

# Tutoriel n°1: “*Constraint programming for robotics*”

**Simon ROHOU, Luc JAULIN, ENSTA Bretagne**

This short tutorial is about Constraint Programming (CP), Interval Analysis (IA) and their applications to mobile robotics. Interval analysis yields methods to compute intervals in place of real numbers, enclosing uncertainties in the mean time. Constraint Programming aims at solving a complex problem by defining it in terms of constraints coming from the equations or the measurements. Both concepts match perfectly for a large number of applications including Robotics, which is the subject of this tutorial.

Efforts have been done to propose operators and solvers to apply these constraints. The goal of this tutorial is to learn how to use them and understand the efficiency of the approach on realistic robotic applications. We will see that some problems that are difficult to solve with conventional methods (Kalman filters, particle approaches) can be easily dealt with by constraint programming. This is for instance the case of non-linear localization with poor observation measurements, time uncertainties, delays, or when the initial conditions of the system are not known.

The event will start with short a scientific presentation, providing the audience with elementary knowledge on constraint programming and interval analysis. Next presentation will concentrate on the Python/C++ library "Codac" (<http://codac.io>) so that the audience may be able to use the tools. Some exercises based on realistic robotic applications will then be proposed with increasing difficulty.

The main goals of the tutorial are to:

- discover constraint programming approaches
- have the proposed library installed on personal computers, and ready to be used
- deal with some robotic problems of localization in order to see how to solve them efficiently

Pré-requis :

Connaissances de base en Python ou C++.

Et un programme sur une demi-journée de 4 heures :

45 min : Présentation des concepts, éléments théoriques et exemples

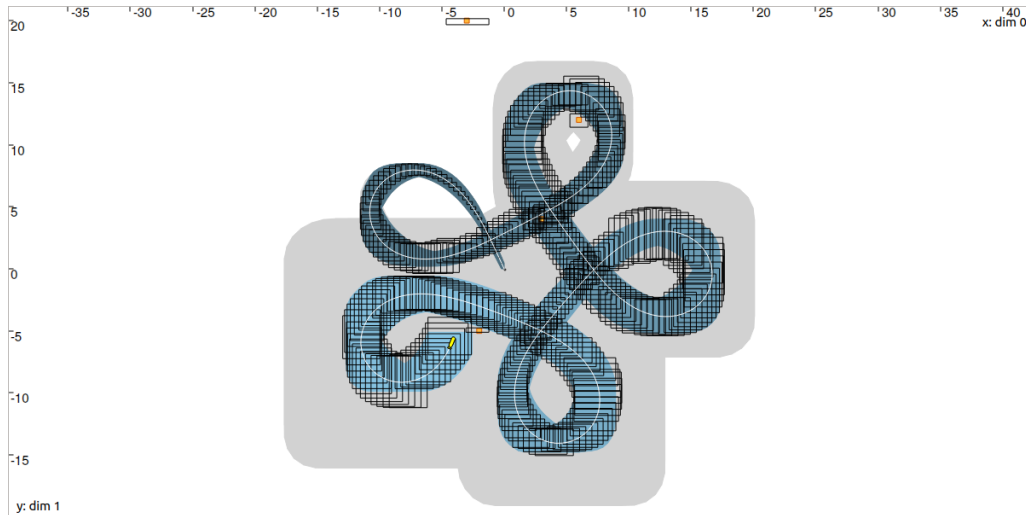
15 min : Installation des outils sur les machines des participants, ou utilisation via un navigateur web

15 min : Pause et discussions

1h15 : Résolution d'un problème de localisation de robot statique par mesures de distances

15 min : Pause et discussions

1h15 : Résolution d'un problème de localisation de robot mobile avec mesures asynchrones



*Fig: Ensemble des solutions d'un système dynamique contraint par des observations d'état non-linéaires.*

Il s'agit d'un résultat de SLAM range-only, qu'on peut imaginer résoudre à l'issu de ce tutoriel.

Voilà une animation vidéo : <https://www.youtube.com/watch?v=Dw6-OHuW0vo>