Explore and return with underwater robots in a minimalist environment

Luc Jaulin, Quentin Brateau and Fabrice Le Bars

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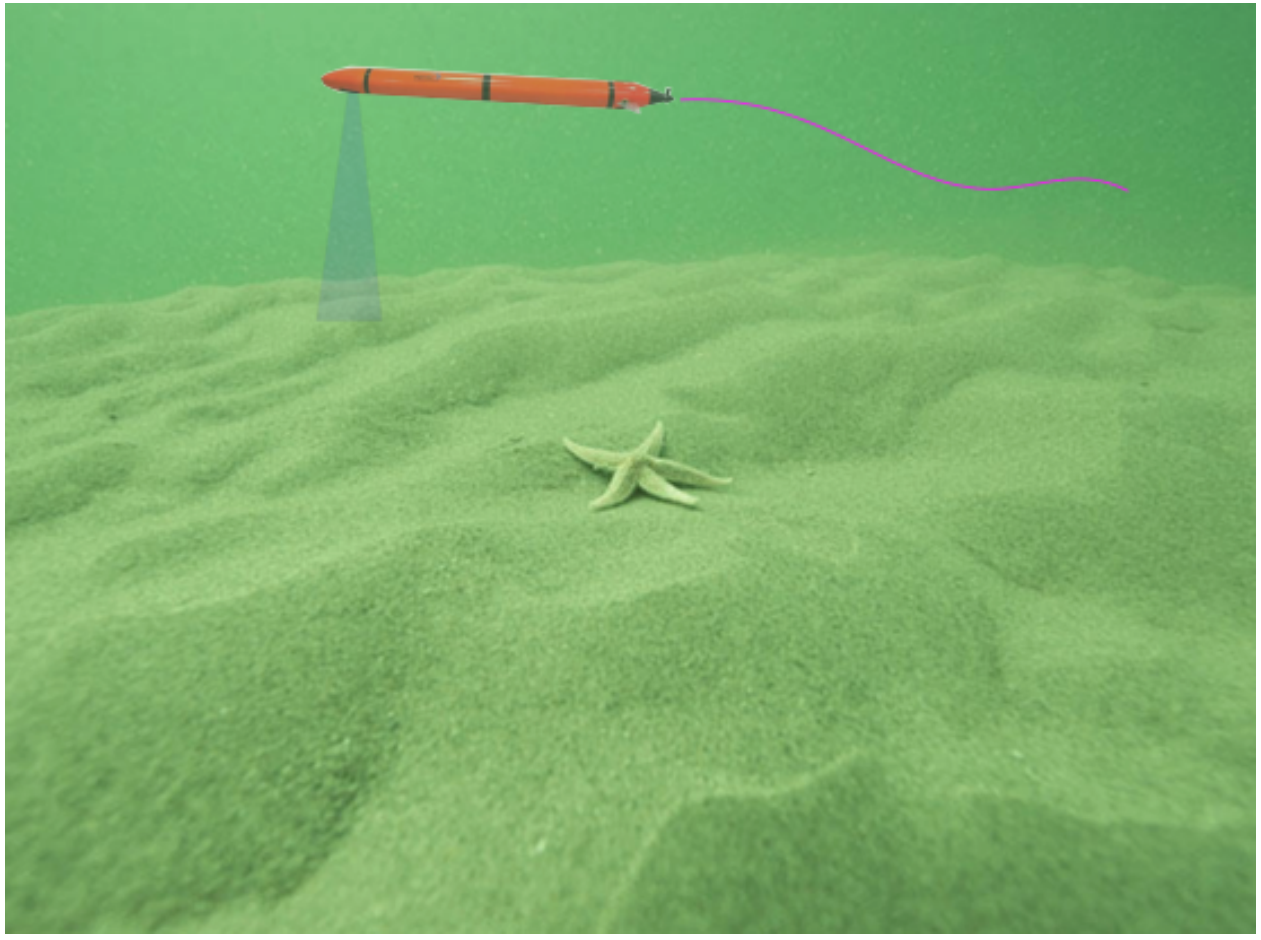
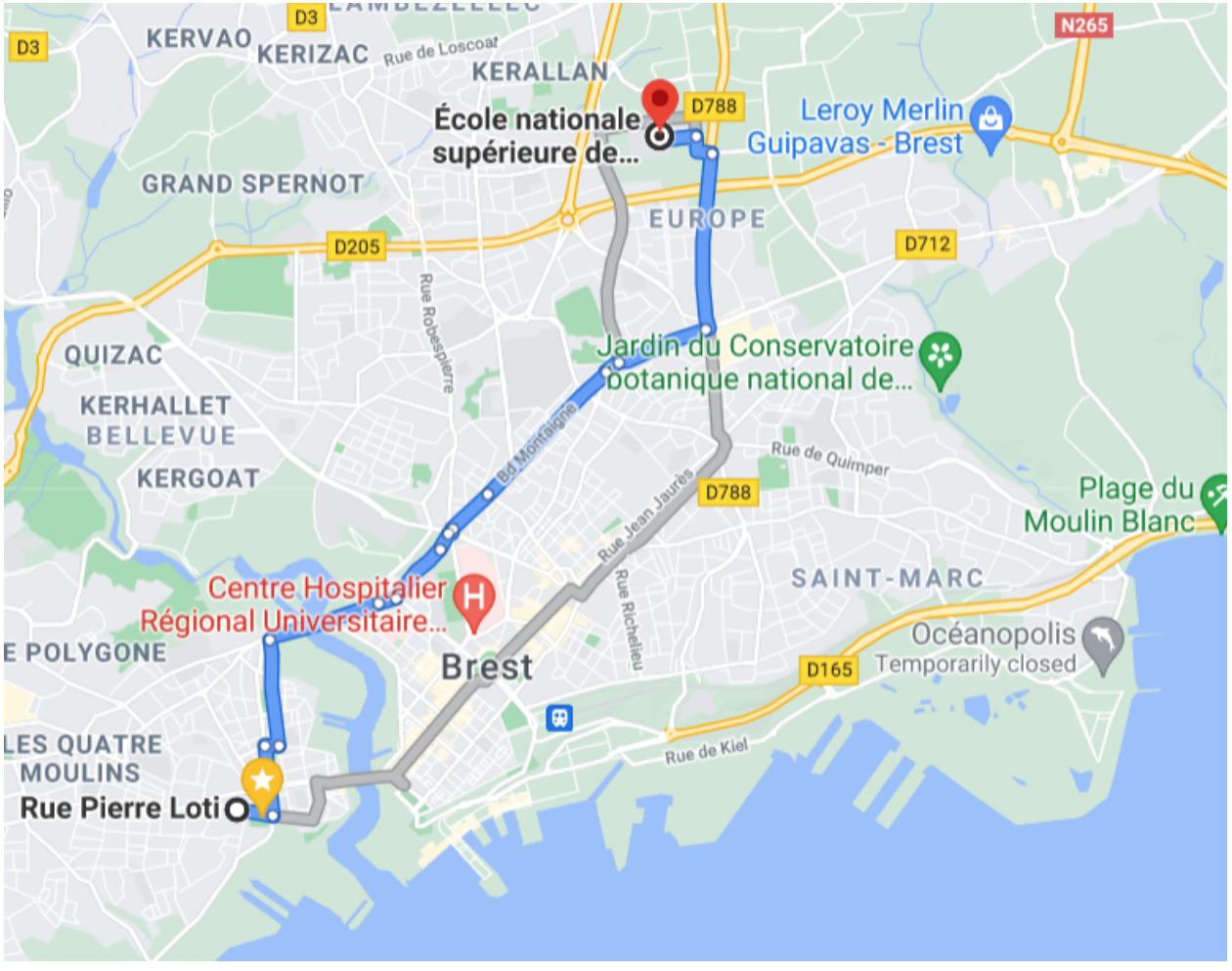
1. Underwater navigation



Explore and return in a minimalist environment

Map-based navigation



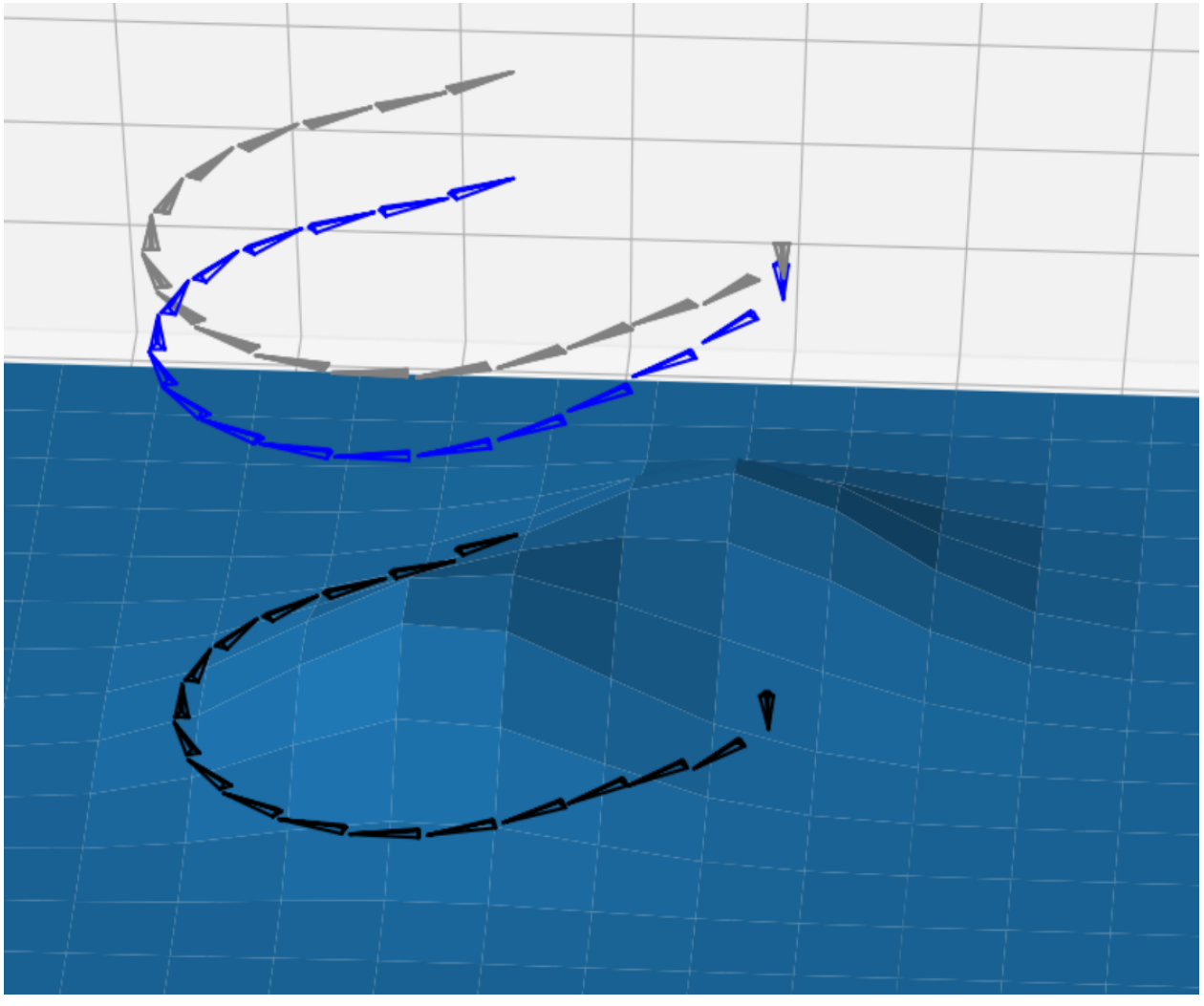
Modern navigation: high cost (computation, infrastructure)

Route-based navigation

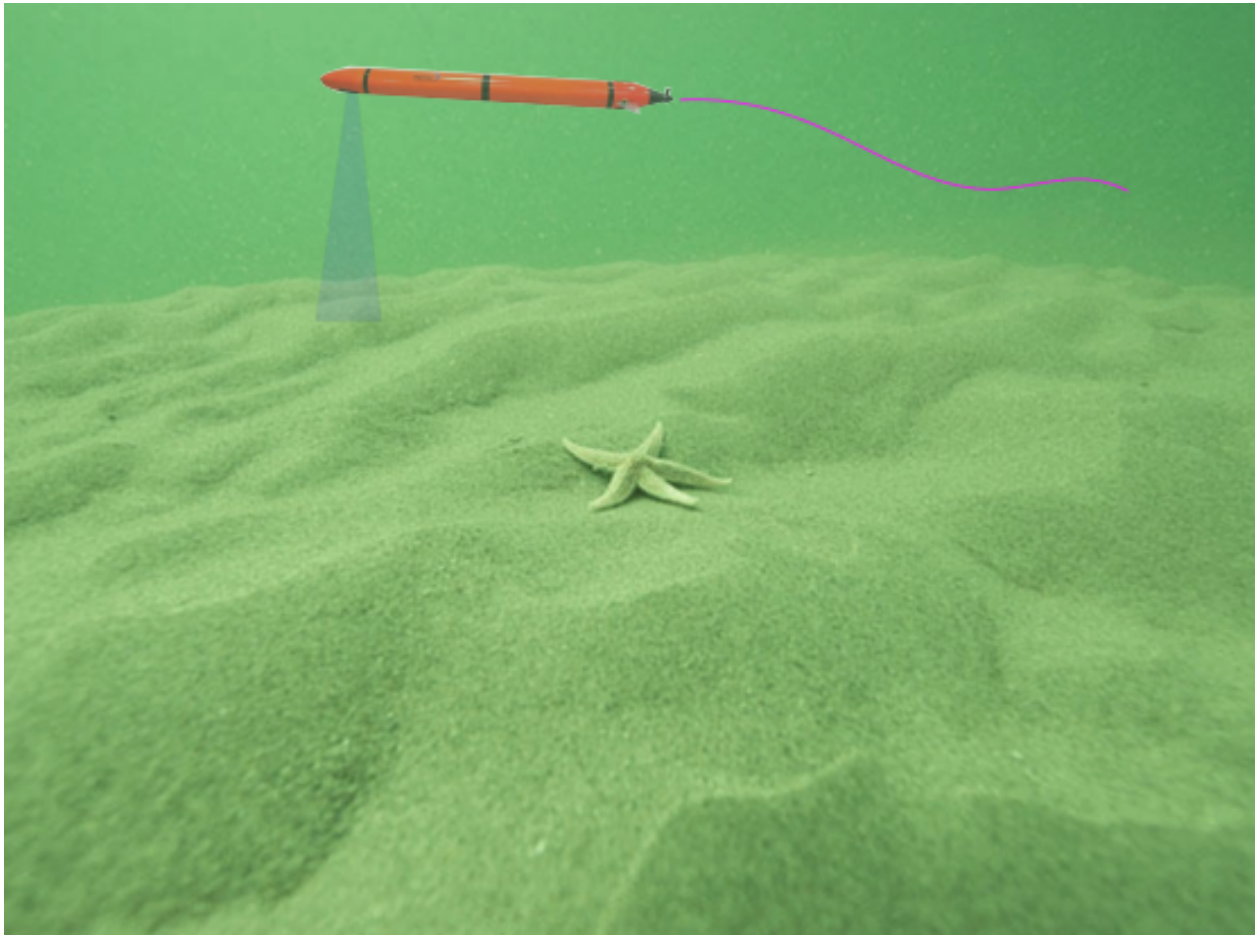
Submeeting 2018

Follow a route

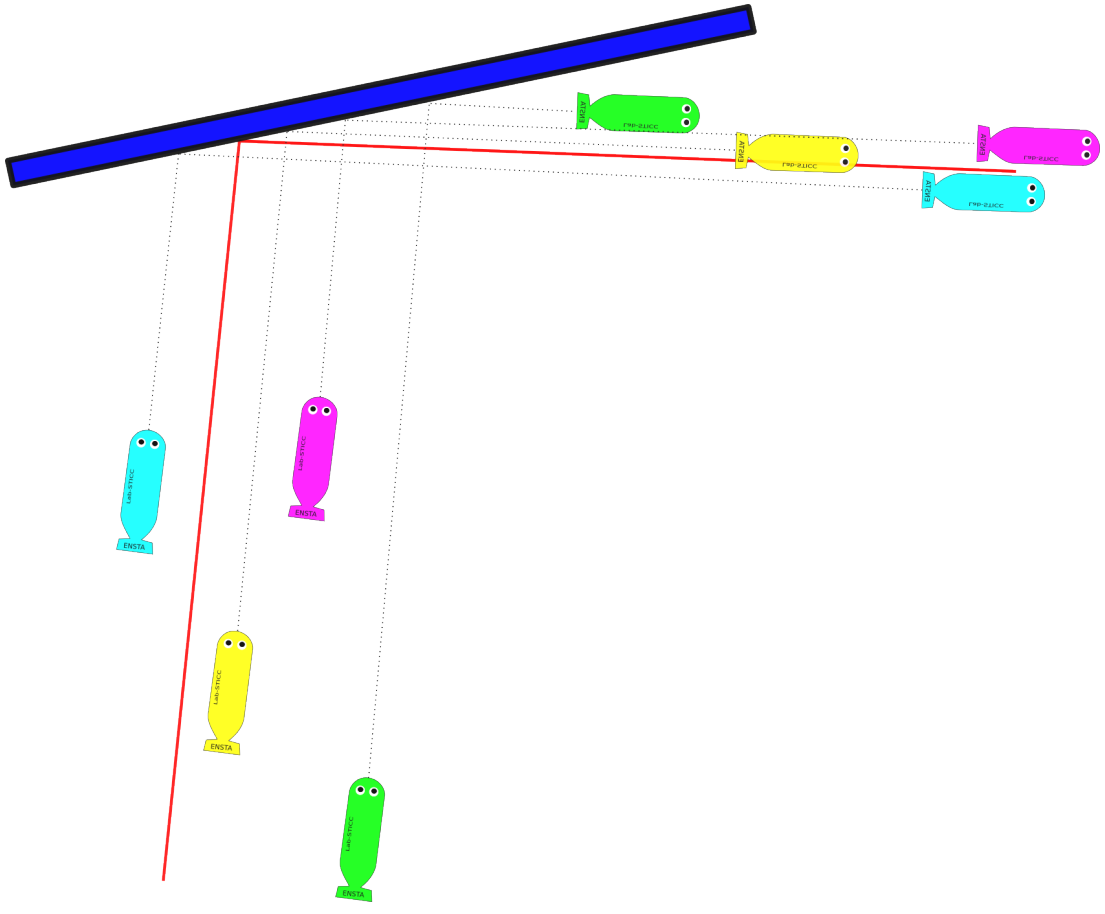
Given a function $h : \mathbb{R}^2 \mapsto \mathbb{R}$, a route in defined by $h(\mathbf{p}) = 0$. h could be the temperature, the radiation, the pressure, the altitude, the time shift between two periodic events.

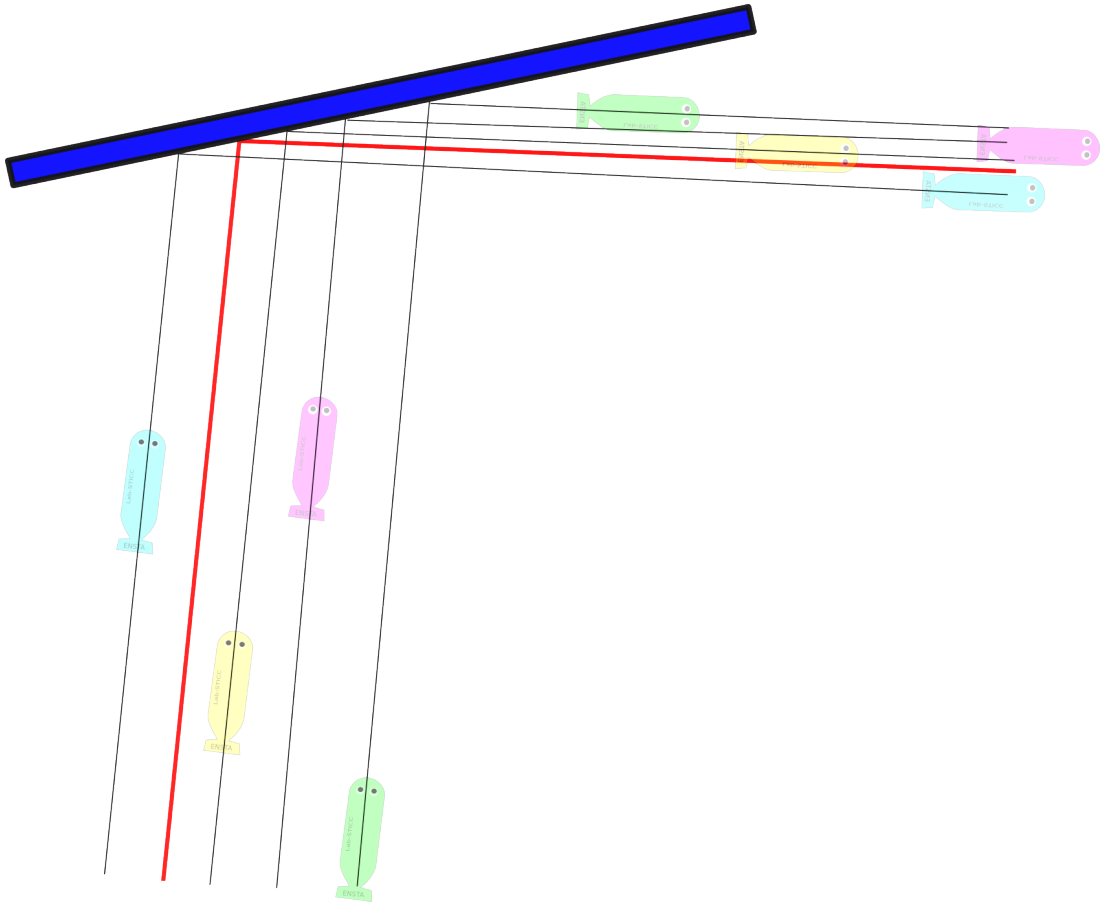


2. Stable bouncing (phd of Quentin Brateau)

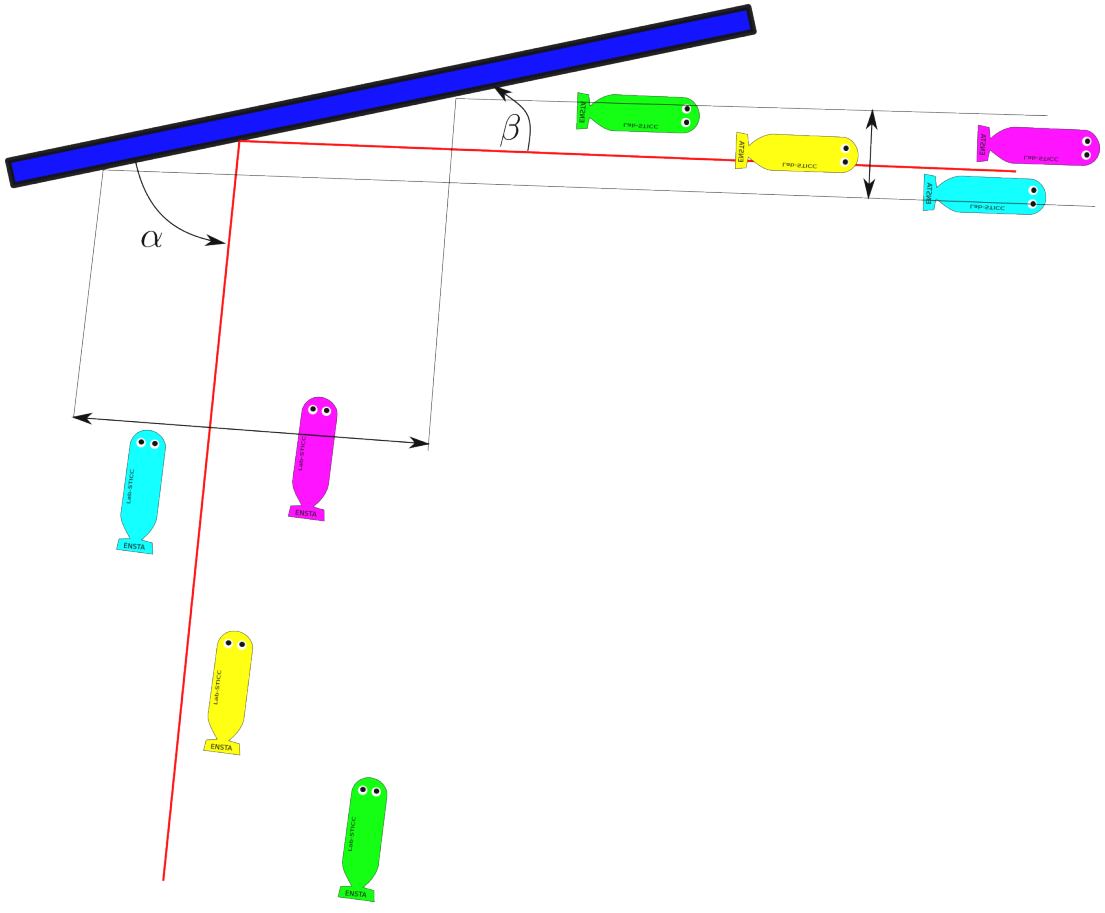


No route exists

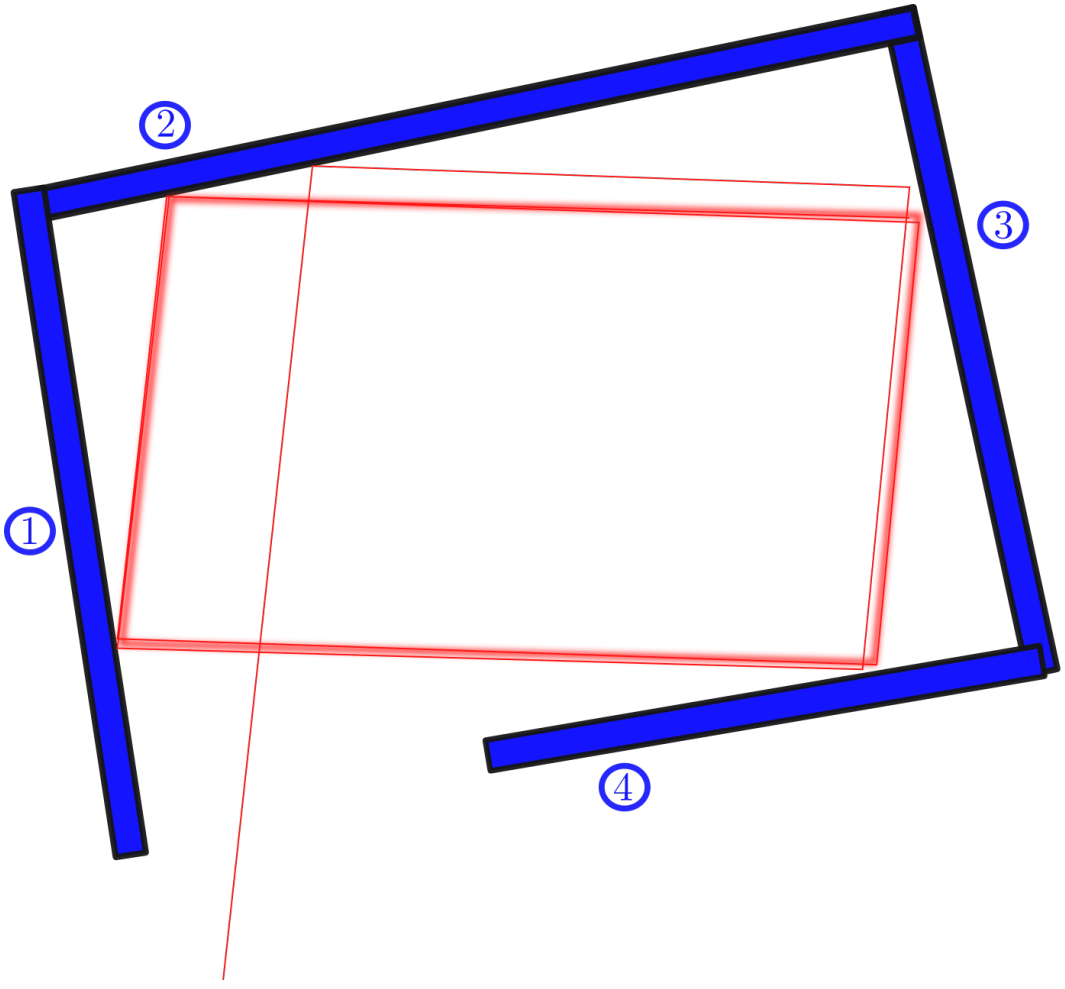




Contraction of the distance



Contraction if $\frac{\sin\beta}{\sin\alpha} < 1$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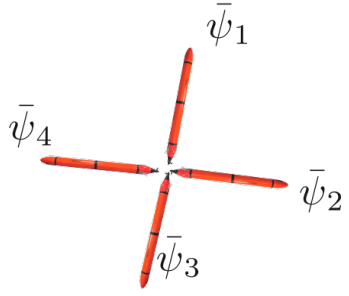
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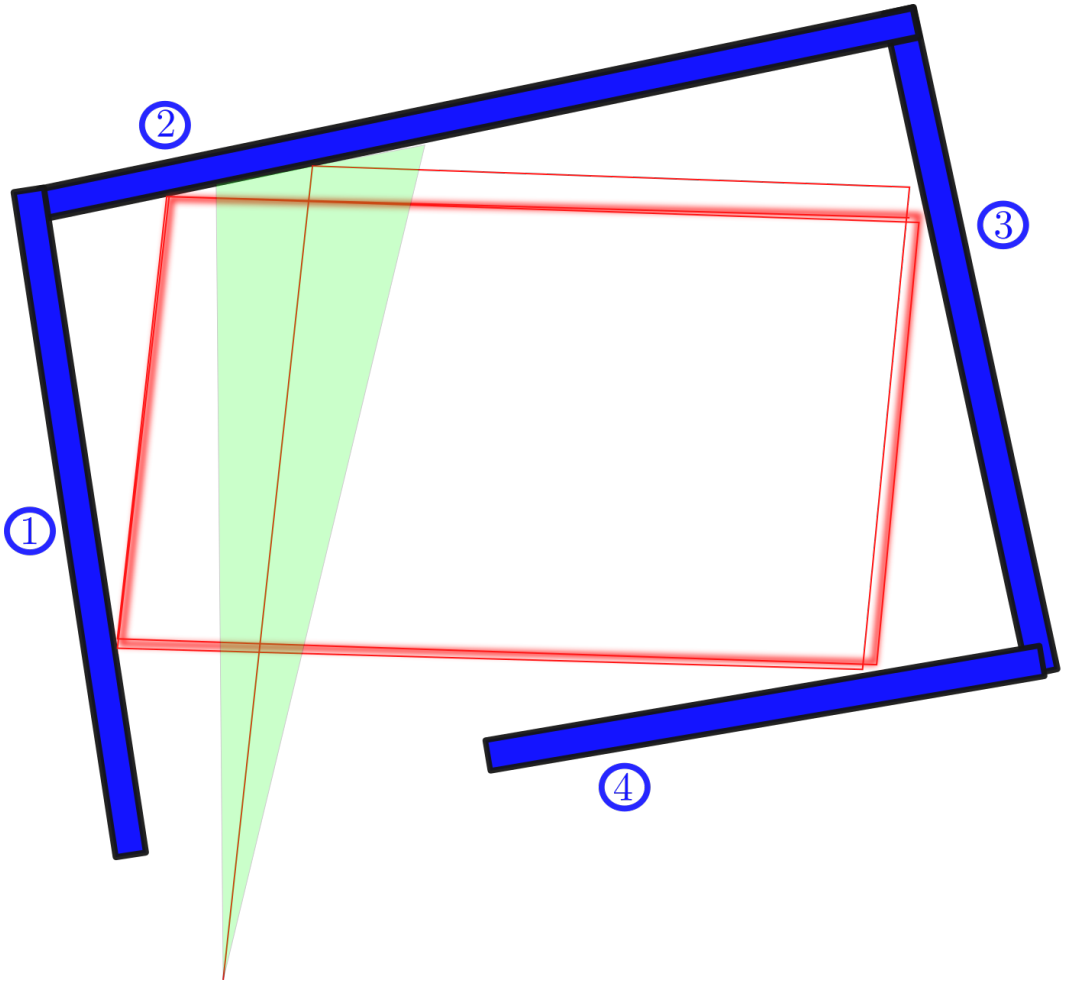
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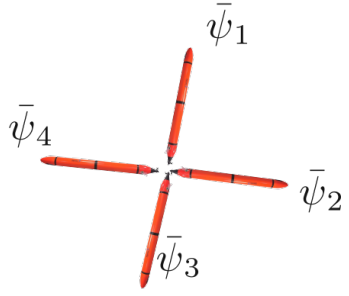
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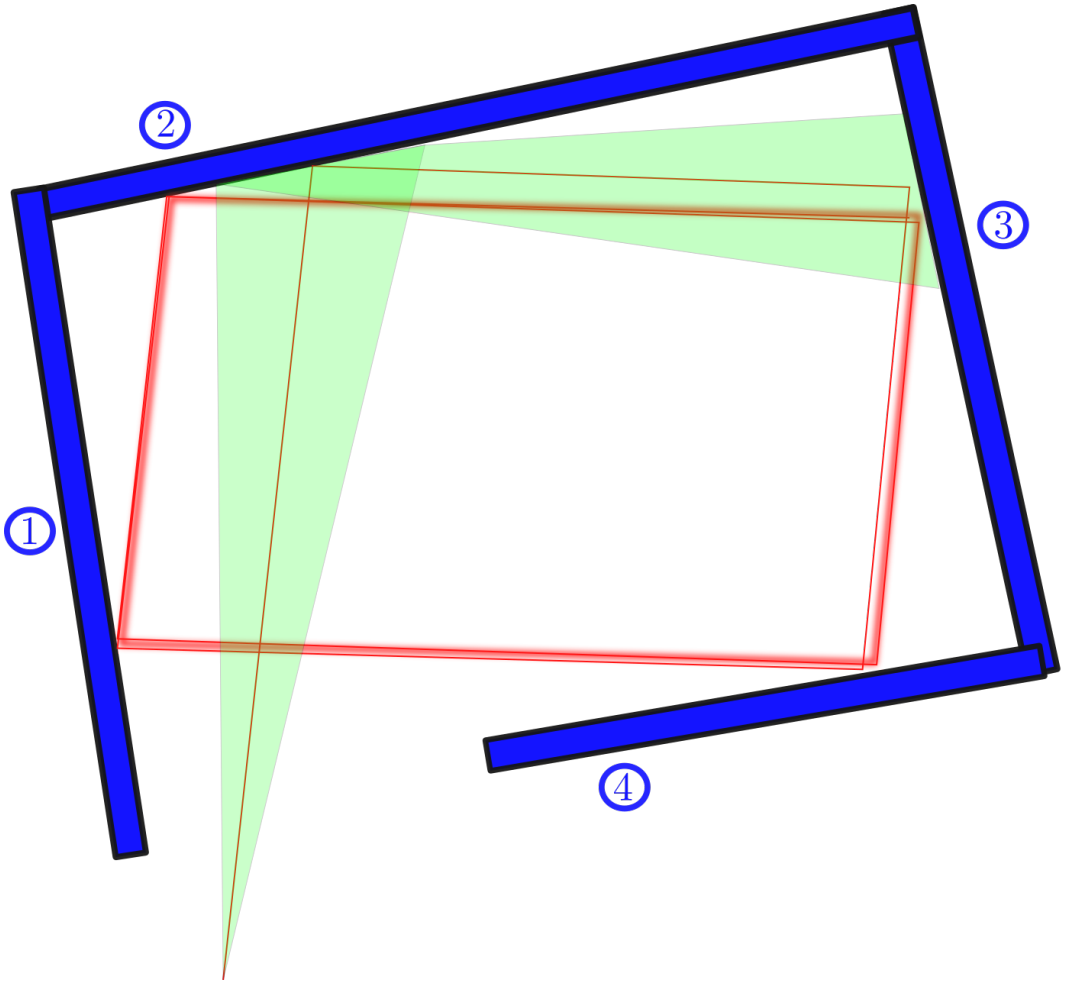
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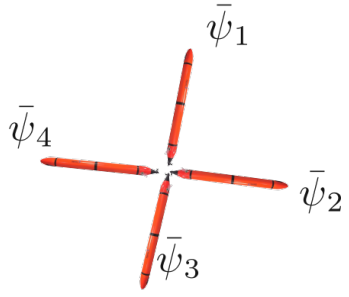
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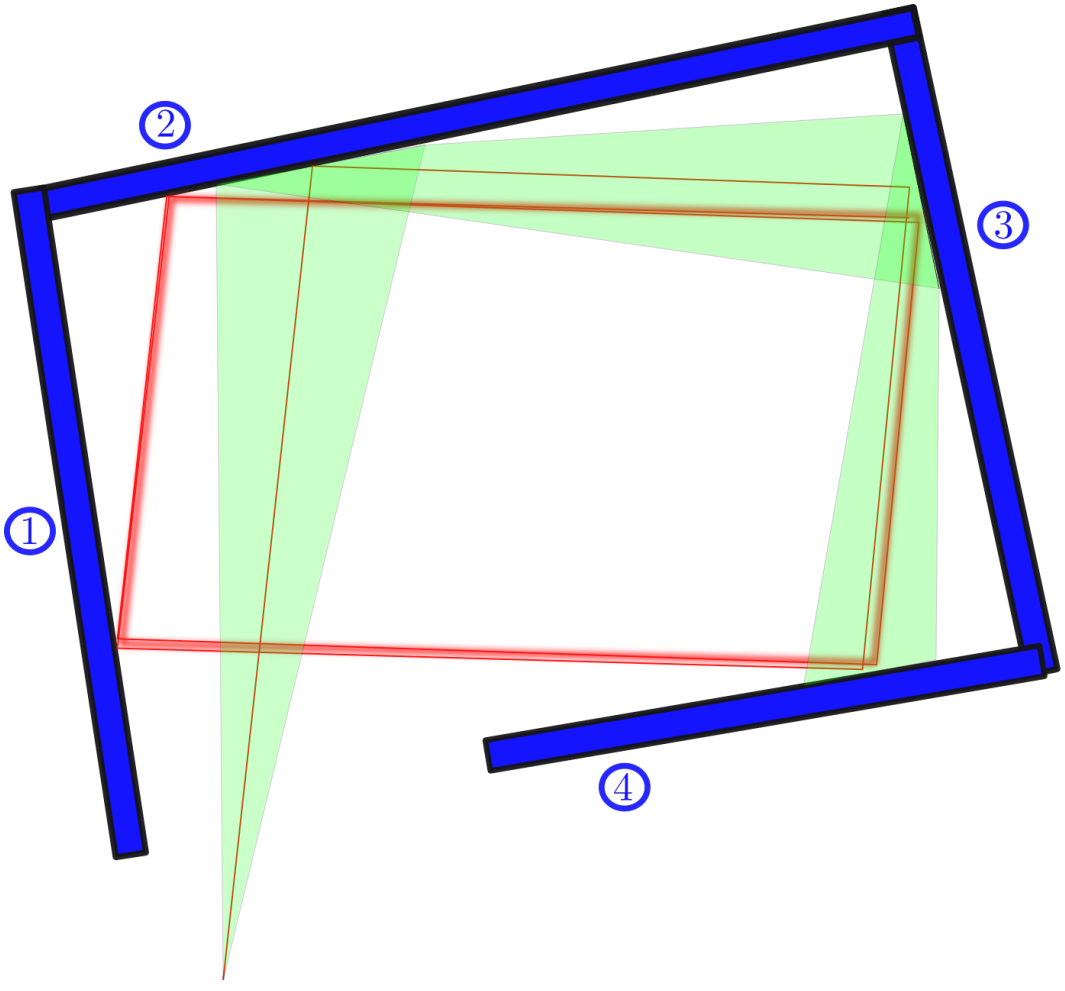
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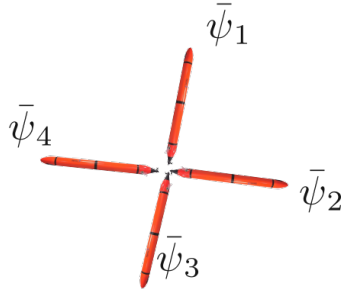
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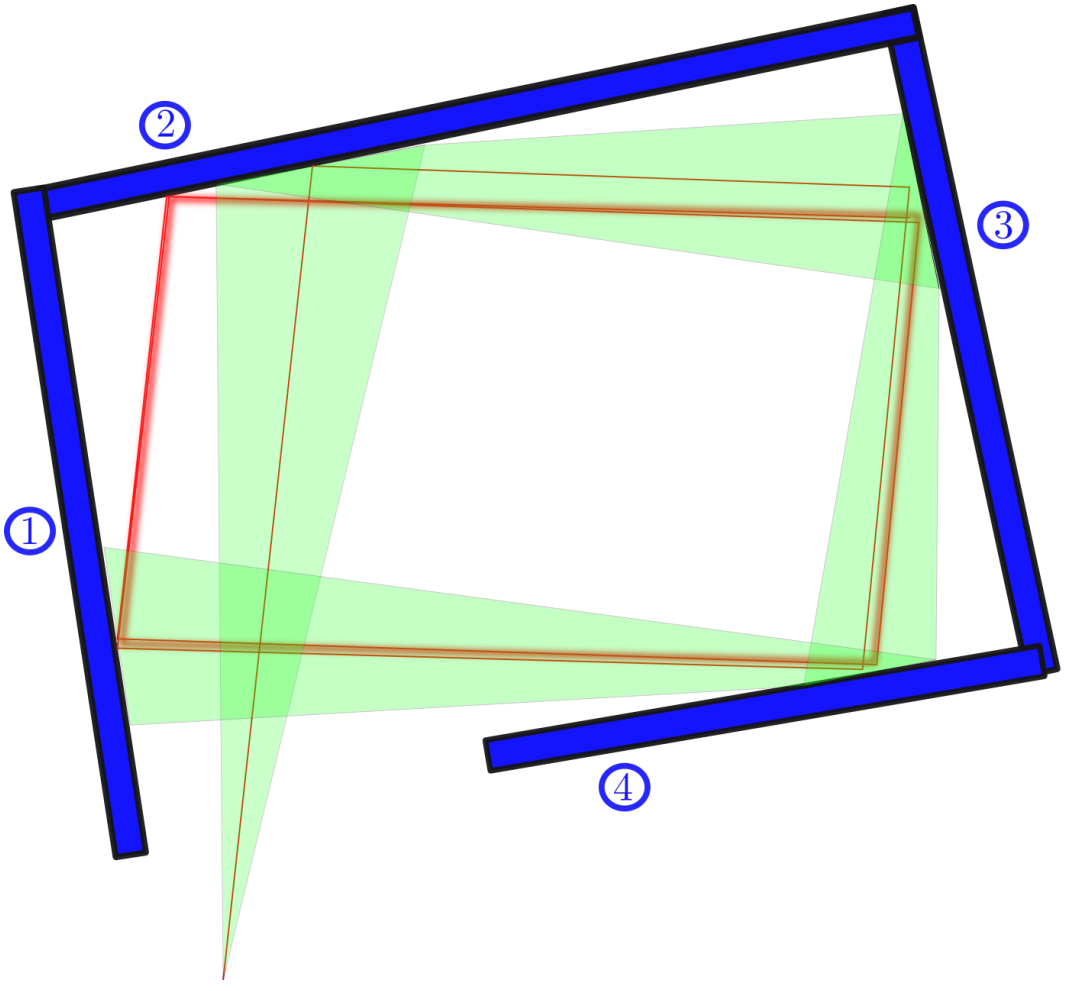
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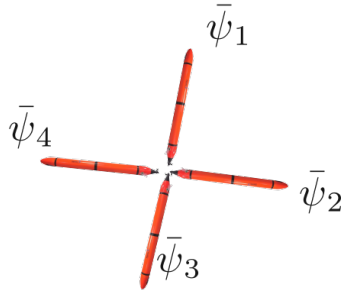
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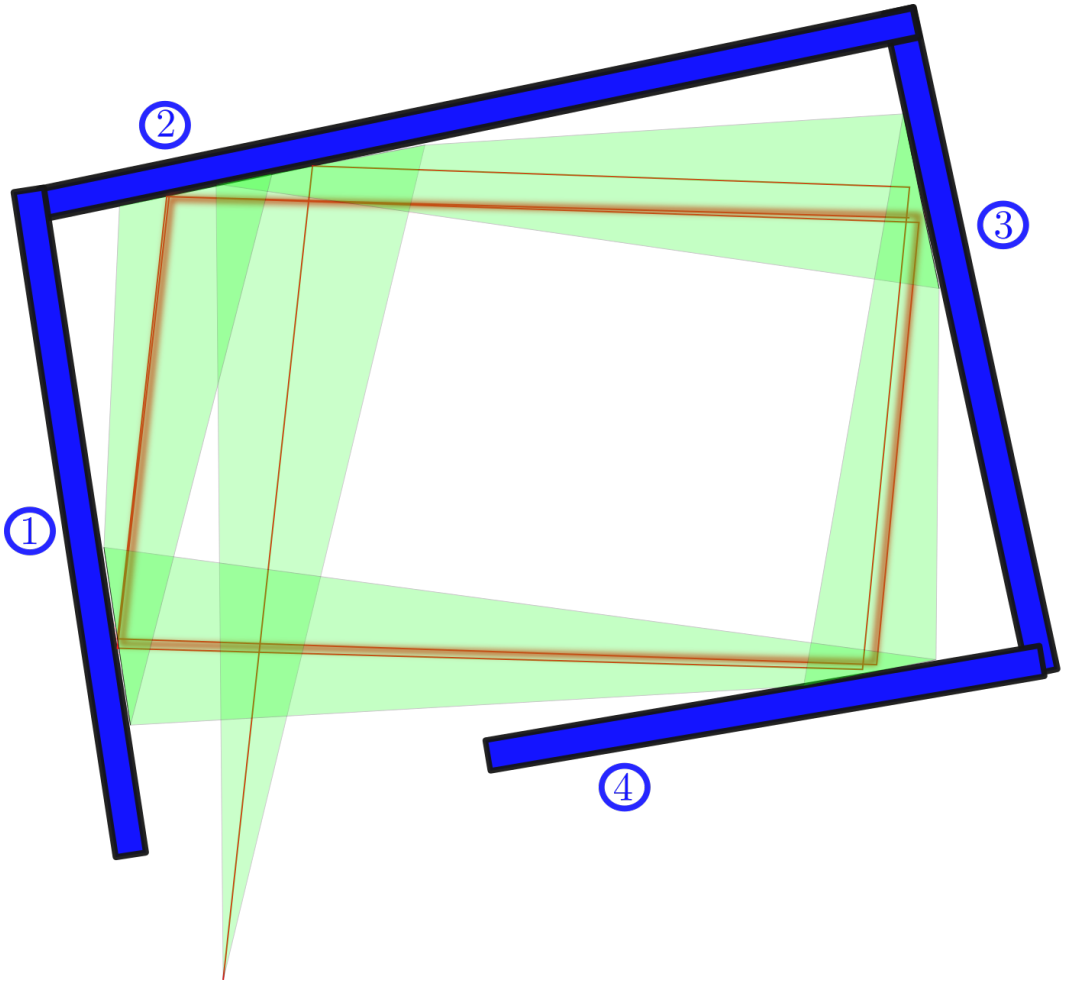
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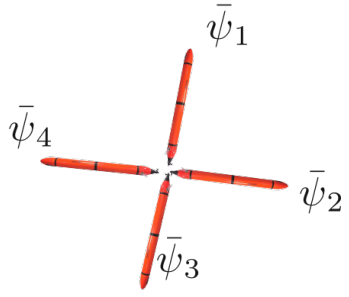
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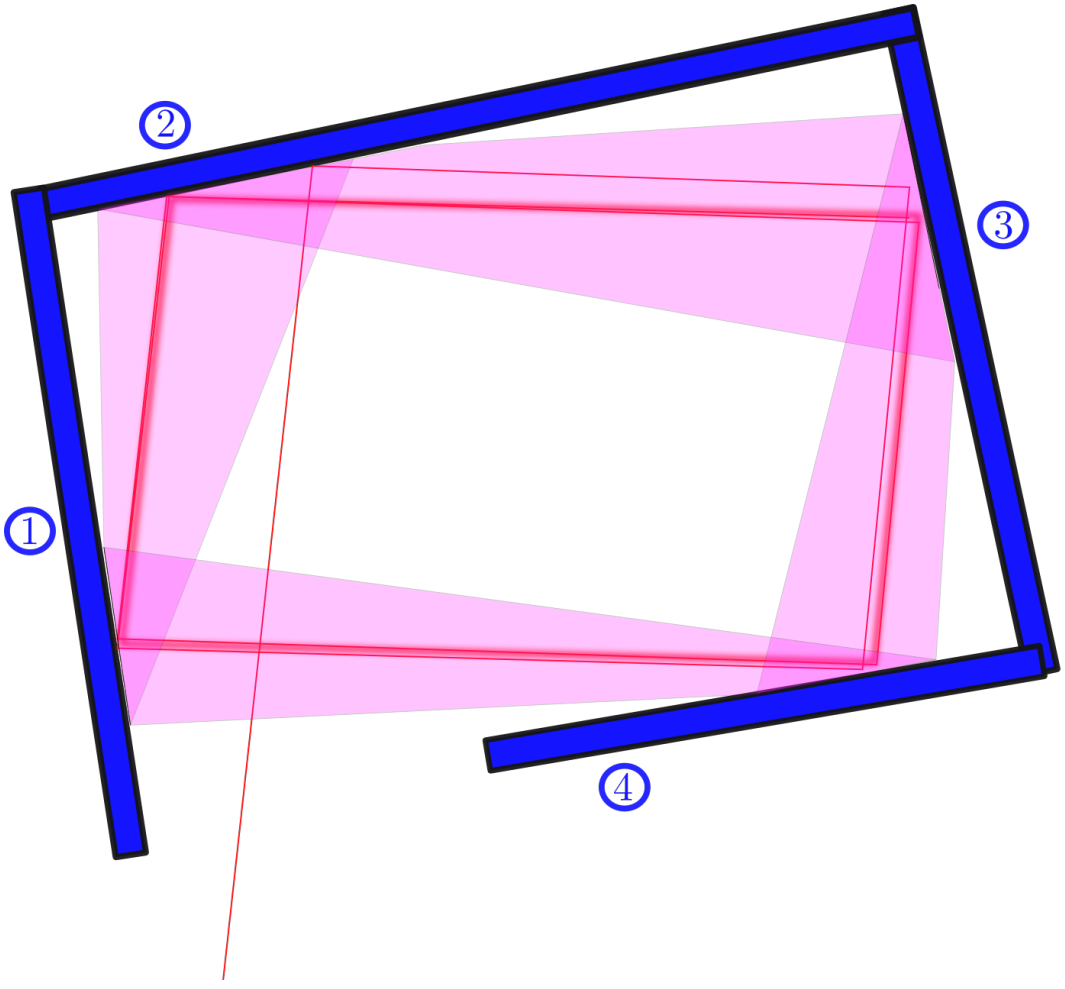
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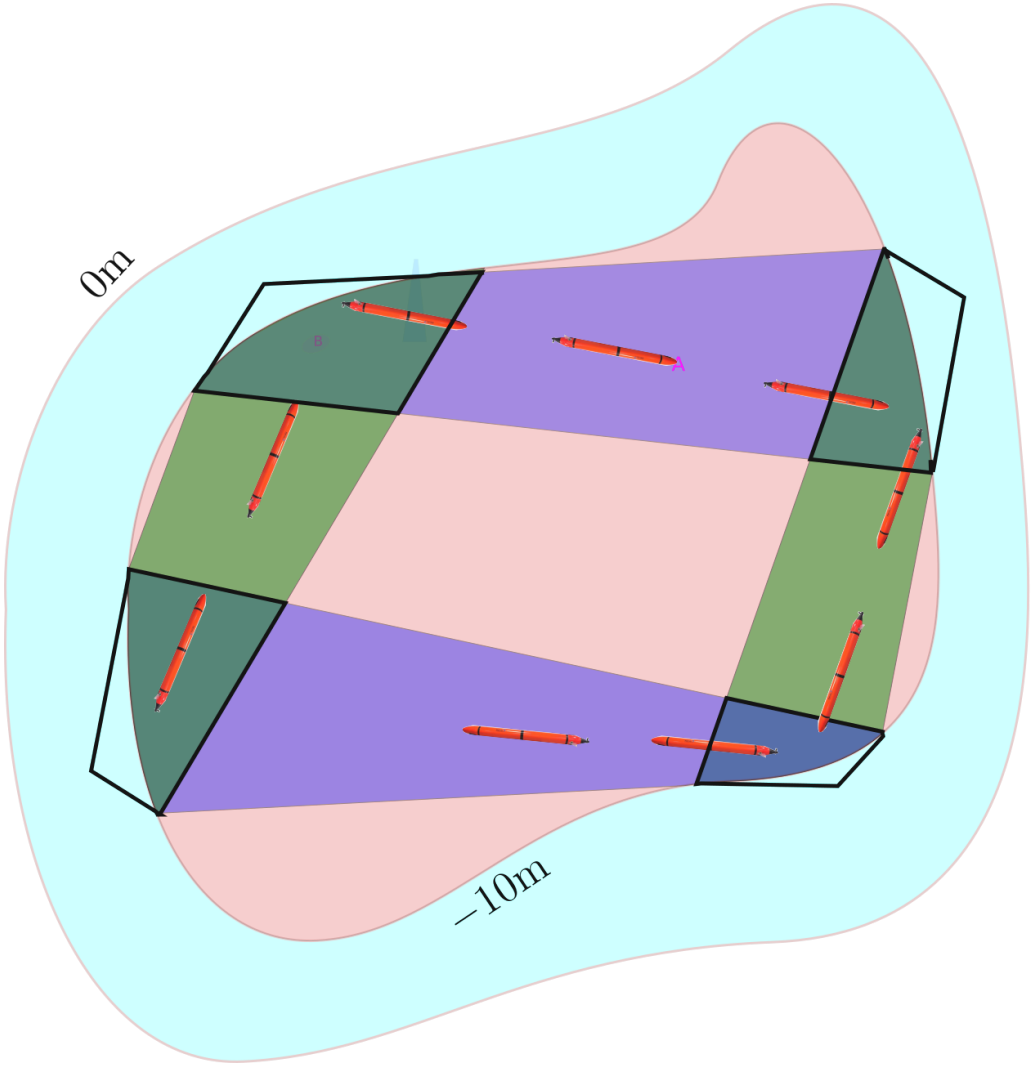
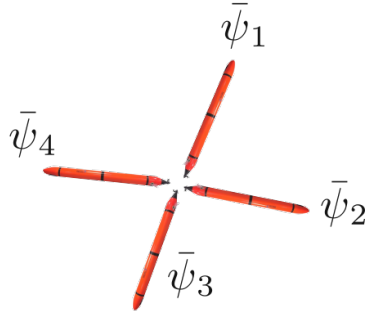

0m
−10m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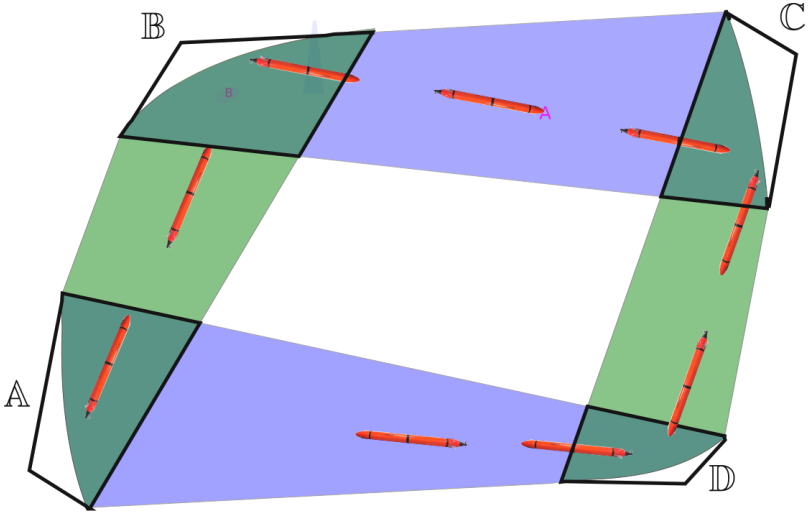
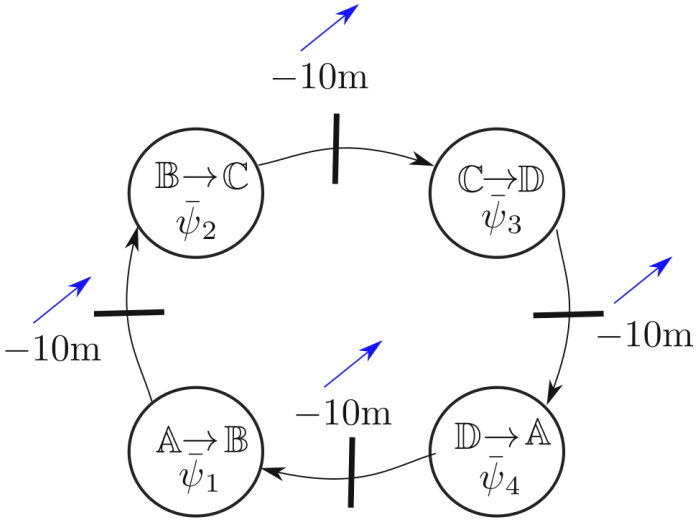
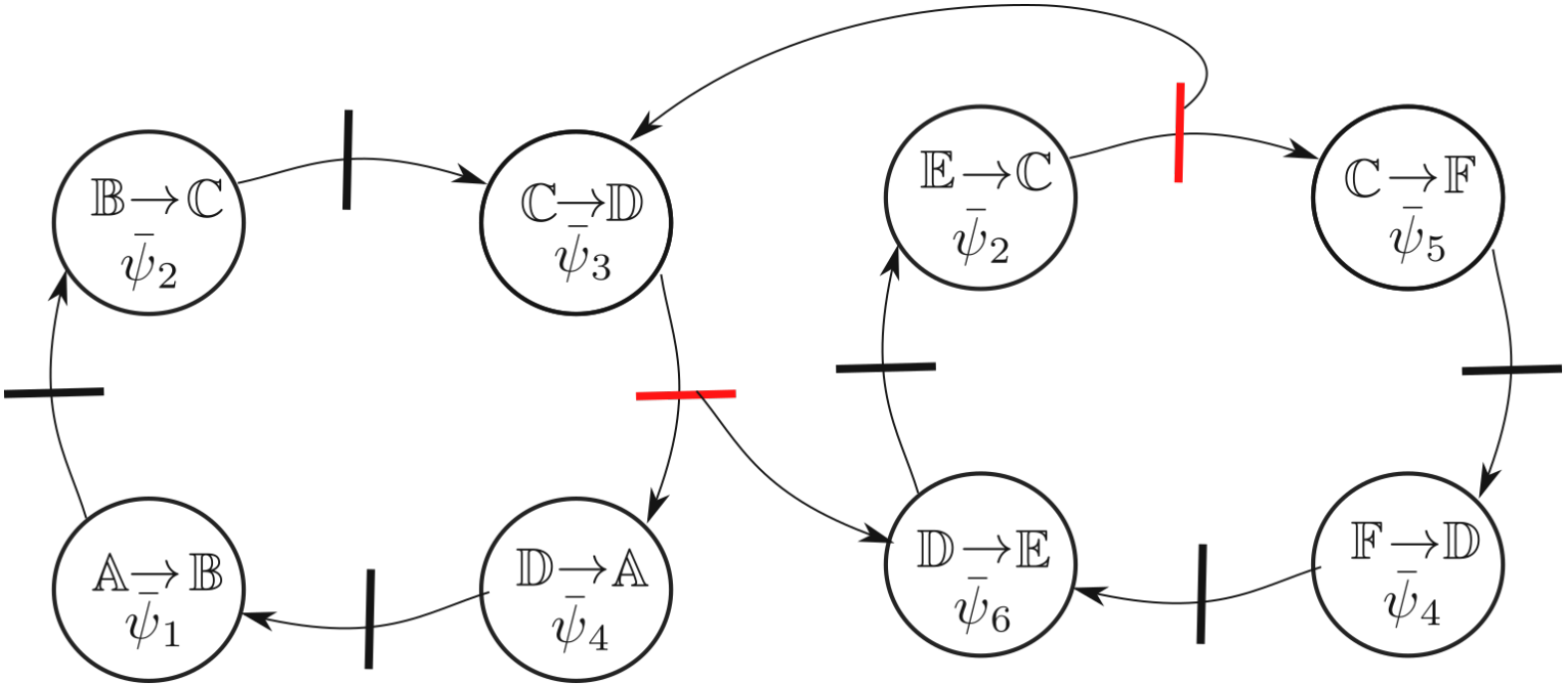
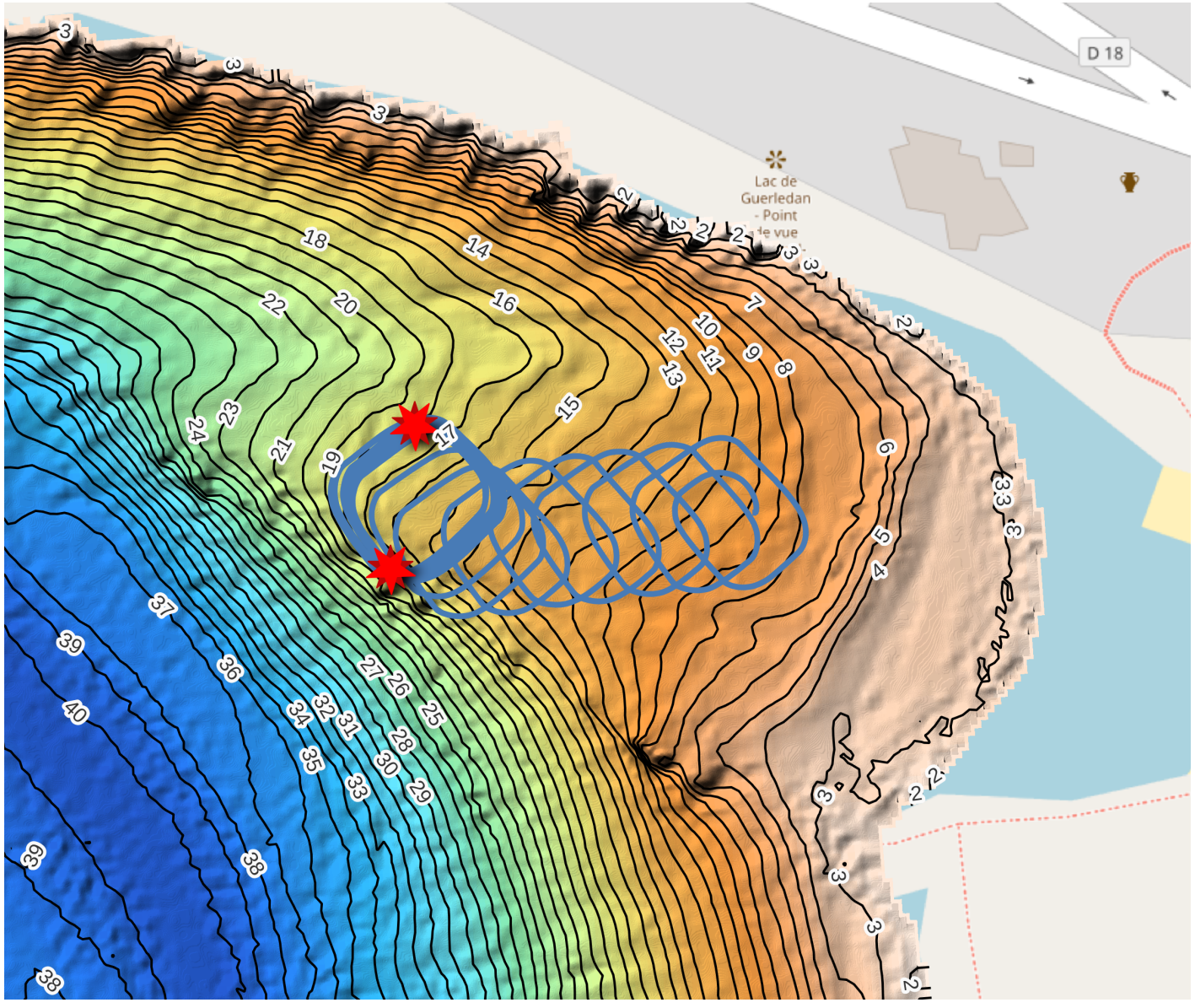

𝔹
ℂ
𝔸
𝔻


−10m
𝔹→ℂ
$\bar{\psi}_2$
ℂ→𝔻
$\bar{\psi}_3$
−10m
−10m
−10m
𝔸→𝔹
$\bar{\psi}_1$
𝔻→𝔸
$\bar{\psi}_4$


$\mathbb{B}\to\mathbb{C}$
$\bar{\psi}_2$
$\mathbb{C}\to\mathbb{D}$
$\bar{\psi}_3$
$\mathbb{E}\to\mathbb{C}$
$\bar{\psi}_2$
$\mathbb{C}\to\mathbb{F}$
$\bar{\psi}_5$
$\mathbb{A}\to\mathbb{B}$
$\bar{\psi}_1$
$\mathbb{D}\to\mathbb{A}$
$\bar{\psi}_4$
$\mathbb{D}\to\mathbb{E}$
$\bar{\psi}_6$
$\mathbb{F}\to\mathbb{D}$
$\bar{\psi}_4$

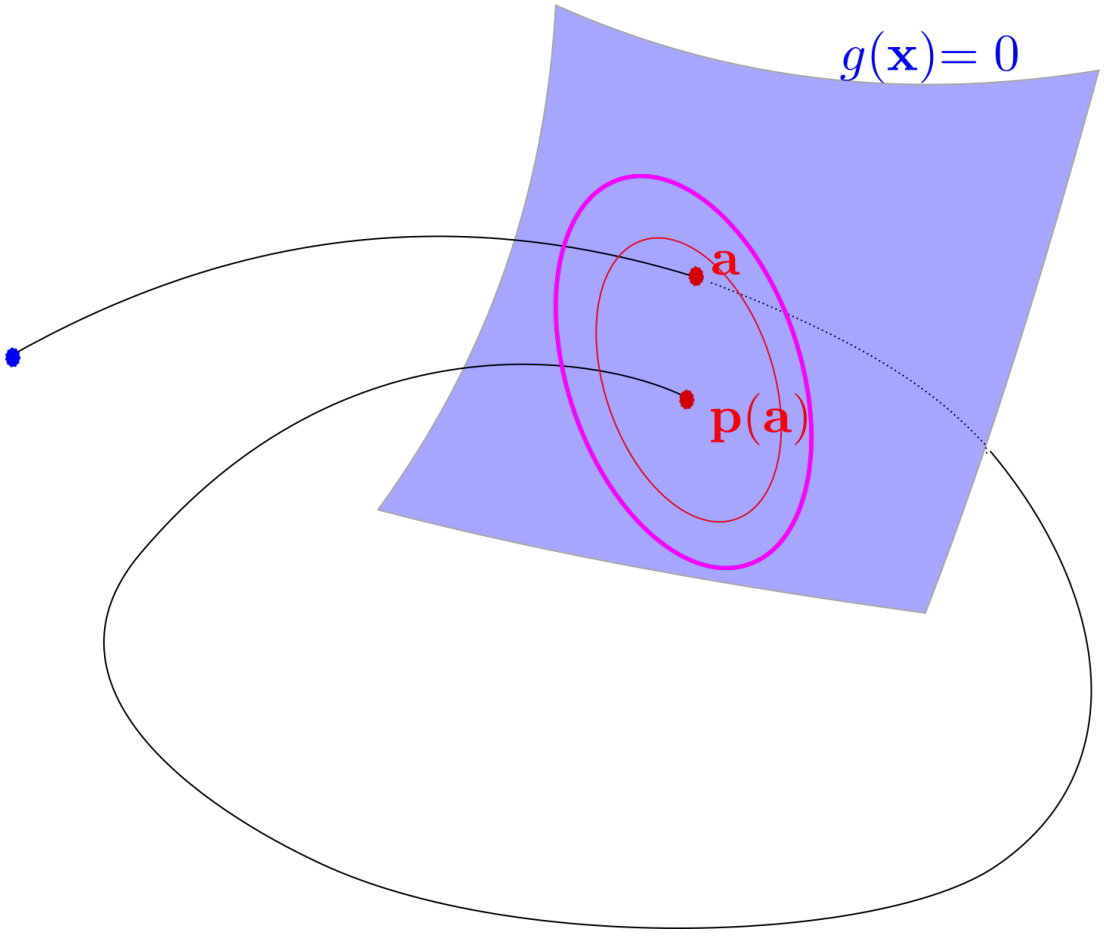
Experiment (phd of Quentin Brateau)


D 18
Lac de
Guerledan
- Point

Stability of cycles

The Poincaré first recurrence map is defined by

$$\mathbf{a}(k+1) = \mathbf{p}(\mathbf{a}(k))$$


$g(\mathbf{x}) = 0$
a
p(a)

References

1. Interval and stability [2][7]
2. Route following [4][5]
3. Navigation with stable cycles [3]
4. Tubes [6][1]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