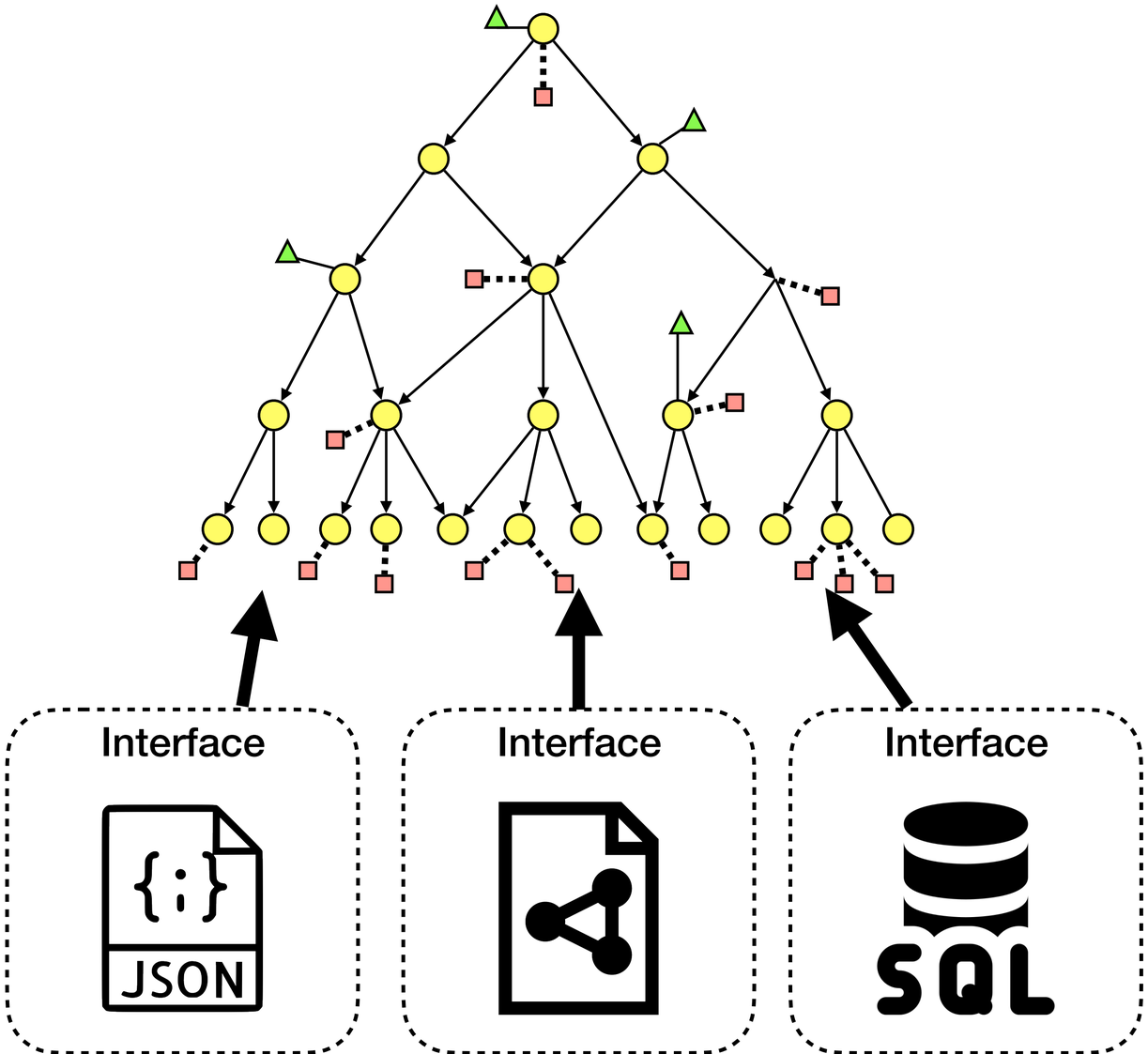




Knowledge Representation: CHAKRA

Example: A specification for the execution x of an assembly step y in which an operator error z occurred:

```
Exists x,y,R.
  IsExecutionOf(x,y,R) /\
  Exists z.
    HasPart(x,z) /\
    LogType(z,Error)
```



Logical Specification: Dependent Type Theory

The calculus of inductive constructions:

1. A functional programming language
2. A constructive higher-order logic

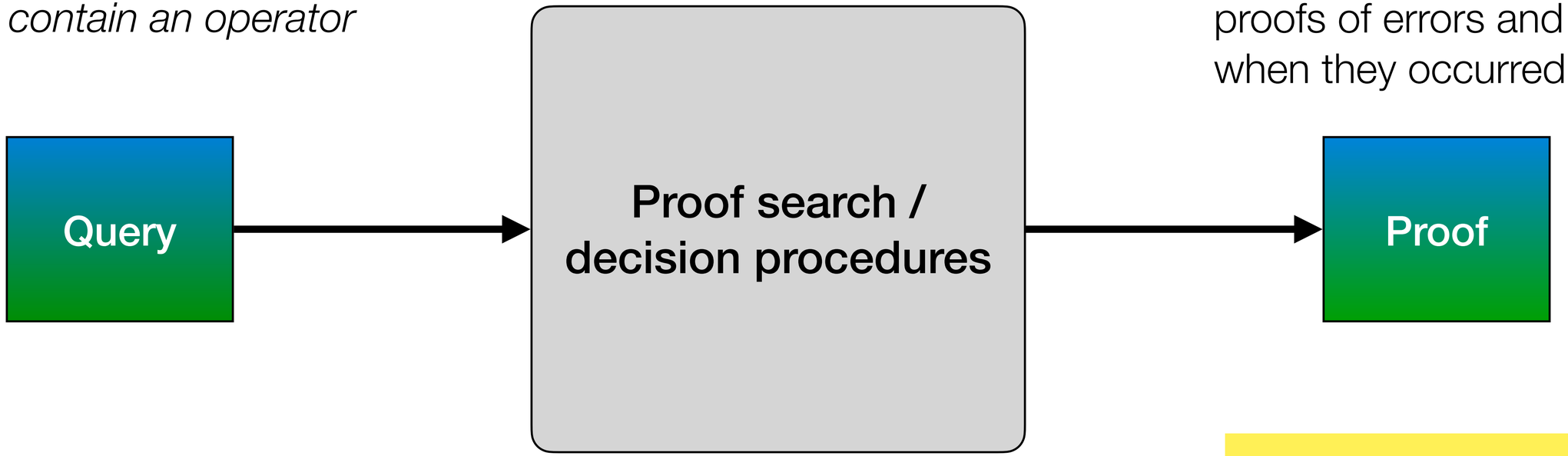
Data, programs, propositions, predicates, theorems, proofs and decision procedures are all expressible as terms in the language

```
Nat : Type

0 : Nat

[1, 2, 3] : List(Nat)

λ(x:Nat).x + 1 : Nat -> Nat

Prop : Type

Even : Nat -> Prop

even0 : Even(0)

odd_s(0,even0) : Odd(1)

even_s(1,odd_s(0,even0)) : Even(2)

decideifeven : forall x:Nat,
     Even(x) \/ ~ Even(x)
```

Reasoning: Proof Not Truth

“Find all assembly steps which contain an operator error”

Data structure containing proofs of errors and where / when they occurred

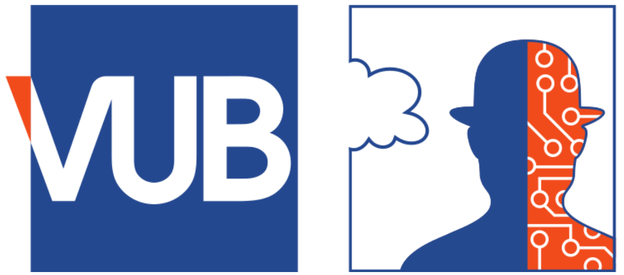


Advantages:

1. Better integration with programming languages
2. Compromise between open and closed world

Proof objects are data which can be computed with

Thanks!



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