COLLEGE DOCTORAL BRETAGNE | MATHSTIC BRETAGNE OCEANE

Fiche sujet pour le recrutement d'un contrat doctoral 2023

Il est impératif que cette fiche ne dépasse pas 5 PAGES

Titre du sujet : **Multi-objective Optimization for sailboat routing (OMER)**

Financement demandé : **CDE 50%**
Indiquer l'origine du cofinancement (s'il y a lieu) : ARED 50%
et en fournir une preuve avant le 24 mai 2023 : michele.kerleroux@univ-brest.fr (UBO), noluenn.chauvin@univ-ubs.fr (UBS)

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HDR[1]	12/9/2005		
Noms des doctorants actuellement encadrés (date de 1ère inscription et date estimée de soutenance). Préciser le % de direction[2].	1 docteur encadrée, inscription le 1er Octobre 2021, date de soutenance estimée : Octobre 2024		

[1] L'HdR doit être effective à la date d'audition.
[2] Soit 50% ou 100%.

Title	Multi-objective Optimization for sailboat routing
Context	Considering weather forecast for offshore sailboat races, with regular updates by local measures or external sources (satellite communications), a crew, or eventually a single skipper, has to decide about the route for a race sailboat. Decison making has great impact on boat performance but also for his own safety.
Objectives	In order to help the skipper to refine his decision, the PhD aims at defining optimization algorithms for computing in reasonable times a good, near optimal, routing. The following scientific locks are identified : • Modeling the problem includes routing and environment models. Isochrone algorithm is widely used for computing time to destination, based on weather and boat polar files, but concerning the risk assesment, the capabilities and behahior of the boat in bad weather conditions, models are to be defined and validated. And the same holds for the human aspects, with the stress and maneuvers induced by hard weather conditions. • Current MOO (multi objective optimization) methods are also to be faced with the objectives defined for risk and stress measure, either by extra metrics reflecting confidency of the results, or by using algorithms natively taking into account uncertainty on input data, in order to provide robust solutions. • Fiability of solutions can also be used to define an updating policy in order to ensure relevant updates, according also to local and external data updates. Energy cost induced by computations, skipper particular needs about precision of results, runtimes of algorithms can also influence update frequency. • Validation of the methods is also to be examined. Benchmarks and test methods must be set up, using as realistic as possible data. Since such data are not publically available, cooperations with local actors (racing teams) is required. • And extendibility of the methods and tools is also a key point. We expect to enlarge the applicability of the approach to other routing problems, for sailing cargo ships or cruising sailboats for example, with adapted metrics (energy consumption for sails manoeuvers, waves movements, etc).
Novelty of the project	For sailboat racing, main objective is of course time to destination. We propose for this PhD to go further : • MOO approaches are not often used in the domain, existing software focus on isochrone algorithm, with adapted GUI, and decision making is strongly related on router experience. • Data uncertainty and noise is only partially taken into account in the existing MOO approaches for the field. • Multiple other criteria can be embedded into a MOO approach for weather routing, and we can envisage to extend the applicability of the approach to drones, cargo ships or cruise ships, depending on their specific constraints
International collaboration	We are collaborating with race sailboat team MerConcept for a long time (e.g. CIFRE PhD achieved in 2019). This allows us to get realistic data about weather and performance of the boats and to get informed about the specific needs for routing domain. Goulven Guillou also developped relationships with Mer Agitée race team during his PhD experimental phase. All of these privilieged contacts should facilitate the domain specific aspects modeling and realistic data collecting with the final users.

Expectations	Collaborating with MerConcept could help to validate and valorize methods and tools developped during the PhD. Indirectly, these could also be profitable in connected fields such as cargo ships (e.g. Neoline) with their own constraints and objectives. Furthermore, experience and skills induced could be reused in other marine projects, such as our ongoing collaboration with the university of Split for USV drone routing.