Foundations of a Generative C++ Platform for Generalised Satisfiability Problems

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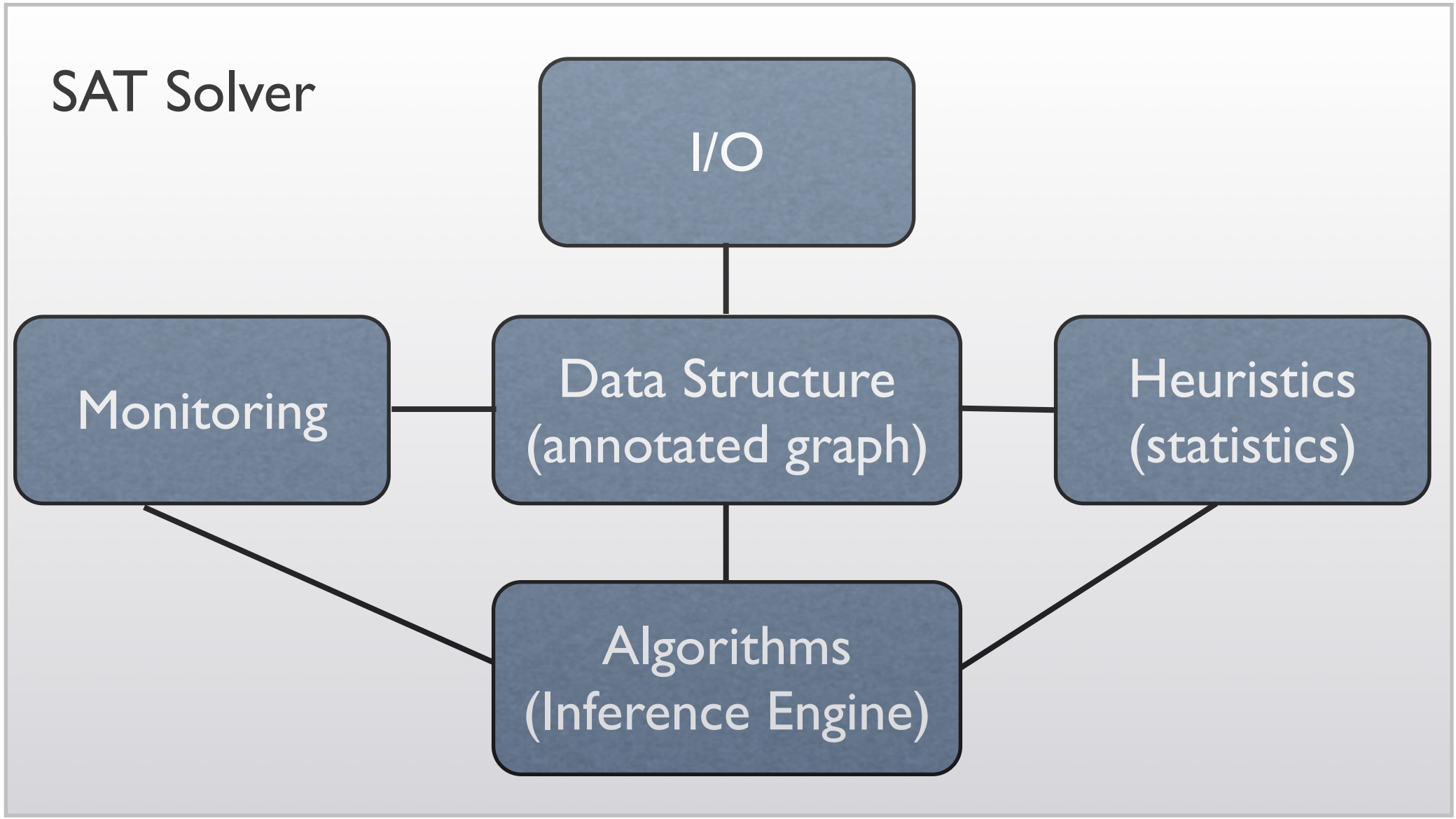
SAT Solvers

- A “theoretical” SAT Solver - OKSolver (1998 - 2002)
- Won four awards in SAT Competition 2002
- Carefully handcrafted (like all existing SAT Solvers) to ensure high efficiency.

Tightly Coupled Components



Why not use libraries?

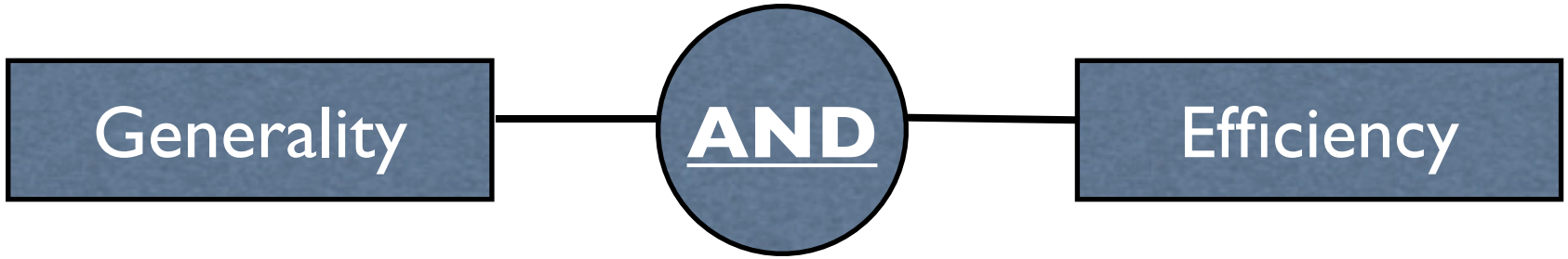
Libraries don’t deliver

- Exponential running time results in enormous scope for algorithms **and implementations**
- Many new algorithms and data structures are developed as well as many variations on existing algorithms and data structures.

Generality and abstraction that are required for a good library are (until now) always achieved at the expense of efficiency!

Generic Programming in C++

- Programming using **types** as *generic* parameters.
- Fundamental method that produces highly general and reusable components.
- Parametric static polymorphism.
- Realised in C++ by the powerful template mechanism.



Express software components in the most abstract form possible.

The abstract component can be instantiated back to a concrete implementation which is as efficient as a handcrafted one.

- Compiler performs optimisation on all source code.
- Template Meta-Programming fine tune optimisation and delivering general components (DSL)

Managed Coupling

Using generic and generative programming :
Types include **classes**, classes include interface **and** implementation

Concepts

- Specifies syntactical, semantical and complexity requirements of generic parameters
- Concrete type that fulfil these requirements are said to be a **model** of the concept.
- Extended Abstract Data Type

Concept Checker

- In an ideal world.
- Input a model and check it against a given concept
- Output indicate where the problem is if any. Whether it's syntactically incorrect or the semantics differs from our definition or complexity of the model doesn't match.

Syntax

- Can be specified at source code level
- Boost Concept Checking Library (BCCL) that enforces these syntax rules at compile time.

Semantics

- How to express this?
- Correctness checker impossible.

Every concept comes with its own testing system

Complexity

- Prediction of resource usage for every operation of the model.
- In general, can only be done by running the operations.

- Stipulated complexity term belongs to the model. e.g,

$$t = \alpha * 2^{\beta * n}$$

- System does curve fitting to obtain alpha and beta. We then get the estimated resource prediction.

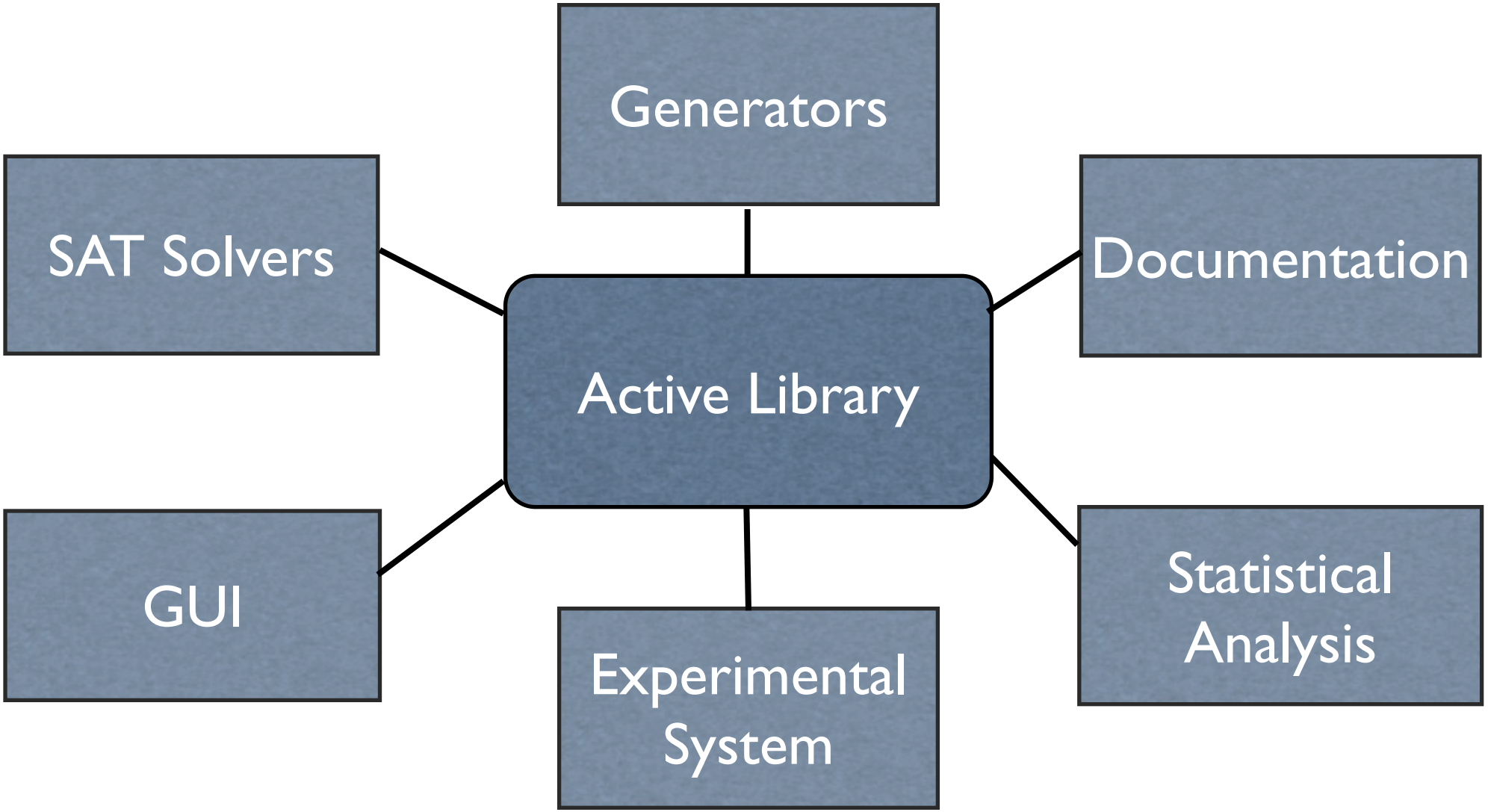
Families of Concepts

- Differentiation in semantics and complexity
- Additionally causes syntax changes

Generative Programming

- Built To Order components i.e, **type inference**
- Active library
- Configuration knowledge on top of components
- High level user spec input. System automatically works out a solution. Ideally
- In reality, a lot of help are needed for this

OKPlatform - The platform for comprehensive Satisfiability solution



OKPlatform

- Extreme Open Source
- Holistic approach
- Hackable, in a good way