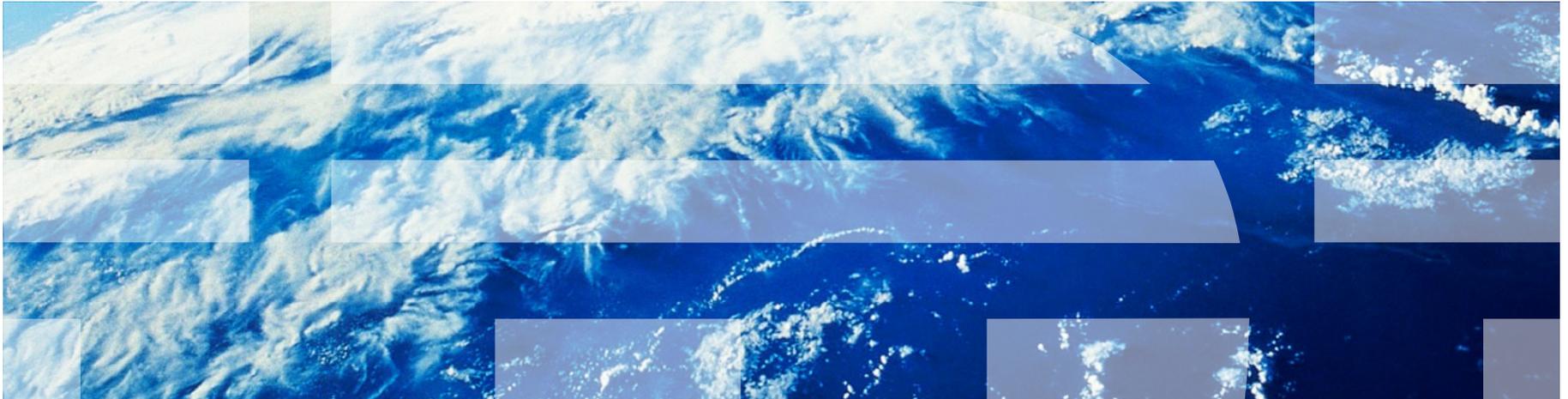
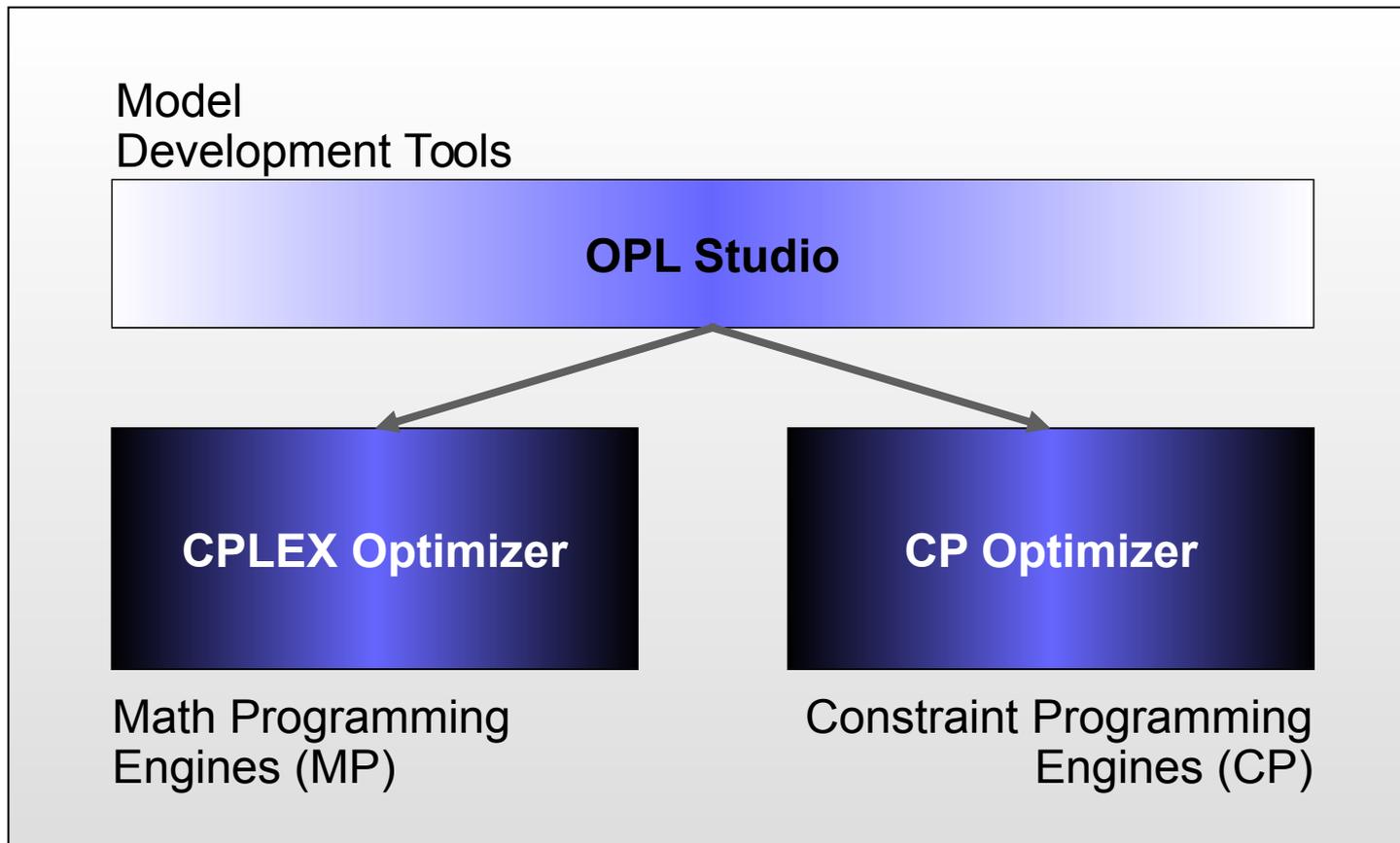

CP Optimizer Quick Introduction

CP Optimizer Development Team
Petr Vilím



What is CP Optimizer?

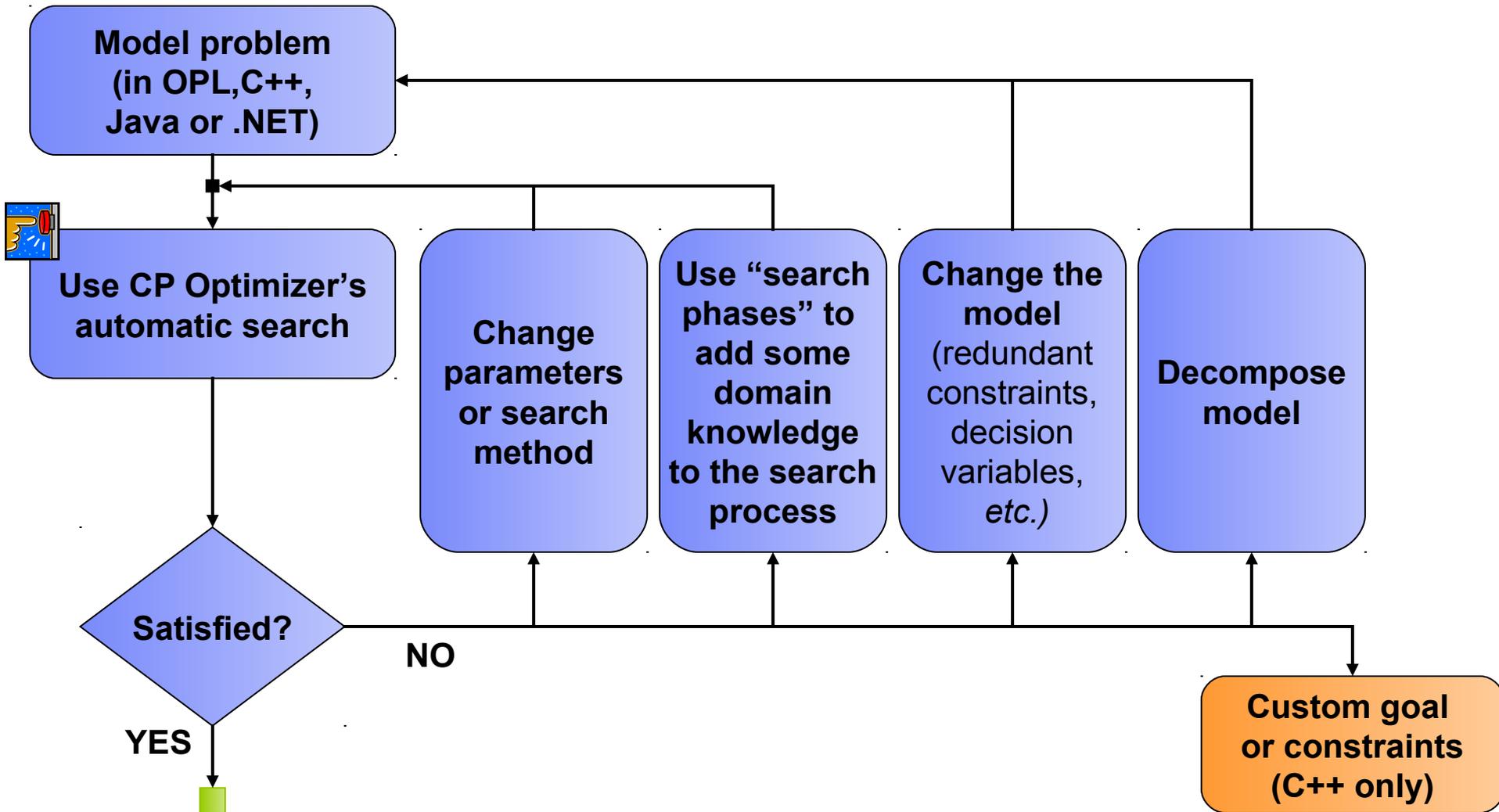
- A component of **IBM ILOG CPLEX Optimization Studio**



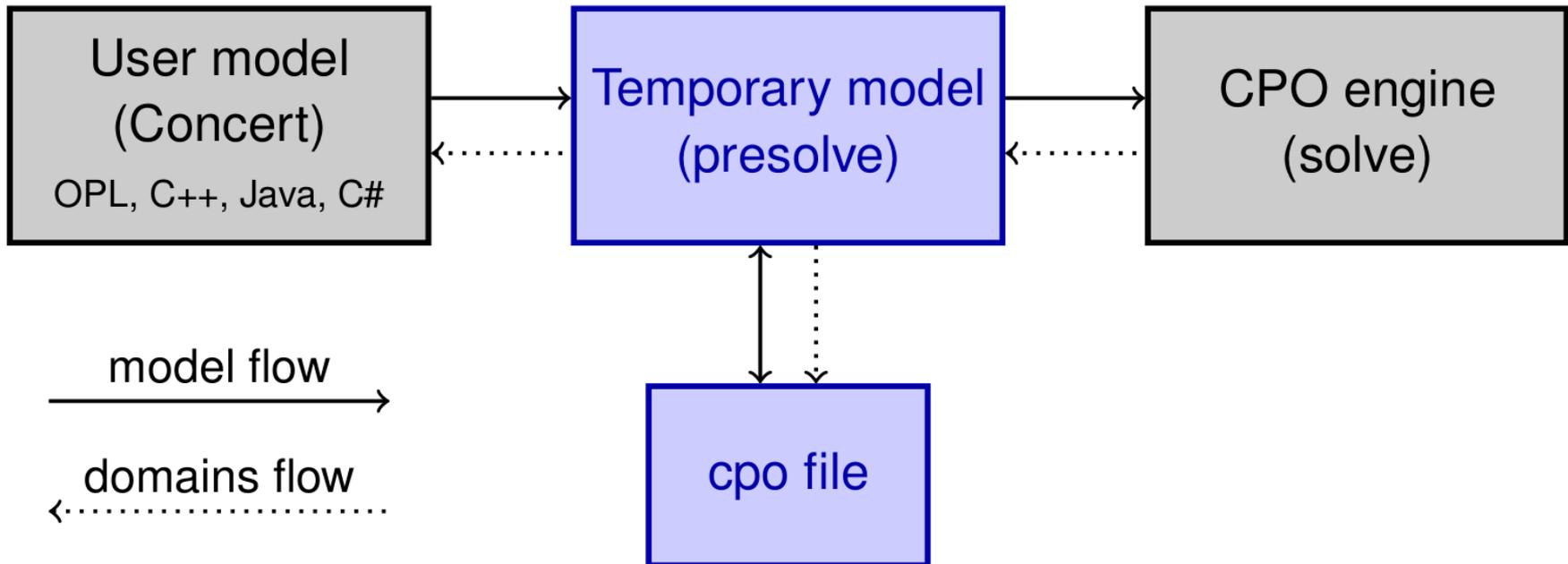
Getting CPLEX Optimization Studio

- Free of charge for academics via IBM Academic Initiative
- CP Optimizer is available through the following interfaces:
 - OPL
 - C++: native interface
 - Java: wrapping of the C++ engine
 - .NET: wrapping of the C++ engine
- and on the following platforms
 - 32-bit
 - Windows, Linux, Solaris, AIX, Darwin (Mac OS X)
 - 64-bit
 - Windows, Linux, Solaris, AIX

Typical use of CP Optimizer



Presolve



Examples of presolve

- Partial expression evaluation
- Common sub-expression elimination
- Precedence strengthening:
 - If a and b cannot overlap and $\text{startsBeforeStart}(a,b)$
 - then $\text{endsBeforeStart}(a,b)$.
- Precedence recognition:
 - If $\text{endOf}(a, \text{intmin}) \leq \text{startOf}(b, \text{intmax})$
 - then $\text{endsBeforeStart}(a,b)$.
 - Precedences are aggregated into **temporal network** for faster and stronger propagation.
- 2-SAT clauses recognition:
 - $\text{presenceOf}(a) \leq \text{presenceOf}(b)$
 - $\text{presenceOf}(a) = \text{presenceOf}(b)$
 - Such clauses are aggregated into **logical network** for stronger propagation.
- Cumulative expressions are preprocessed into cumulative constraints.

New feature: Optimization on cloud (demo)

<http://www-969.ibm.com/software/analytics/docloud/>

The screenshot displays the IBM Decision Optimization on Cloud interface. At the top, the IBM logo is on the left, and the user name 'Petr Vilím / Sign out' is on the right. Below this is a teal navigation bar with 'Decision Optimization on Cloud **BETA**' on the left, and 'DropSolve', 'FAQ & Samples', and 'Developer' on the right. A dark sidebar on the left contains 'Free Trial', 'Send us feedback', and a back arrow. The main content area features the 'DropSolve' logo with a download icon. Below the logo, text reads: 'Drop your problem file(s) and download results when complete. All relevant files must be dropped in together (lp, mps, sav, prm, mod, dat, ops ...)'. A link for 'More information in FAQ & Samples' is provided. A large dashed box contains the instruction: 'Drop a problem here to solve or click to select file(s) from your computer'. At the bottom, a file upload status bar shows a green checkmark icon, the text 'sched_jobshop.mod (2K) 1 more file', and the word 'Completed' in green. To the right are icons for 'Results' (download), 'Info' (upward arrow), 'Log' (document), and a close button (X).

New feature: CPO file format

```
internals {
  version(12.6.1.0);
  architecture("x86-64_linux/static_pic", 64);
  ids(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17);
}

// Interval-related variables:
a = intervalVar(size=5, optional);
b = intervalVar(start=1..intervalmax, size=5);
c = intervalVar(start=2..intervalmax, end=0..14, size=7);
x = intervalVar(start=-100..intervalmax, end=intervalmin..intervalmax, size=1);

// Objective:
minimize(endOf(a) + endOf(b) + endOf(c) + endOf(x));

// Constraints:
noOverlap([a, b, c, x]);
startBeforeEnd(b, a, -6);
#line foo.cpp 150
startBeforeEnd(a, x, -10);

parameters {
  LogVerbosity = Quiet;
}
```

New feature: Warnings

Like a compiler, CP Optimizer can print warnings

- When there is something suspicious in the model.
 - Especially for scheduling
- Regardless how the model was created (C++, OPL, ..)
- Including guilty part of the model in the cpo file format
- Including source code line numbers (if known)
- 3 levels of warnings, more than 50 types of warnings

```
foo.cpp:24: Warning: Unused interval variable x .
```

```
    x = intervalVar(start=1..50, size=5..10)
```

```
foo.cpp:30: Warning: Constraint alternative: master interval variable task  
                is optional but alternative interval model is present.
```

```
    alternative(task, [model, mode2])
```

```
file.cpo:7: Warning: Constraint alternative: array of alternatives is empty.  
                Interval variable A will be set to absent.
```

```
    alternative(A, [])
```