

GRENE 北極気候変動研究事業 特別セミナー

北極海航路の利用実現に向けて

最適ルート選択モデルの検討

釧路工業高等専門学校

高木 敏幸

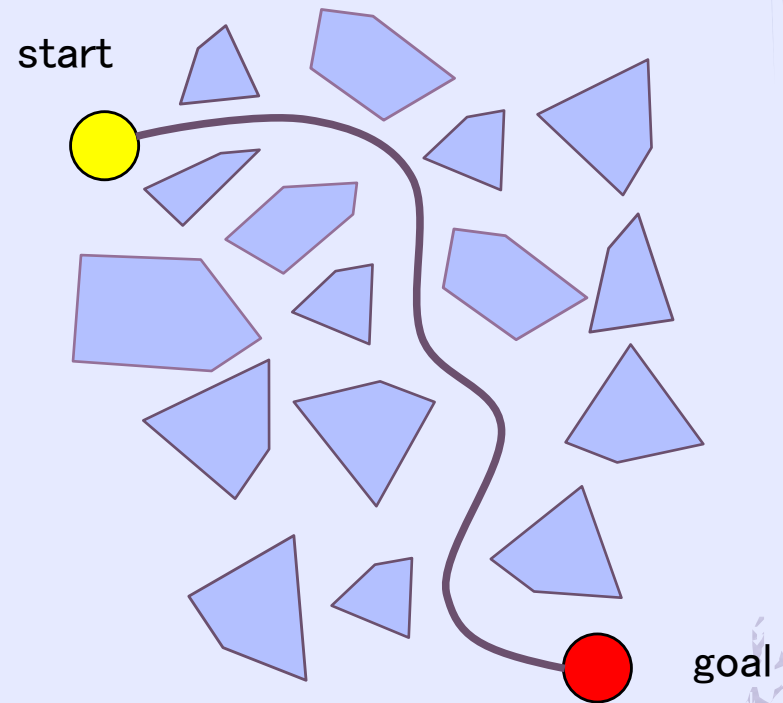
障害物回避経路計画

海水による船舶の損傷

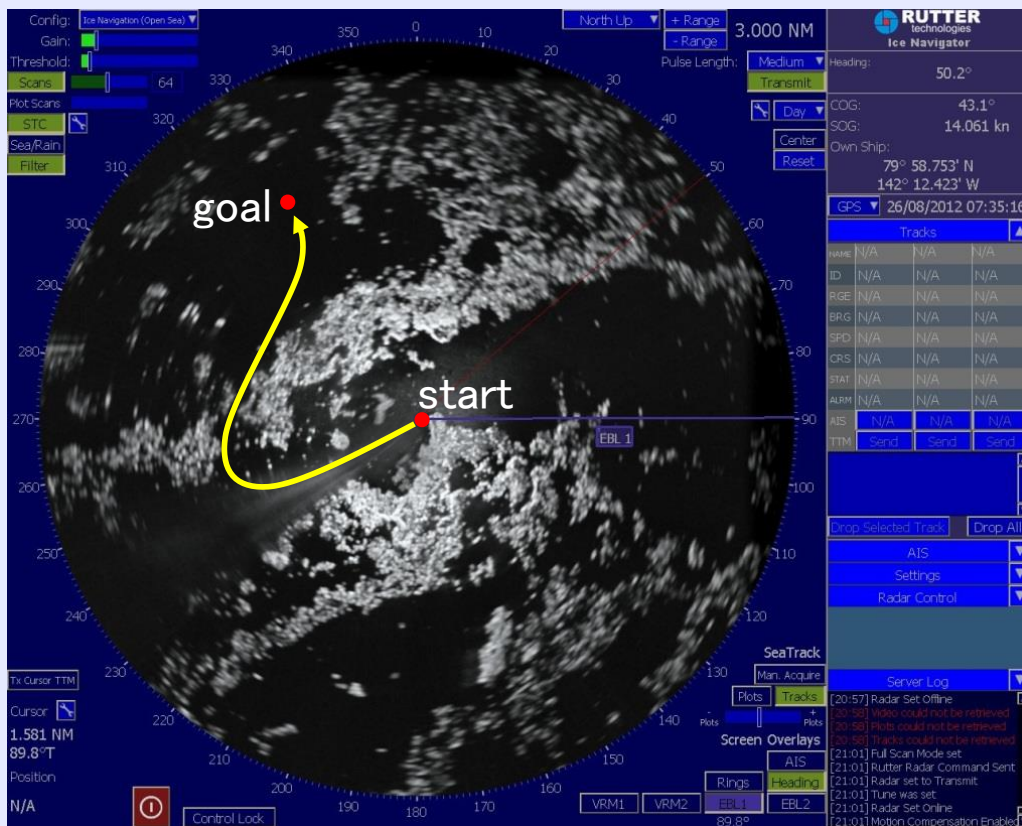


過去25年感に200件以上

障害物回避経路計画



船舶レーダ画像と航路



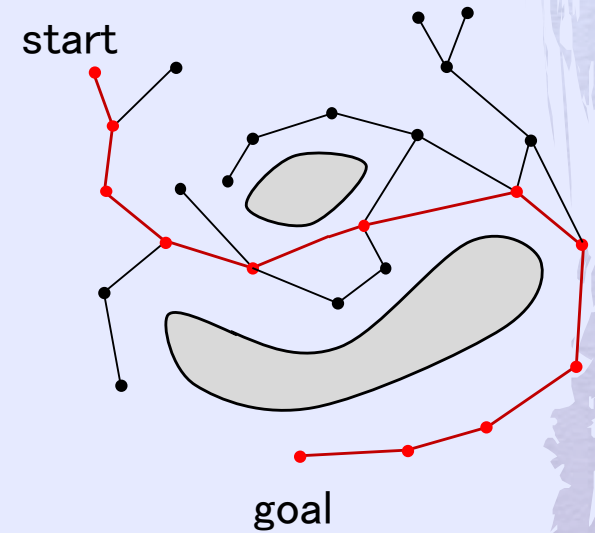
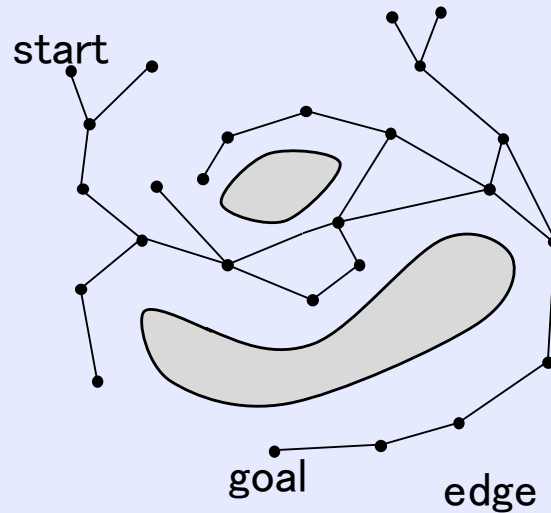
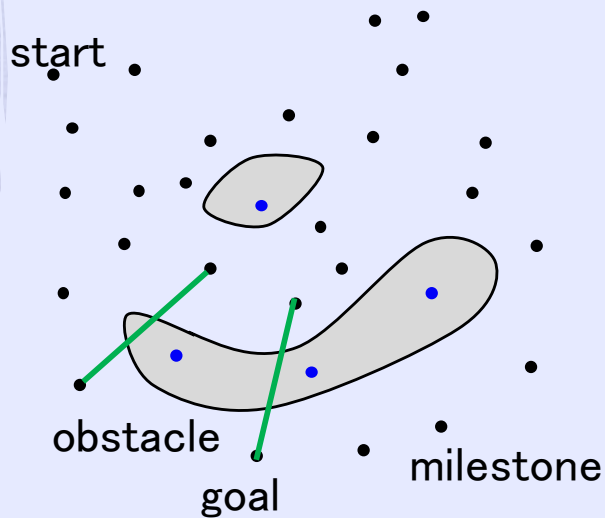
79° 58.753'N
142° 12.423'W
26/08/2012

0 3.0
NM (5556 m)

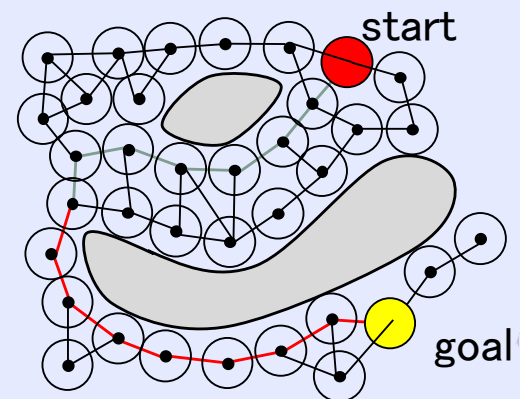
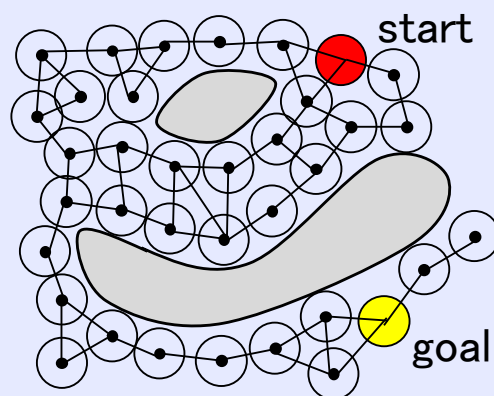
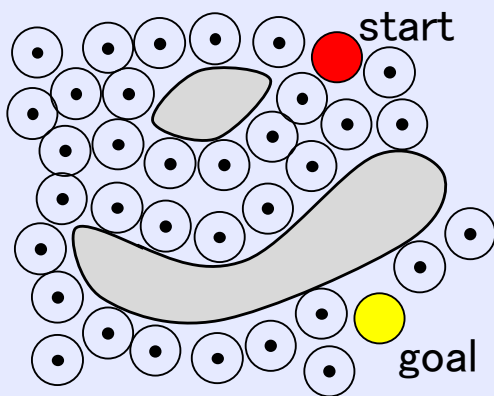
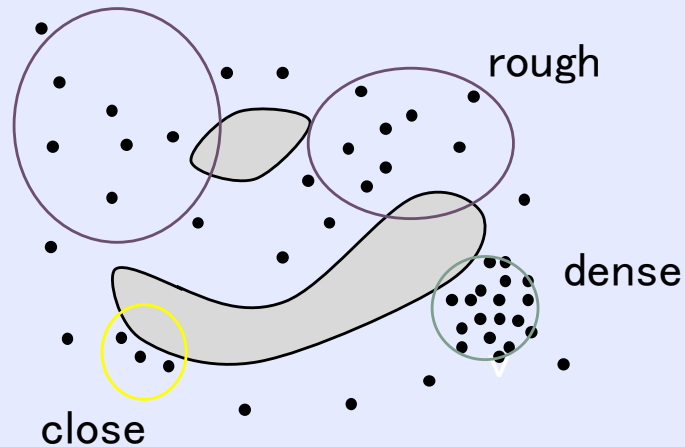
確率的ローマップ法

① ロードマップ構築

② 探索



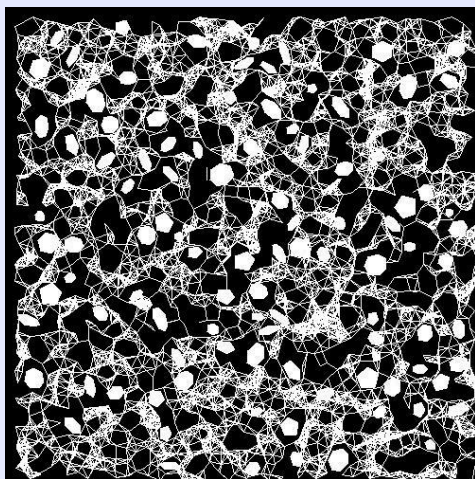
マイルストーンのサンプリング方法



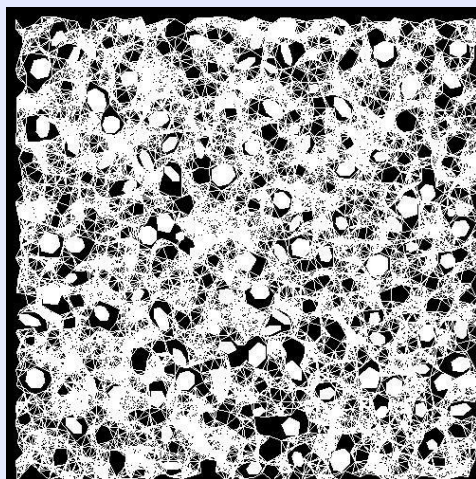
ロードマップグラフ

従来のサンプリング方法

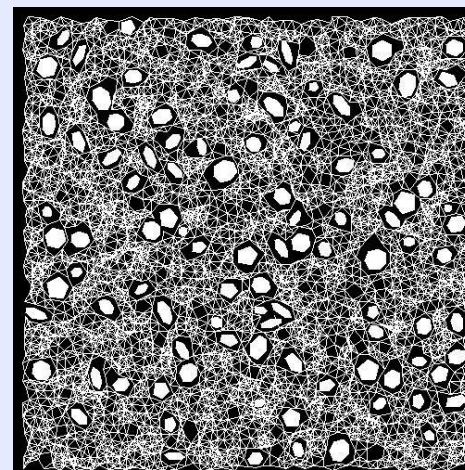
提案手法



2000 milestones



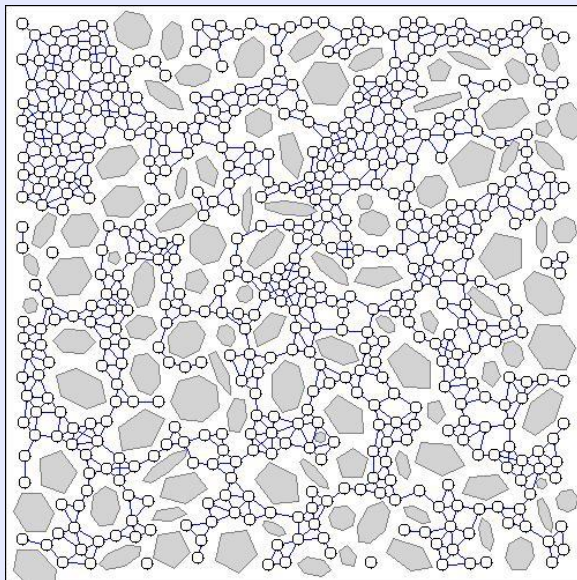
4000 milestones



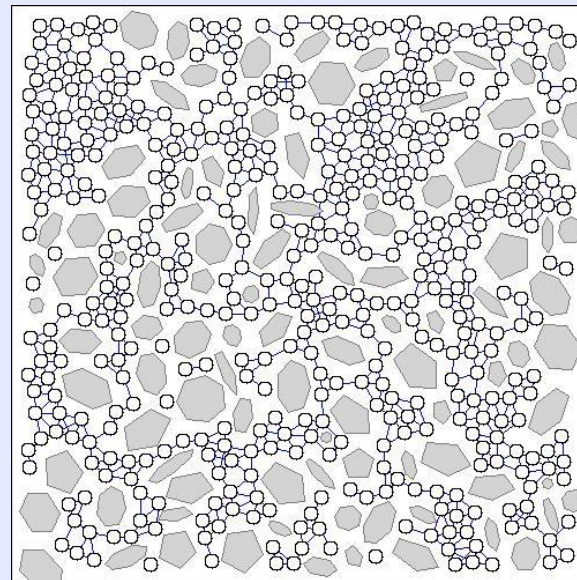
2000 milestones

ロードマップグラフ

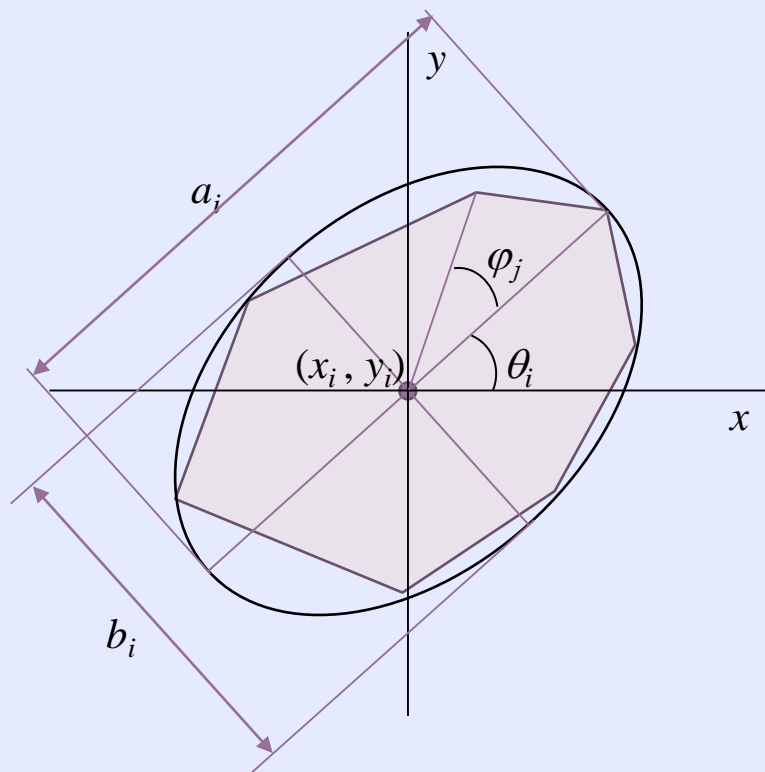
a) $r = 3$ [pixel]



b) $r = 6$ [pixel]



海氷のパラメータ



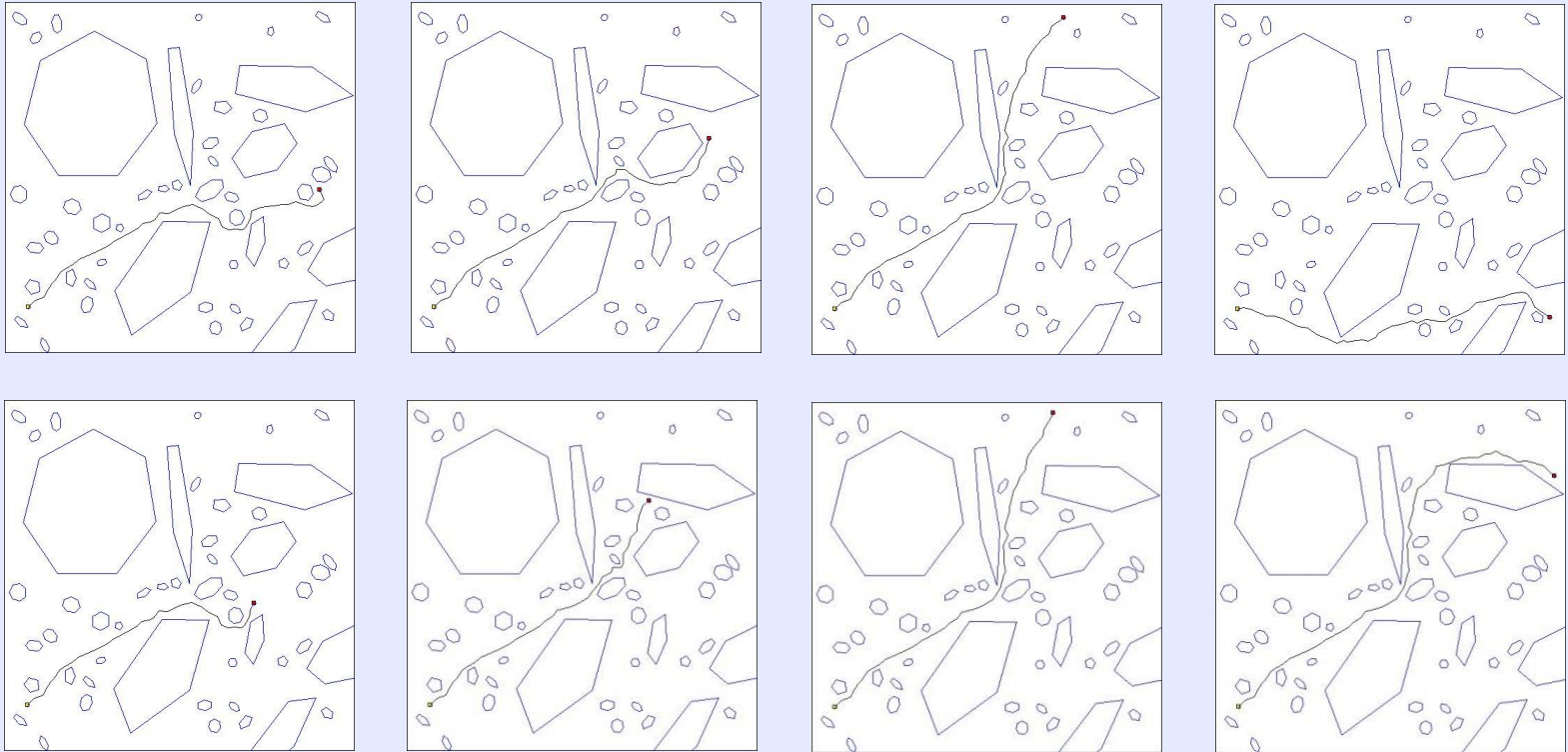
- 長軸: a^i
- 短軸: b^i
- 角数: n^i
- 座標: x_i, y_i
- 傾き: θ_i

$$\varphi_j = \varphi_{j-1} + \frac{2\pi}{n^i} (1 + k\gamma)$$

$$j = 2, \dots, n^i \quad \varphi_0 = 0$$

シミュレーション(1)

—密接度4—



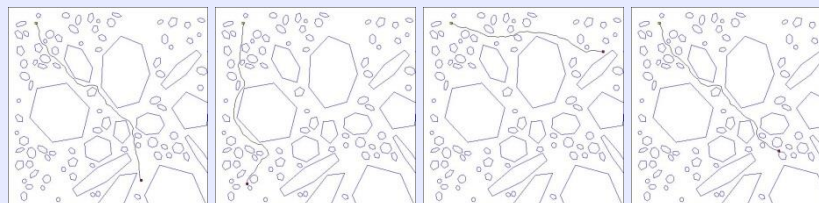
(big ice floe2 & small ice floe2)

$r = 3$ [pixel] 2500 milestones

シミュレーション(2)

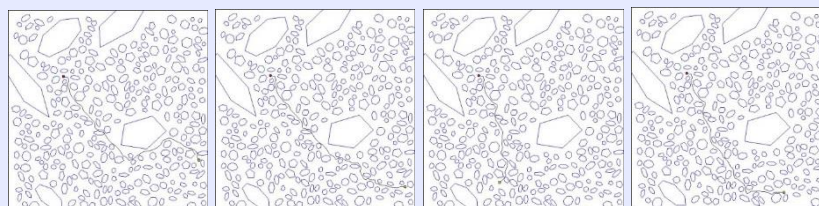
—密接度5—

including 2 tenth of big floes and 3 tenth of small floes



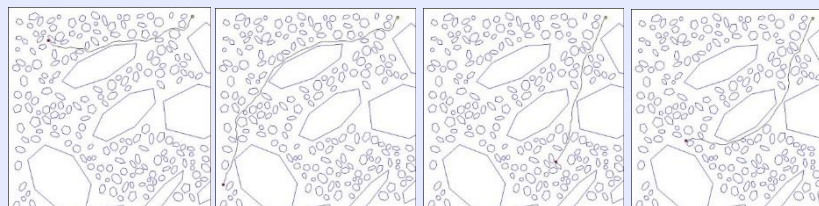
($r=3$ [pixel] 2500 milestones)

including 1 tenth of big floes and 4 tenth of small floes



($r=3$ [pixel] 1800 milestones)

including 2 tenth of big floes and 3 tenth of small floes



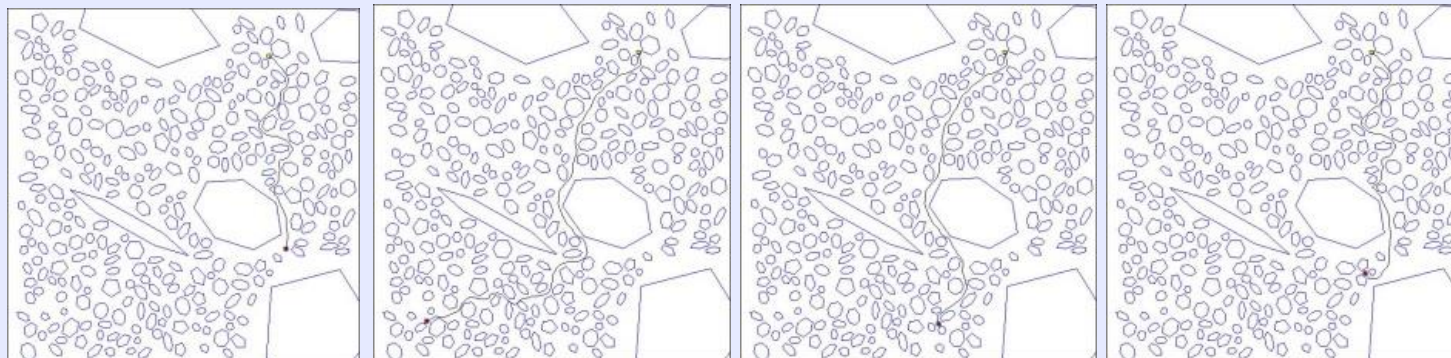
($r=3$ [pixel] 1800 milestones)

シミュレーション(3)

—密接度6、密接度7—

密接度6

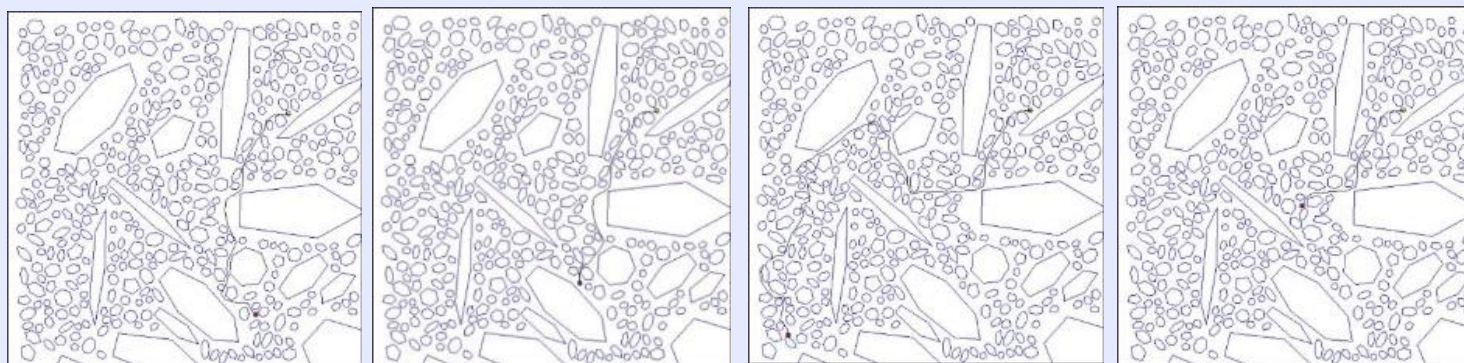
including 2 tenth of big floes and 4 tenth of small floes



($r = 3$ [pixel] 1700 milestones)

密接度7

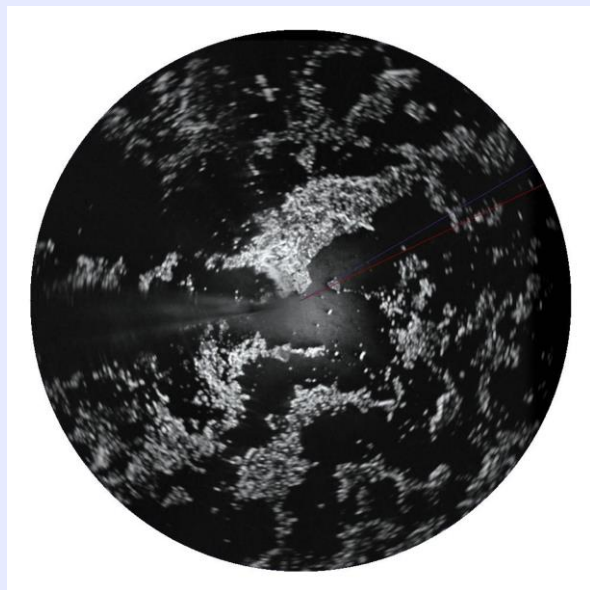
including 2 tenth of big floes and 5 tenth of small floes



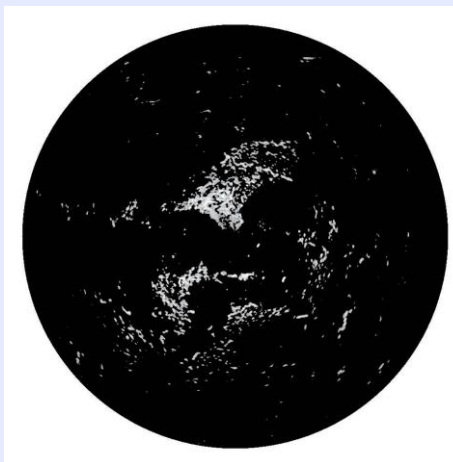
($r = 3$ [pixel] 1600 milestones)

船舶レーダ画像の 解放水面と海氷の分離

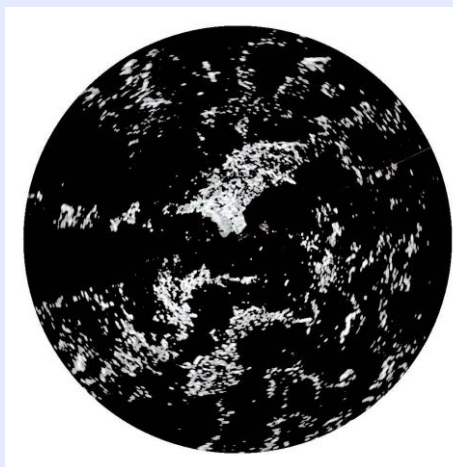
26/08/2012



0 3.0 (5556 m)
NM



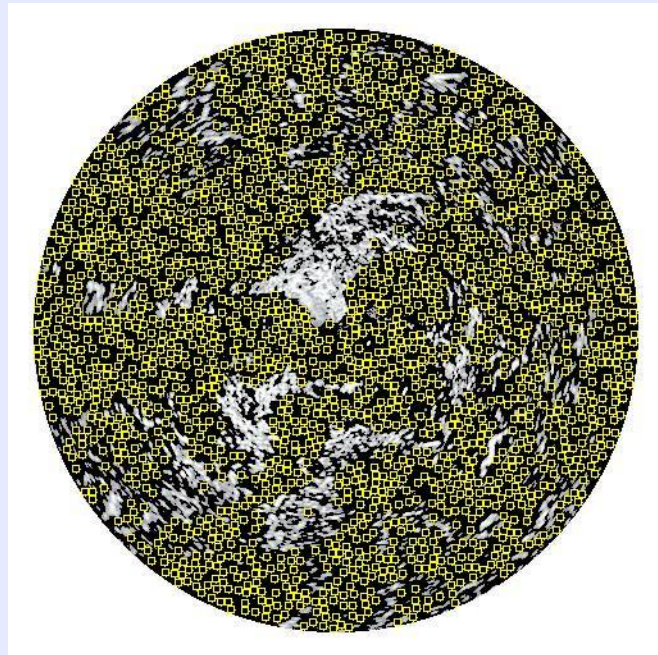
閾値処理 (150)



歪補正
閾値処理

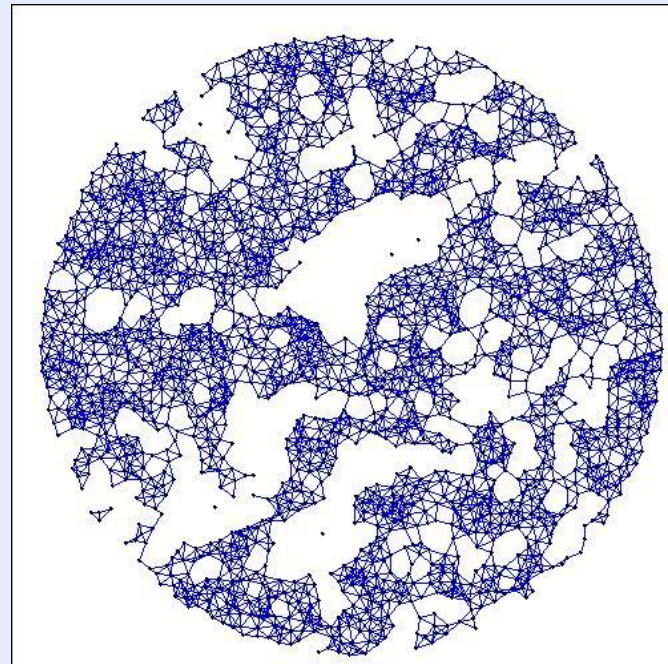
船舶レーダ画像上の マイルストーンとロードマップグラフ

マイルストーン



$r = 36$ [m], $N = 1500$, $C = 122$ [m]

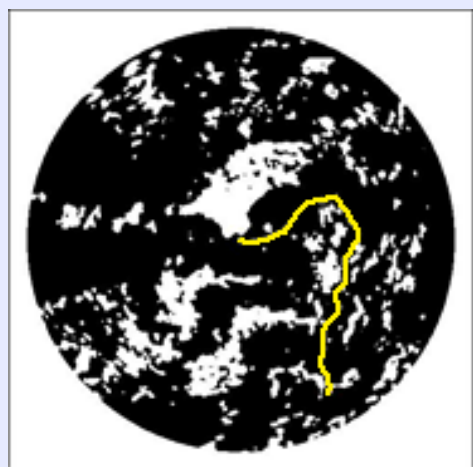
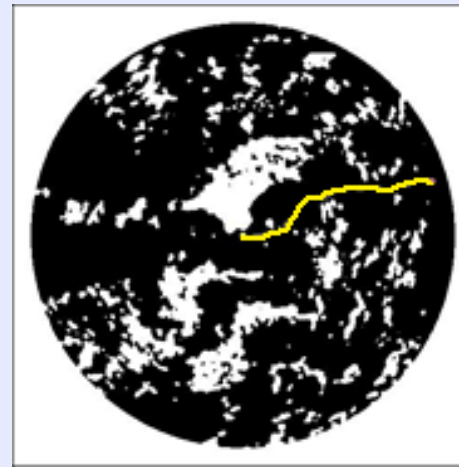
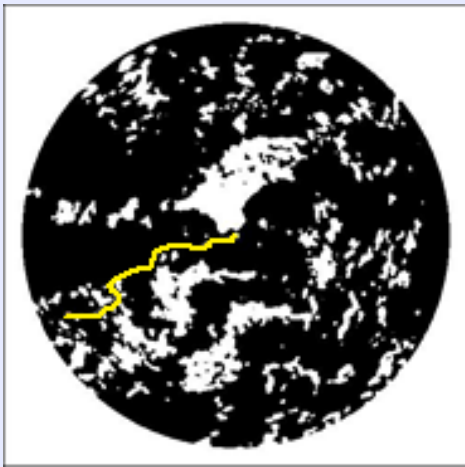
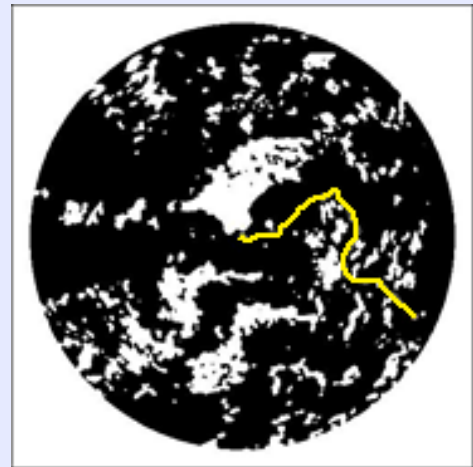
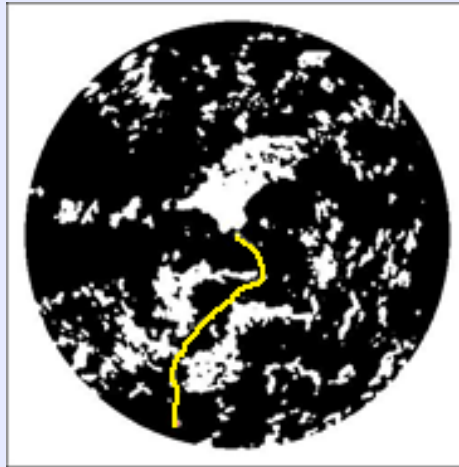
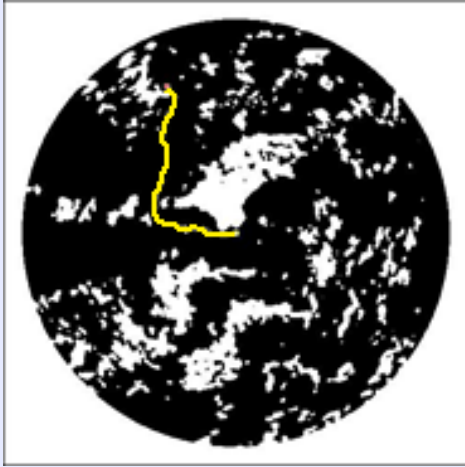
ロードマップグラフ



0 3.0

NM

選択航路



Vessel Classification

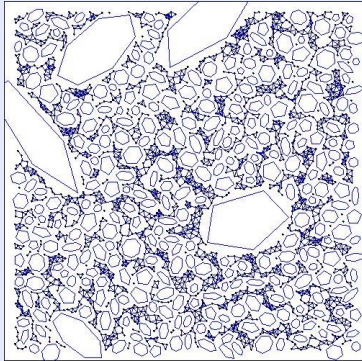
CAC—"Canadian Arctic Class" vessels

Vessel Class	Maximum Allowable Ice Type	Ice Thickness (cm)
CAC1	No Limit	no limit
CAC2	Multi-year	no limit
CAC3	Second-year	no limit
CAC4	Thick First-year	>120
Type A	Medium First-year	70-120
Type B	Thin First-year(state2)	50-70
Type C	Thin First-year(state1)	30-50
Type D	Grey-white	15-30
Type E	Open Water/Gray	10-15

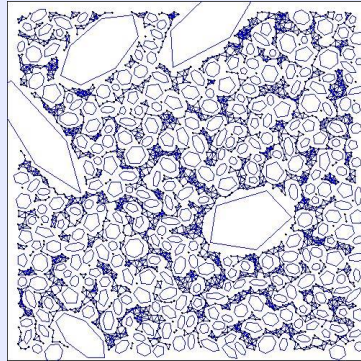


Increasing Ice capability

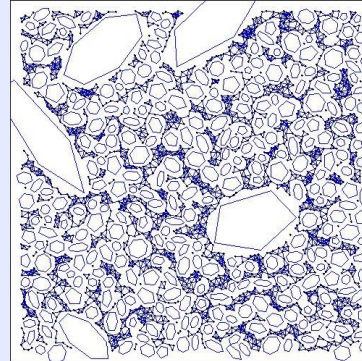
マイルストーン間の接続距離



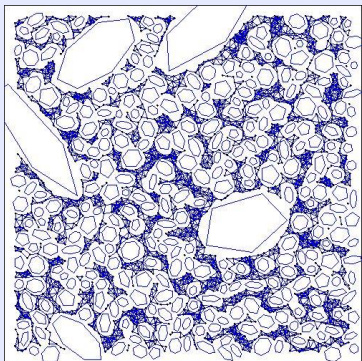
10[pixel]



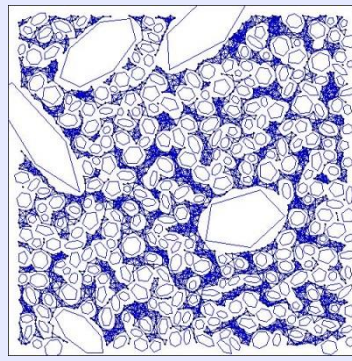
11[pixel]



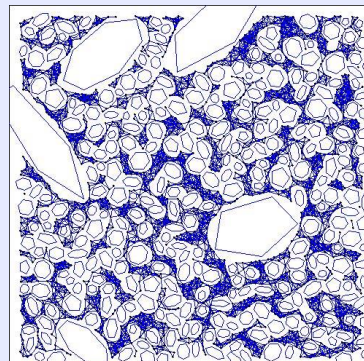
12[pixel]



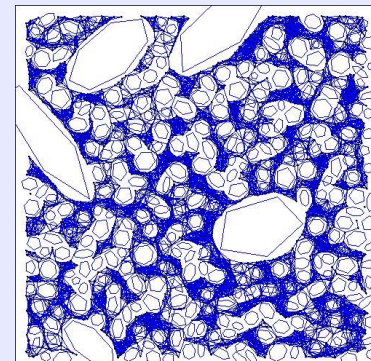
13[pixel]



14[pixel]



15[pixel]



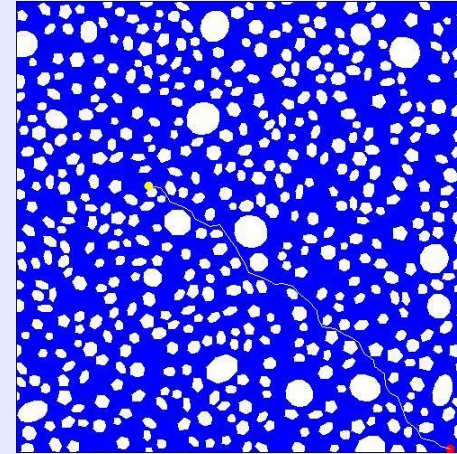
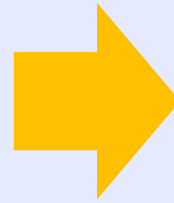
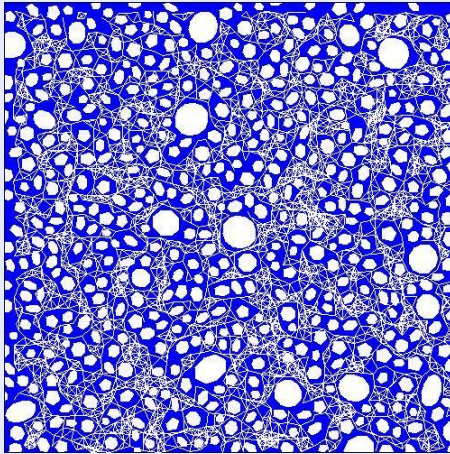
20[pixel]

マイルストーン間の接続距離と航路 (1)

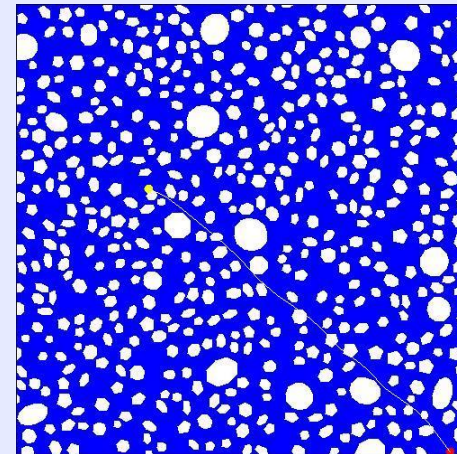
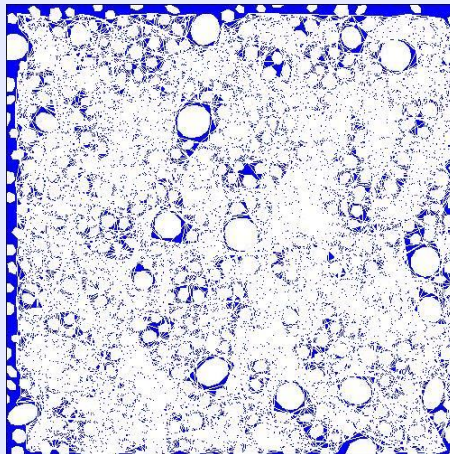
ロードマップグラフ

航路

a) 12[pixel]



b) 20[pixel]

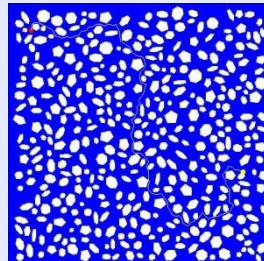
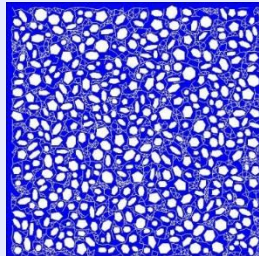


マイルストーン間の接続距離と航路 (2)

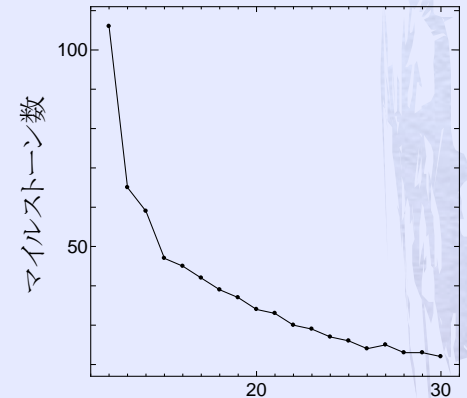
ロードマップグラフ

航路

a) 12[pixel]

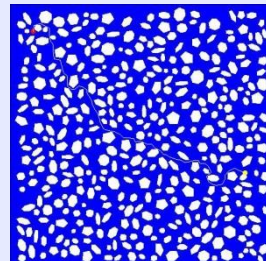
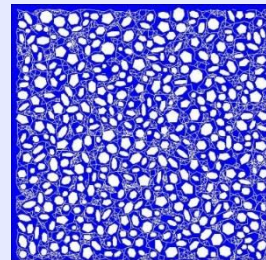


マイルストーン間の
接続距離と用いられた
マイルストーン数の関係

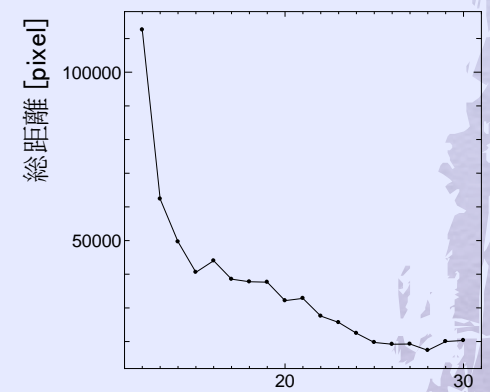


マイルストーン間の接続距離 [pixel]

b) 13[pixel]

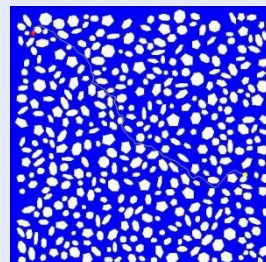
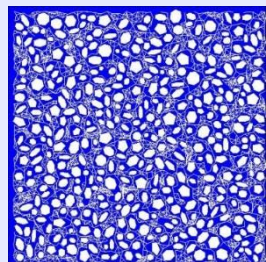


マイルストーン間
の接続距離と用いられた
総距離の関係



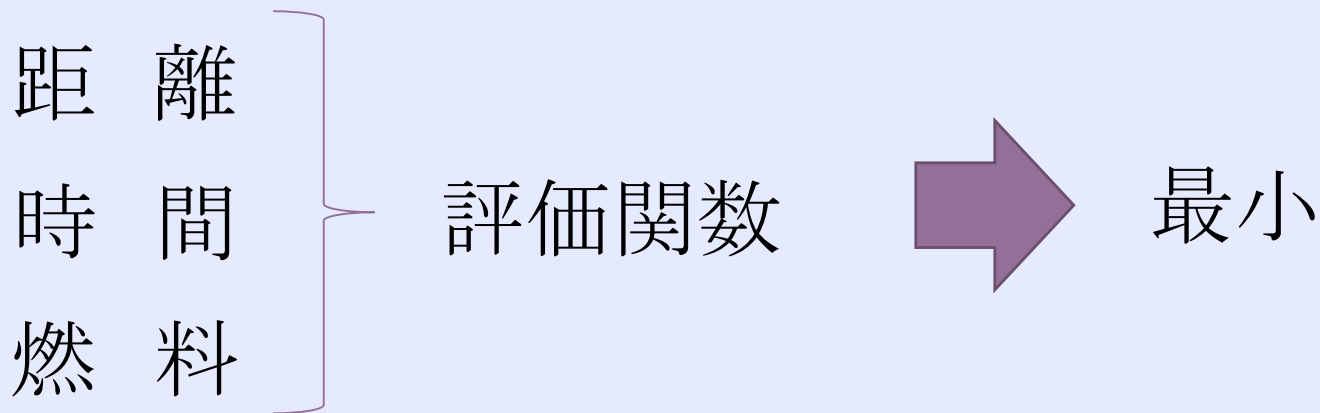
マイルストーン間の接続距離 [pixel]

c) 14[pixel]



今後の予定

◆海氷負荷を考慮した最適航路の探索



ご清聴ありがとうございました

実際の氷海上の航路

