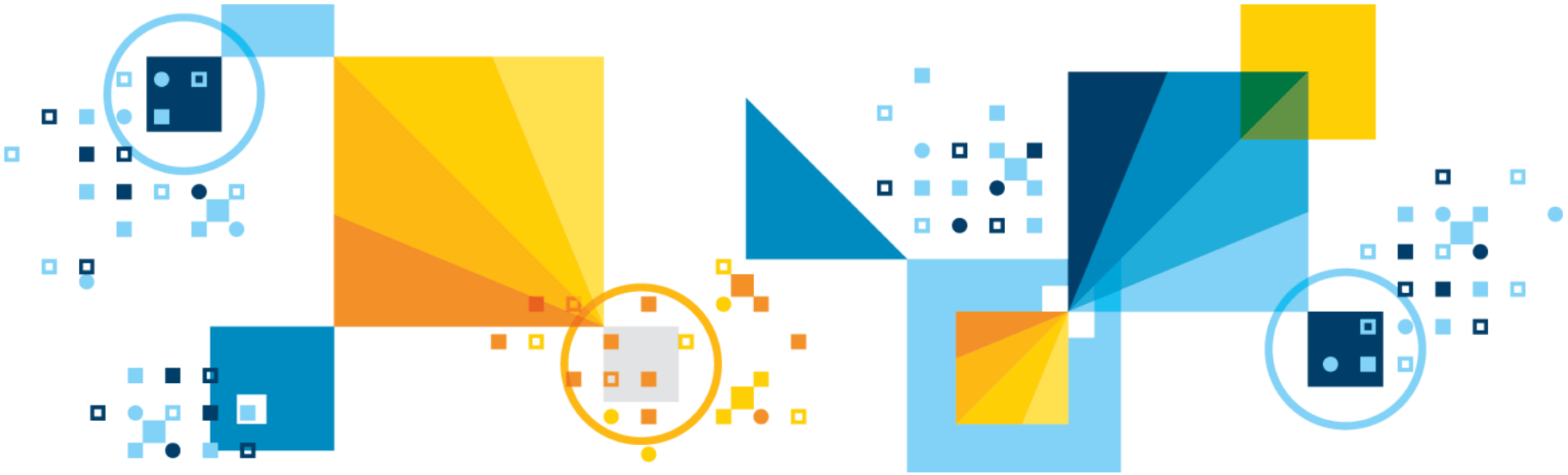
CPLEX APIs

@CPLEX School 2017 Montreal



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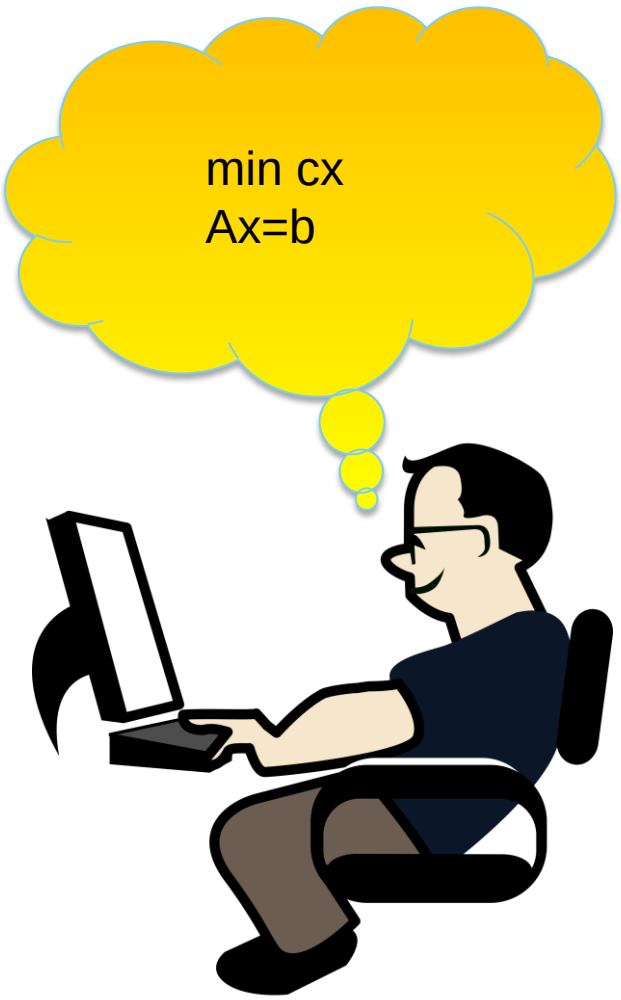
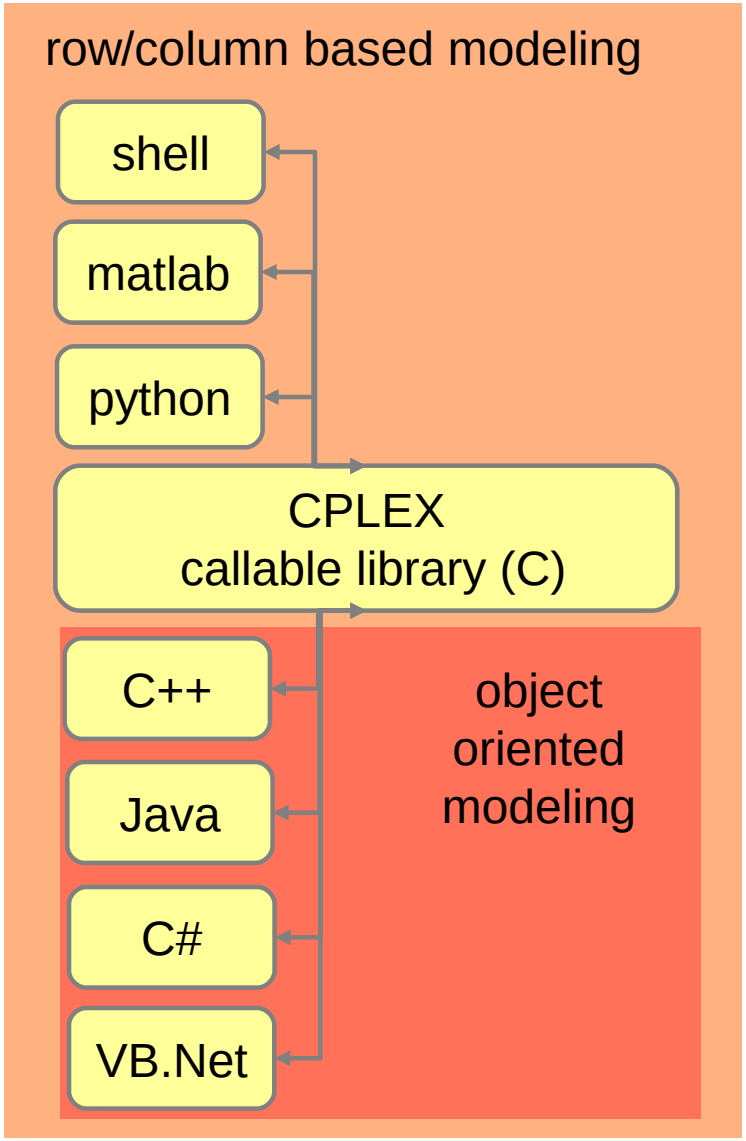
Interfacing with CPLEX: APIs





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Interfacing with CPLEX: modeling languages

Optimization Programming Language (OPL)

- write models in a more descriptive form
- write models in a more compact form
- faster prototyping, easier maintenance
- easier access to data (Excel, database, ...)

```
forall (i in I)
  sum (j in J)
    sum (k in K)
      x[i][j][k] <= 1;
```

- scriptable
- model editor
- IDE support (eclipse based)

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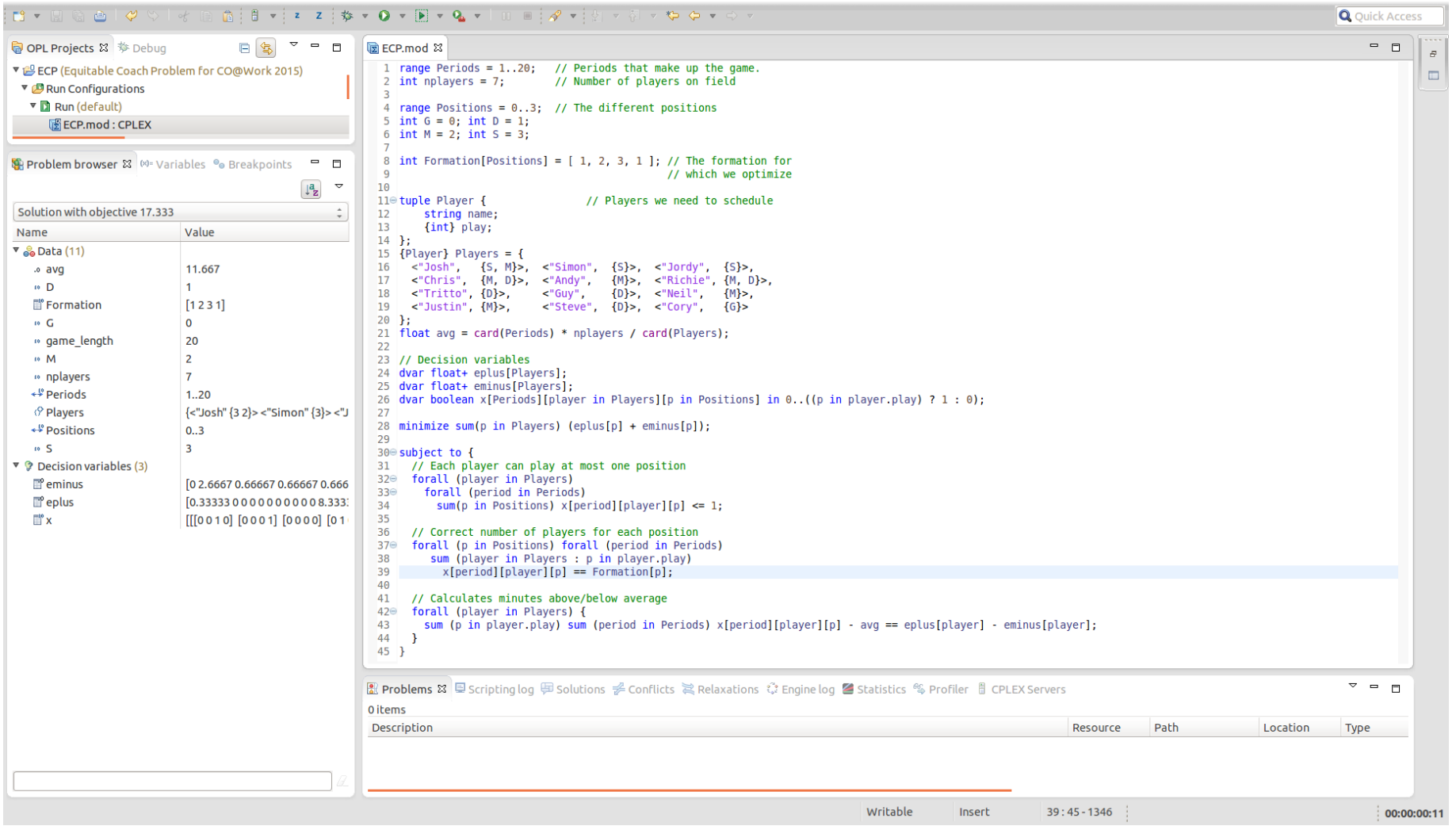

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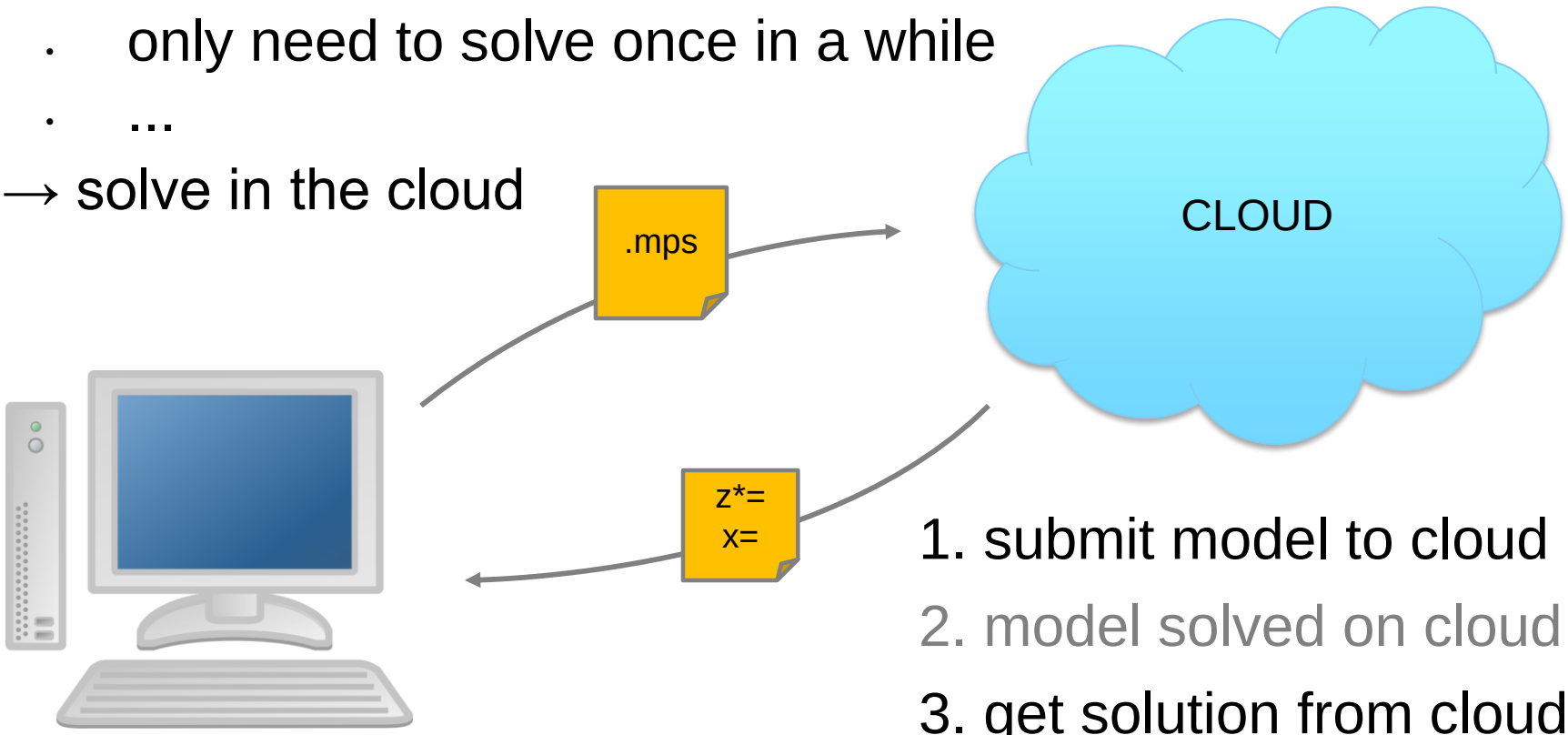
CPLEX in the CLOUD

What if no local resources to solve model?

- model too hard
- only need to solve once in a while
- ...

→ solve in the cloud



1. submit model to cloud
2. model solved on cloud
3. get solution from cloud

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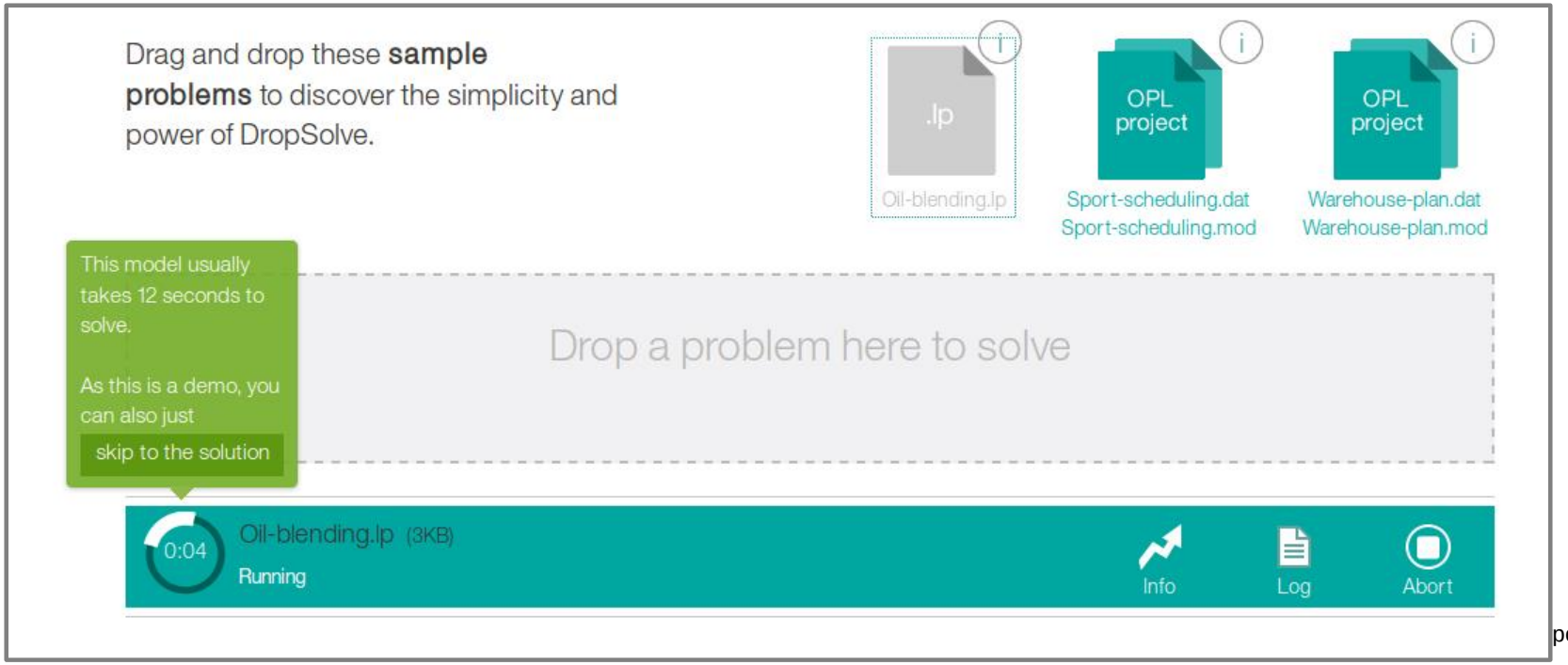
CPLEX in the CLOUD

Two ways to access CPLEX in the cloud

1. DropSolve

https://dropsolve-oaas.docloud.ibmcloud.com/software/analytics/docloud

Drag and drop your model file from disk to web browser



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CPLEX in the CLOUD

Two ways to access CPLEX in the cloud

2. REST API

https://developer.ibm.com/docloud/
https://developer.ibm.com/docloud/docs/welcome/

Access the solve service via its REST API

- ready-to-use clients provided for Java and Python, e.g.

```
JobExecutor executor = JobExecutorFactory.createDefault();
JobClient jobclient = JobClientFactory.createDefault(BASE_URL,
                                                     APIKEY_CLIENTID);
jobclient.newRequest().input(new File("model.mps"))
                      .output(new File("x.sol"))
                      .execute(executor).get();
```

- With any HTTP client (cURL, ...)

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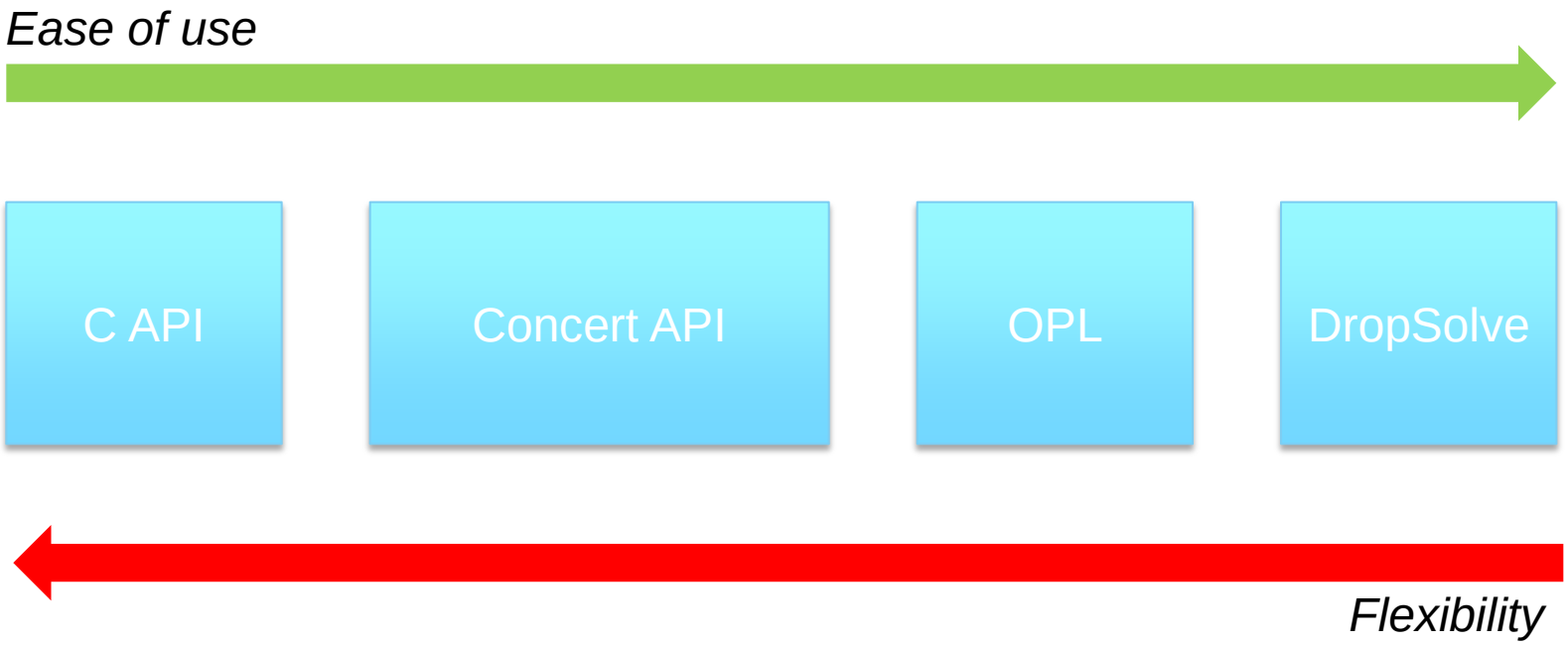
So what should you use?



- Hard to tell in general
- Depends on use case
- But…

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docplex *https://pypi.python.org/pypi/docplex*

- Pure Python modeling API
- Opensource (pypi, github)
- Support local and cloud solves
- Why Python?
  - You don’t need to learn yet another DSL
  - Python provides enough *syntactic sugar* for modeling
  - Get direct access to the whole Python software ecosystem (quite strong in the scientific community: numpy, scipy, iPython/Jupyter notebooks, etc…)

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Callable library: CPLEX C API

- Used for tight/efficient integration into applications
- C libraries are broadly callable also from higher level languages

  (no need to stick to C for using the C API!)

- Most comprehensive CPLEX API:

  if it is not in the C API, it doesn't exists.
- Also the harder to use (C itself is rather low-level)

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Callable library 101

Based on two opaque objects:

- **environment**: parameters/callbacks/license checking
- **problem**: problem data (variables, constraints, objective…)

CPX(C)ENVptr	CPXopenCPLEX/CPXcloseCPLEX
CPX(C)LPptr	CPXcreateprob/CPXfreeprob

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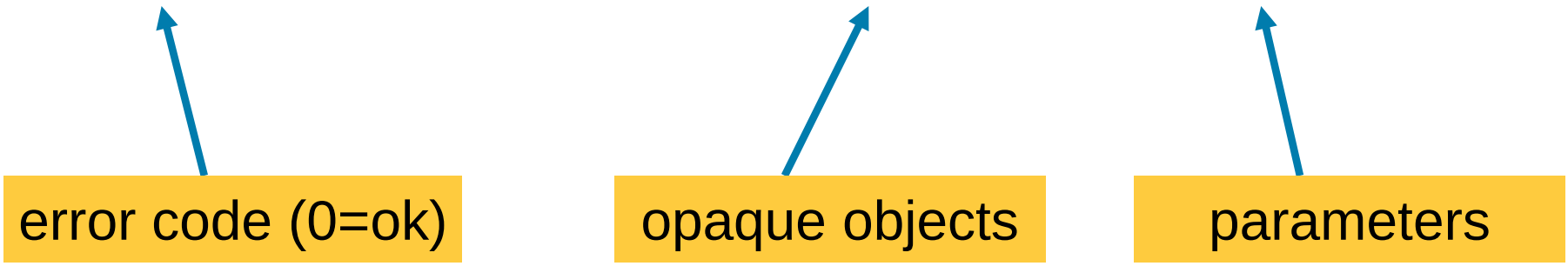
Callable library 101

- The two objects can be inspected/modified by using appropriate functions
- Almost all functions follow the same pattern:

```
int CPXXfunction(environment[,problem],...);
```



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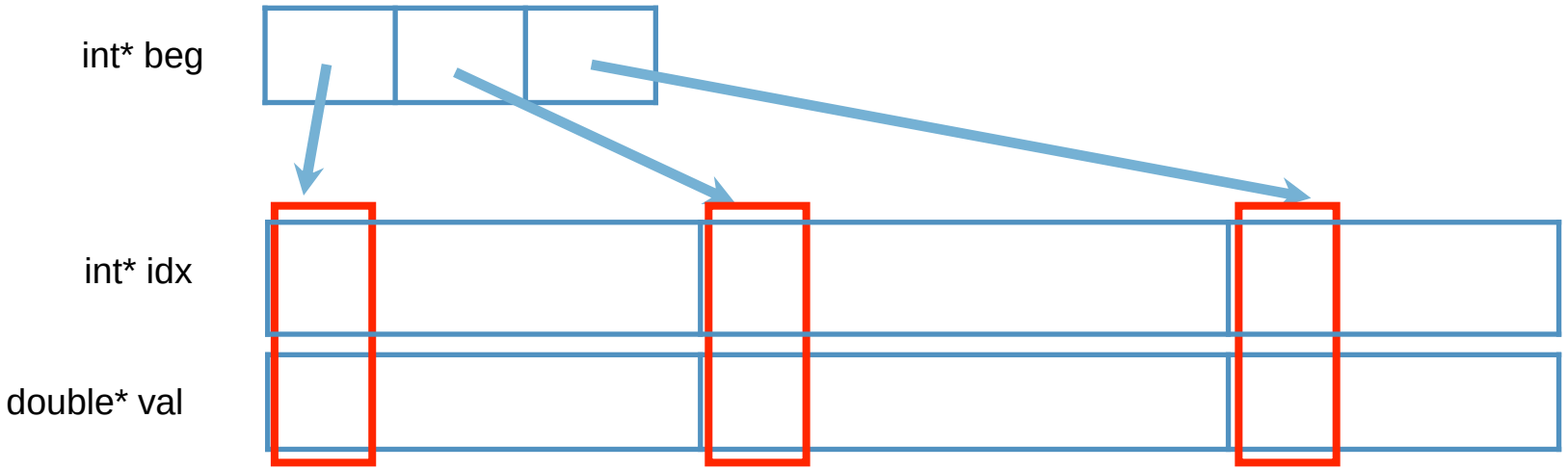
Callable library 101

- As with many C libraries, only basic data types are supported:
  - Scalars (by value and/or pointer): double/int
  - Arrays: double*/int*
  - Strings: char*
- For passing around matrices, a sparse data structure is used:



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Help/Documentation

IBM Knowledge Center: online documentation

https://www.ibm.com/support/knowledgecenter/SSSA5P

IBM developerWorks: community forum

https://www.ibm.com/developerworks

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