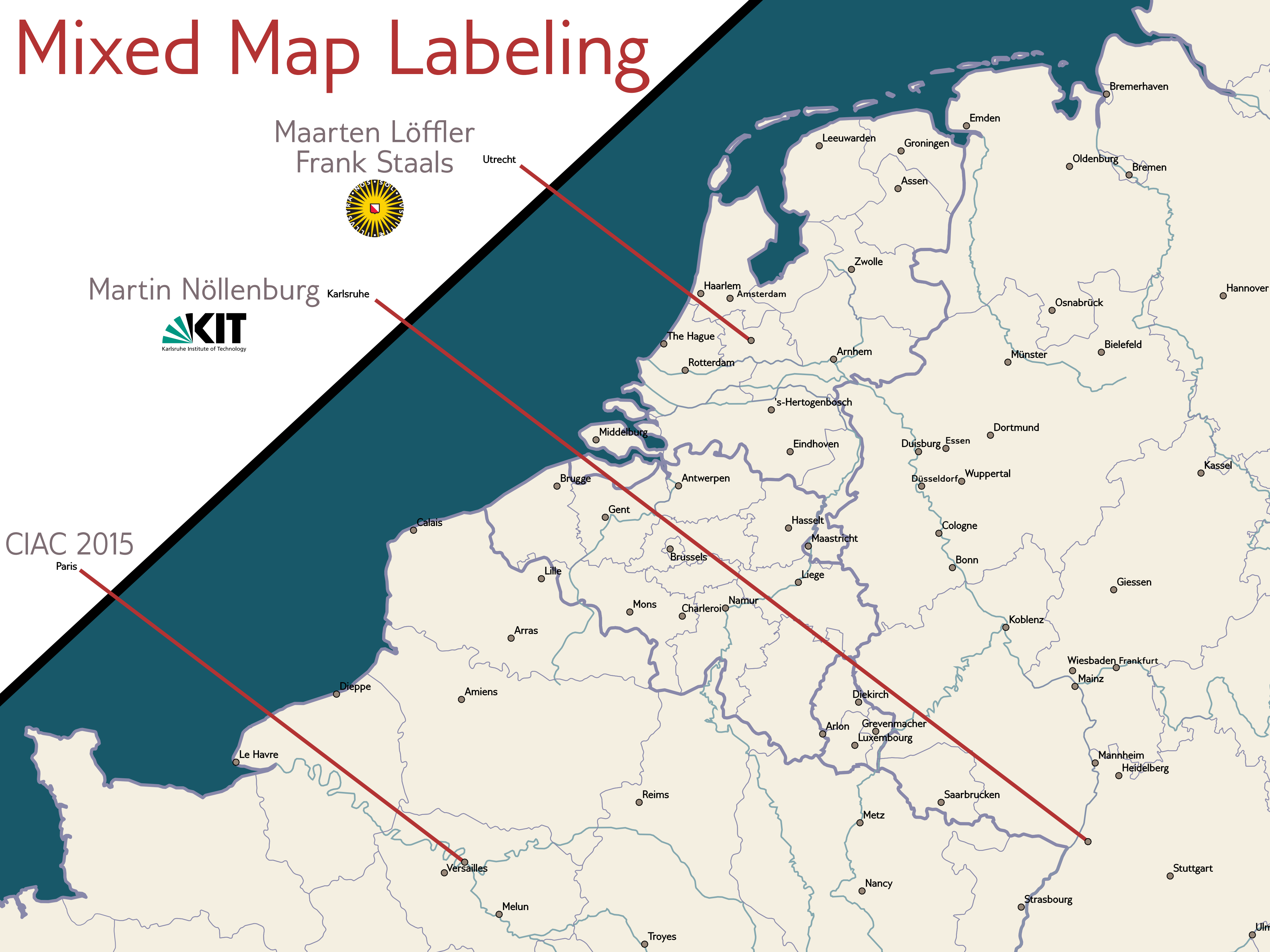
Mixed Map Labeling

Maarten Löffler
Frank Staals

Martin Nöllenburg

CIAC 2015



Map Labeling

Goal: Label all points

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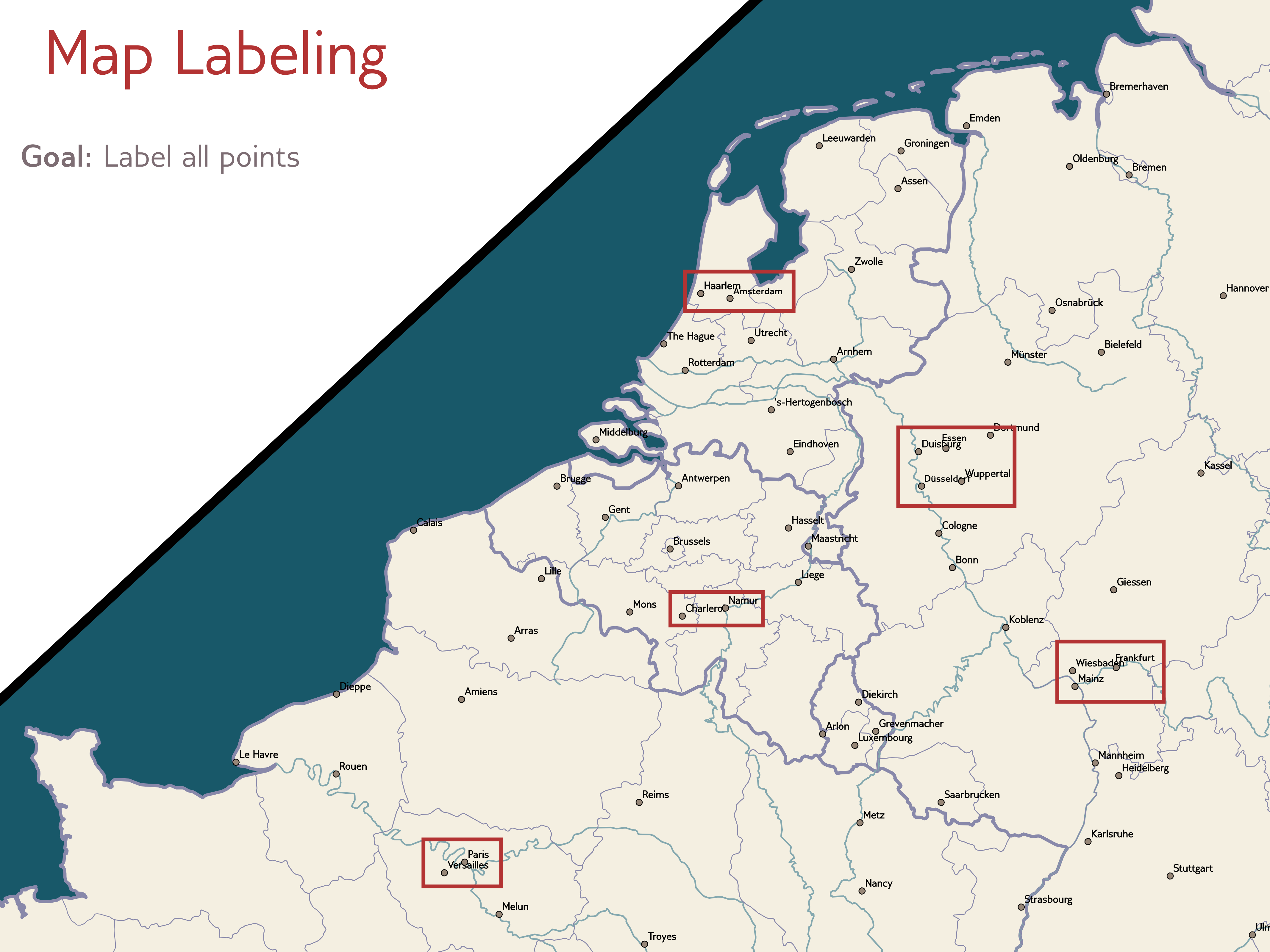

Map Labeling

Goal: Maximize #points labeled

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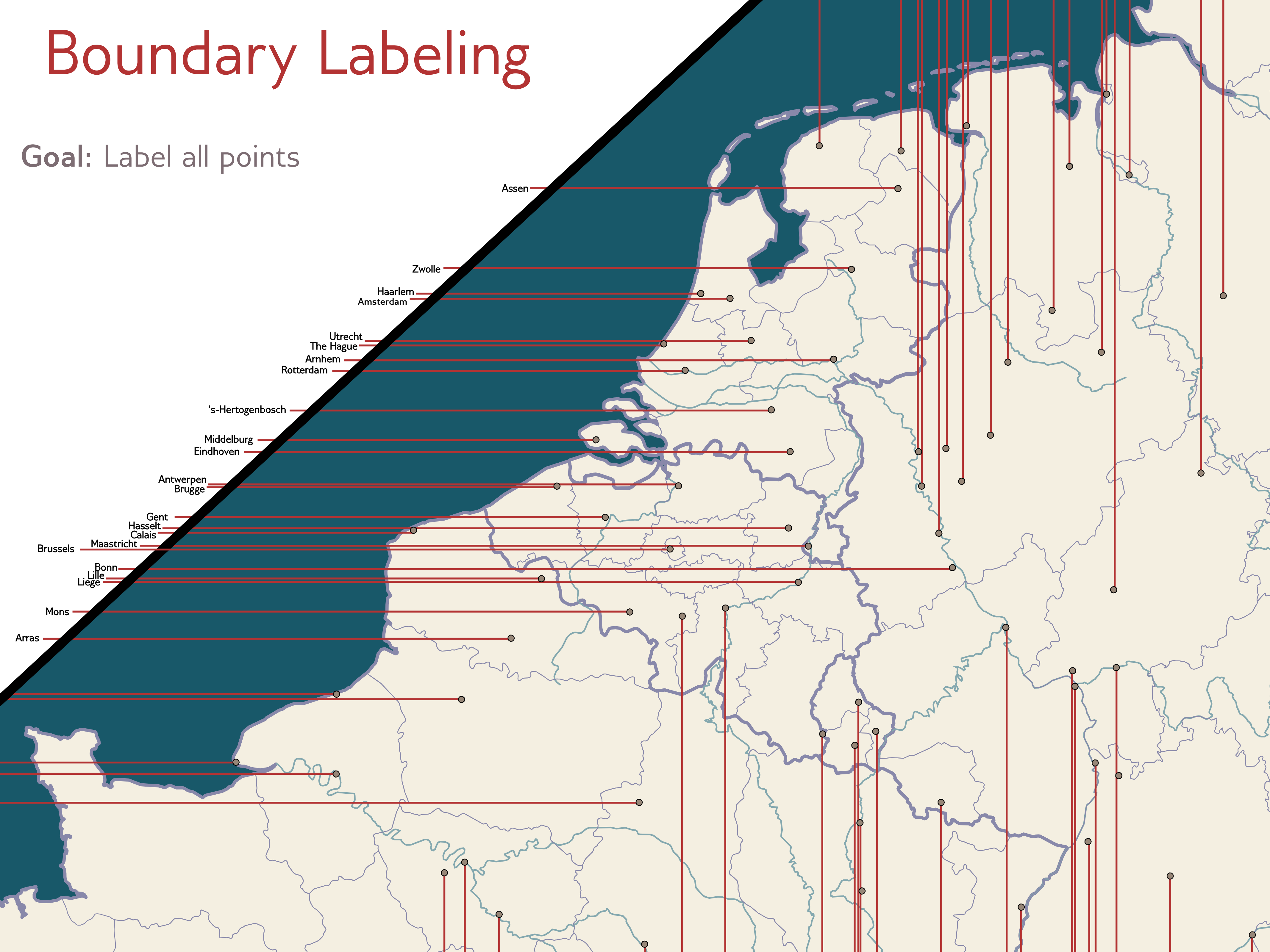
Different versions depending on where we may place the label.

Most versions are NP-hard

Boundary Labeling

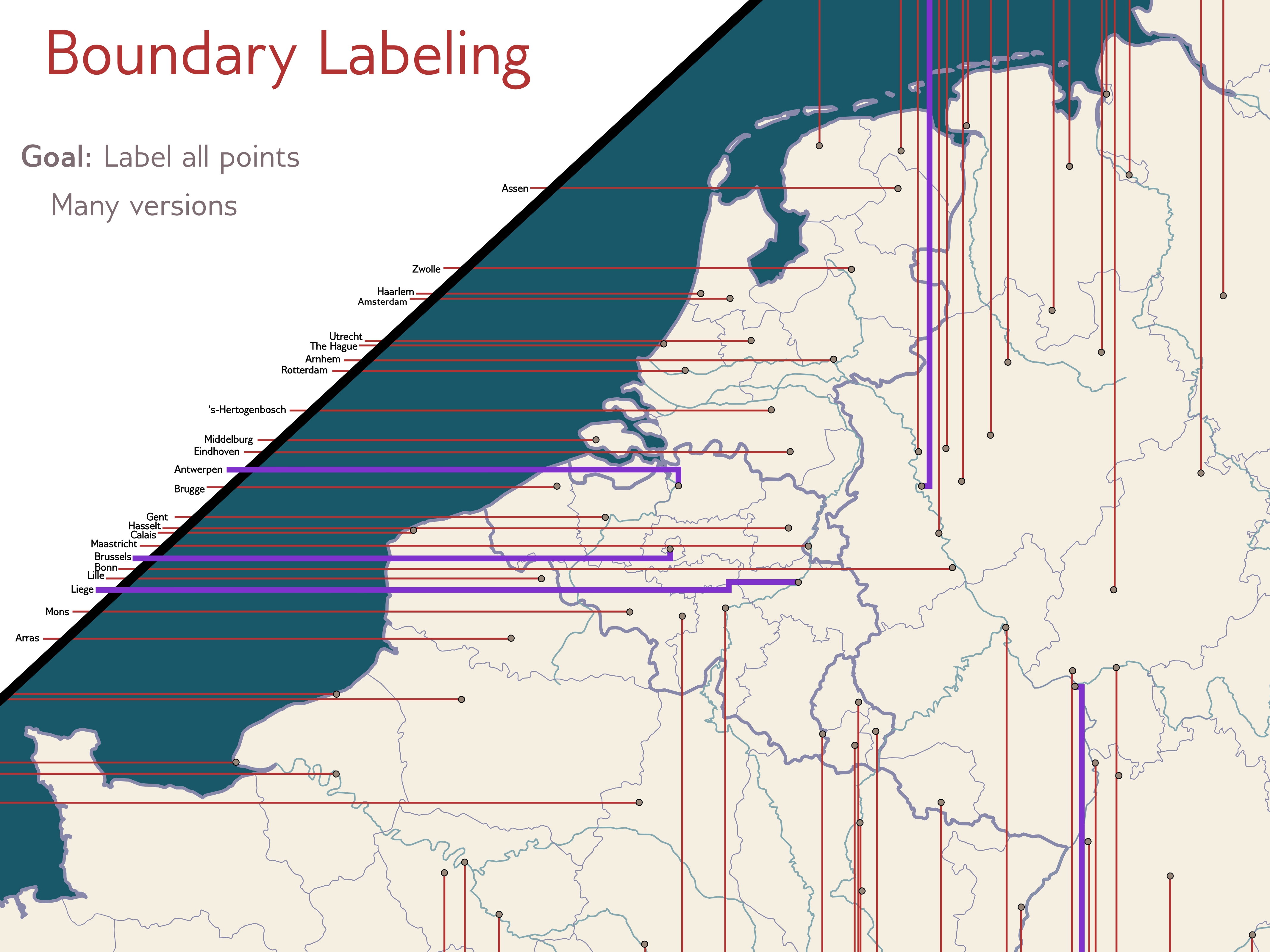
Goal: Label all points



Boundary Labeling

Goal: Label all points

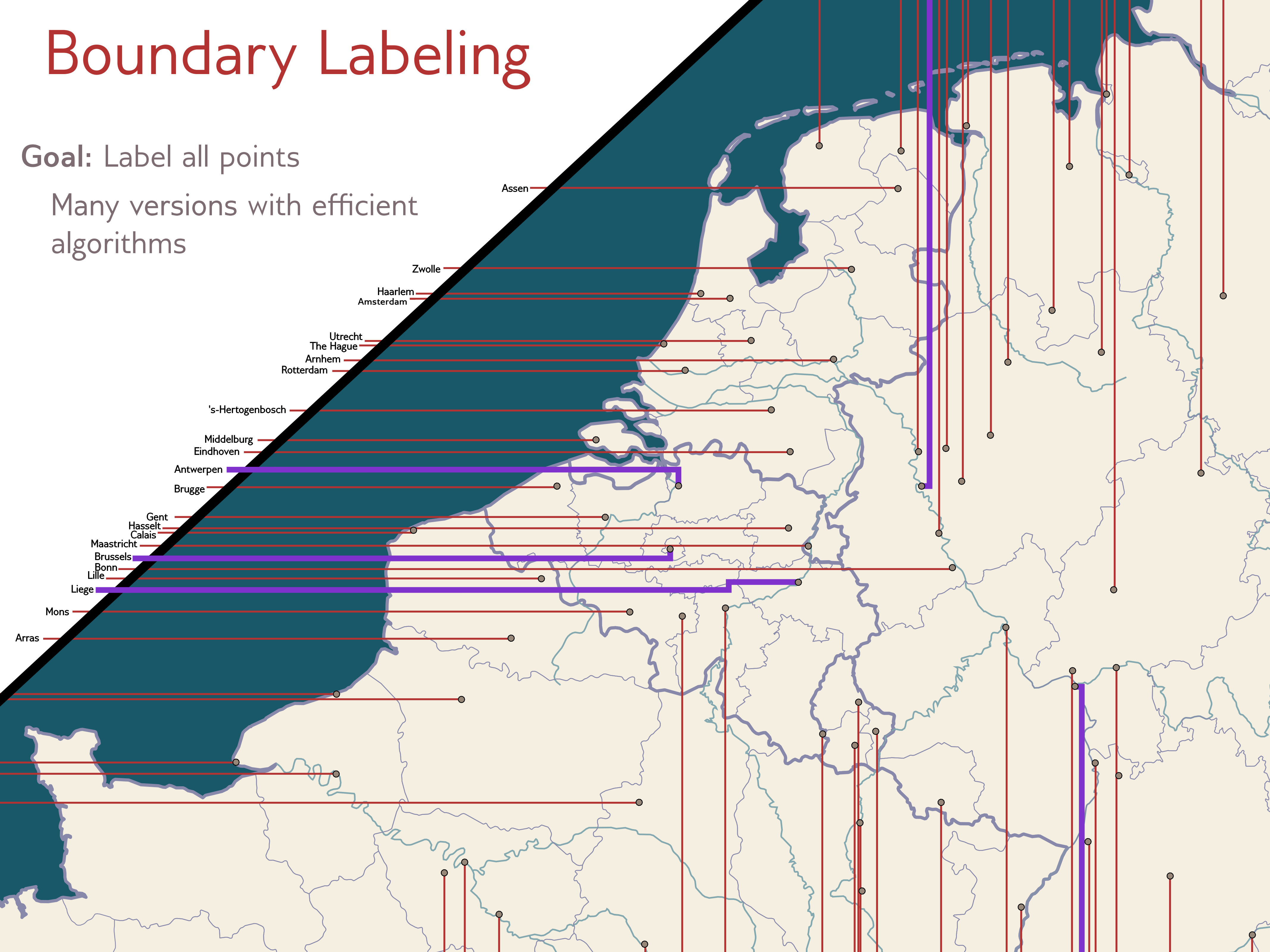
Many versions



Boundary Labeling

Goal: Label all points

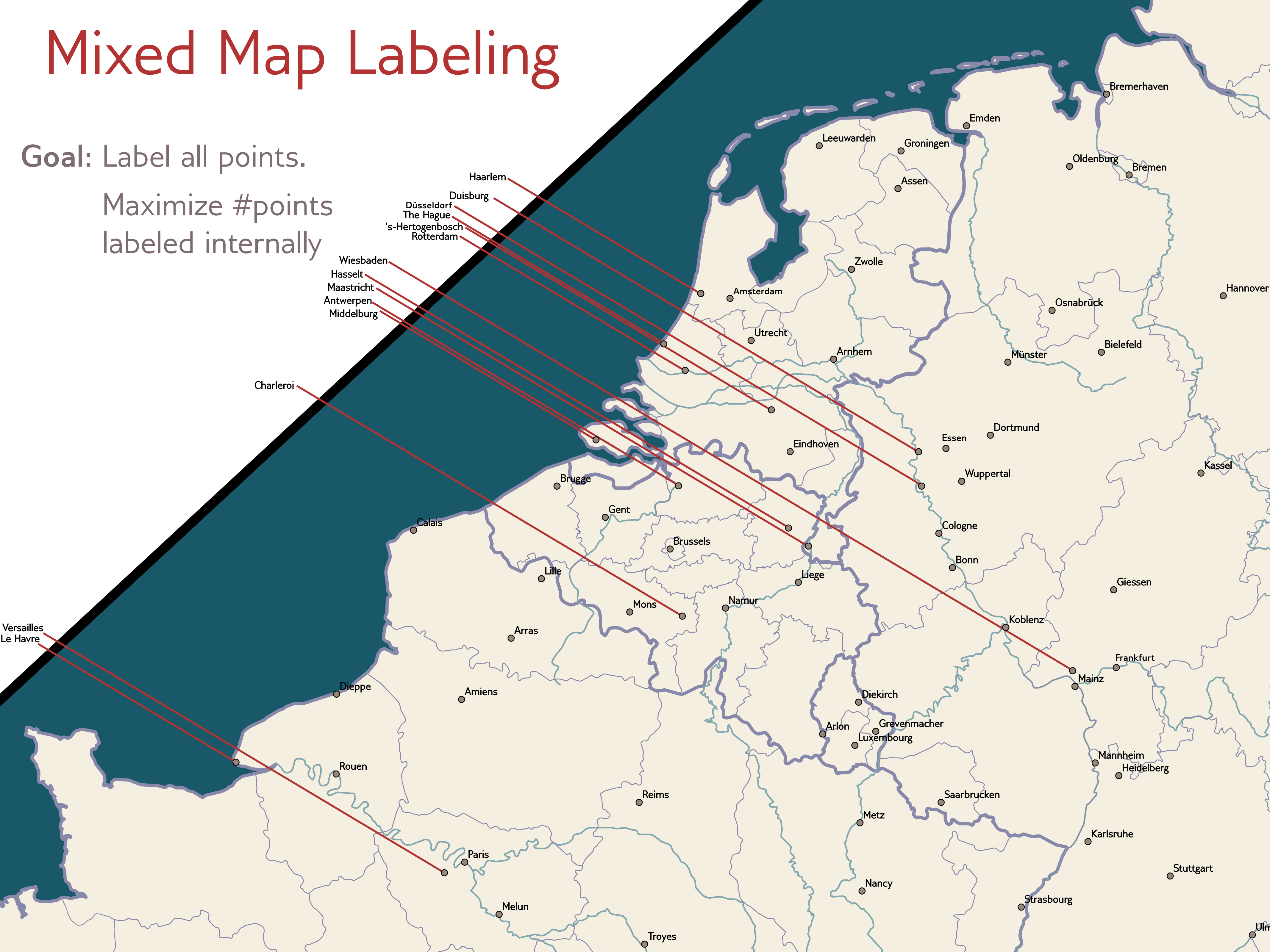
Many versions with efficient algorithms



Mixed Map Labeling

Goal: Label all points.

Maximize #points labeled internally

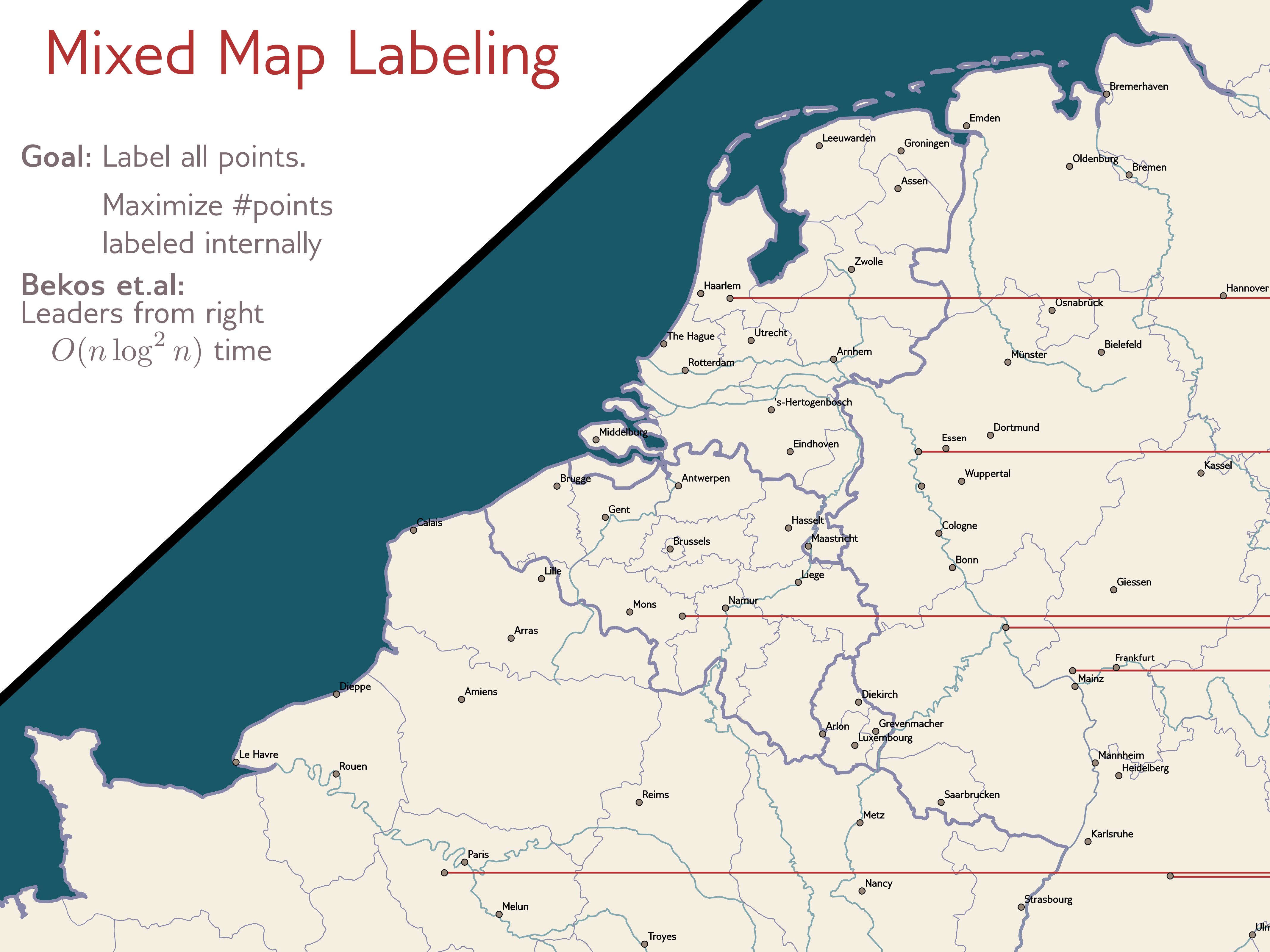


Mixed Map Labeling

Goal: Label all points.

Maximize #points labeled internally

Bekos et.al:
Leaders from right
$O(n \log^2 n)$ time



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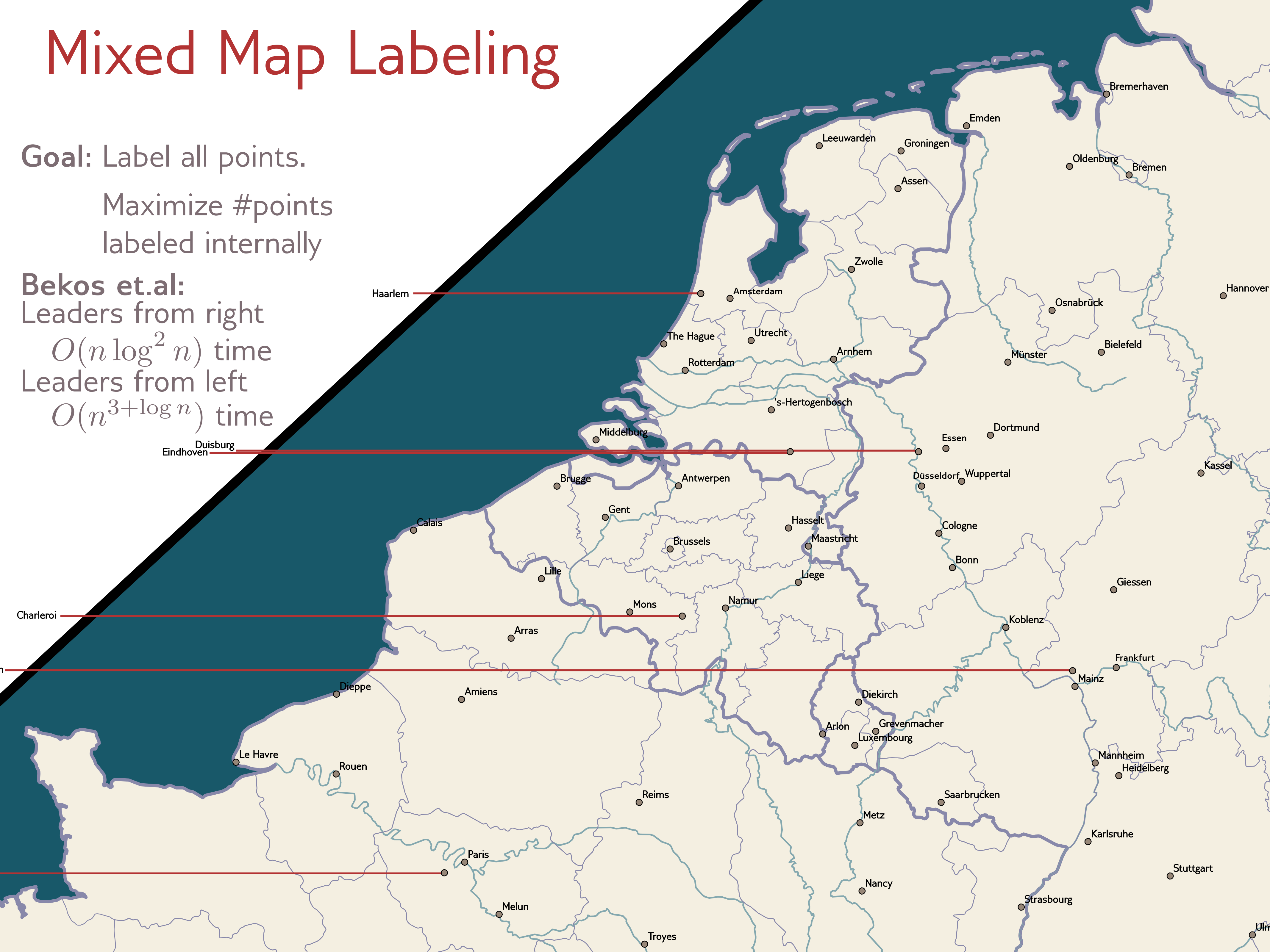
$O(n \log^2 n)$ time

Leaders from left

$O(n^{3+\log n})$ time

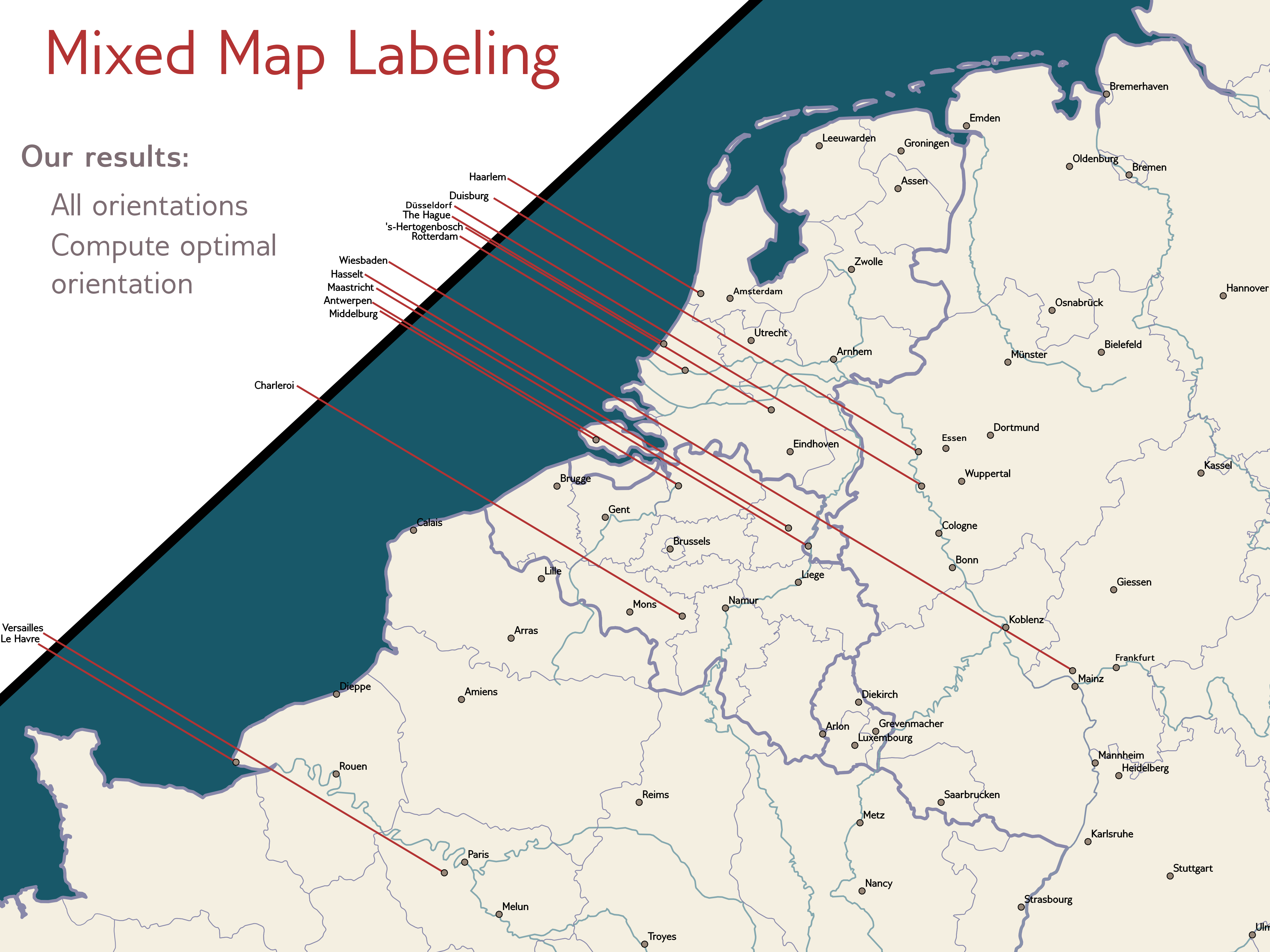


Mixed Map Labeling

Our results:

All orientations

Compute optimal orientation



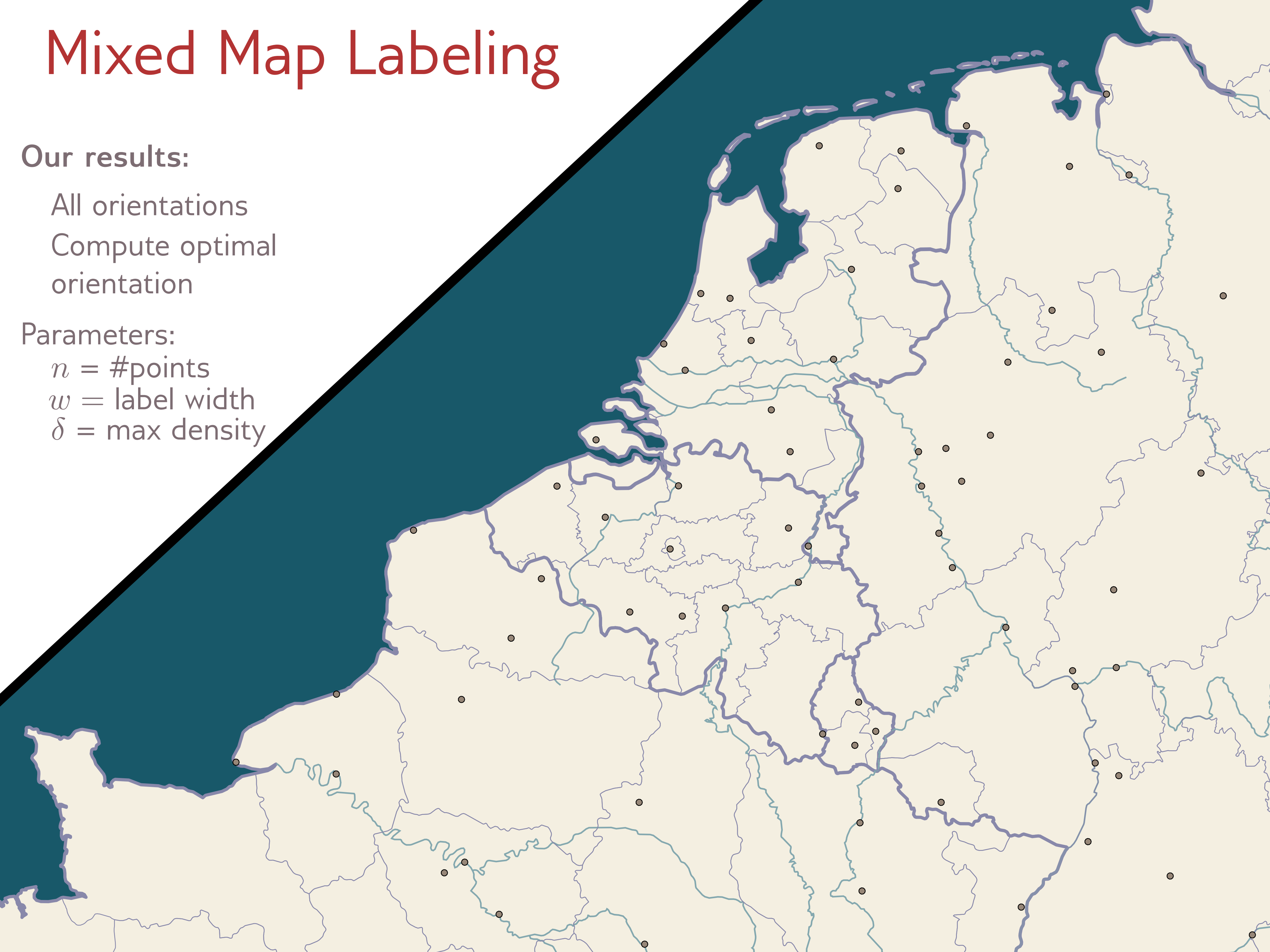
Mixed Map Labeling

Our results:

All orientations
Compute optimal orientation

Parameters:

n = #points
w = label width
δ = max density



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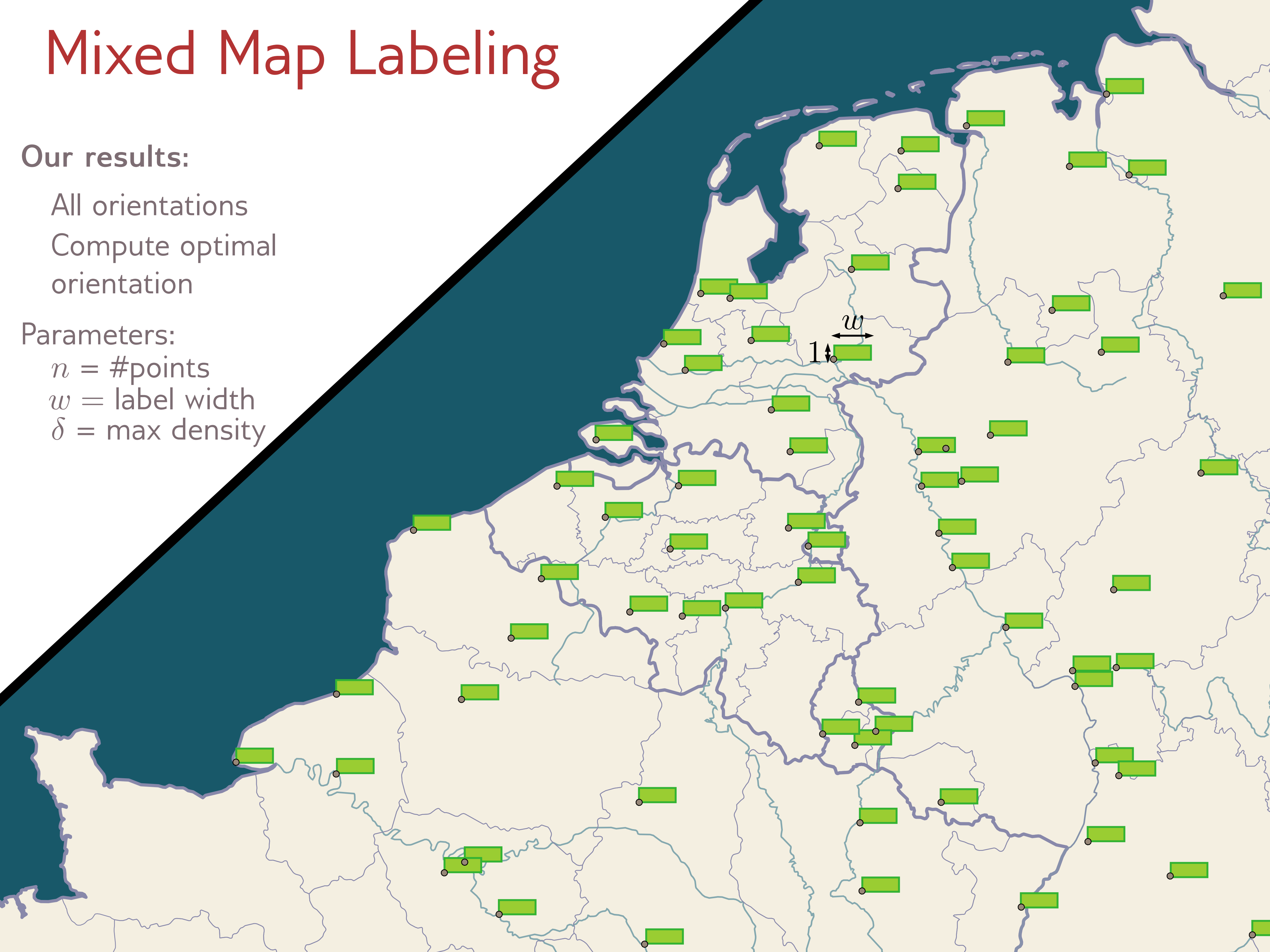

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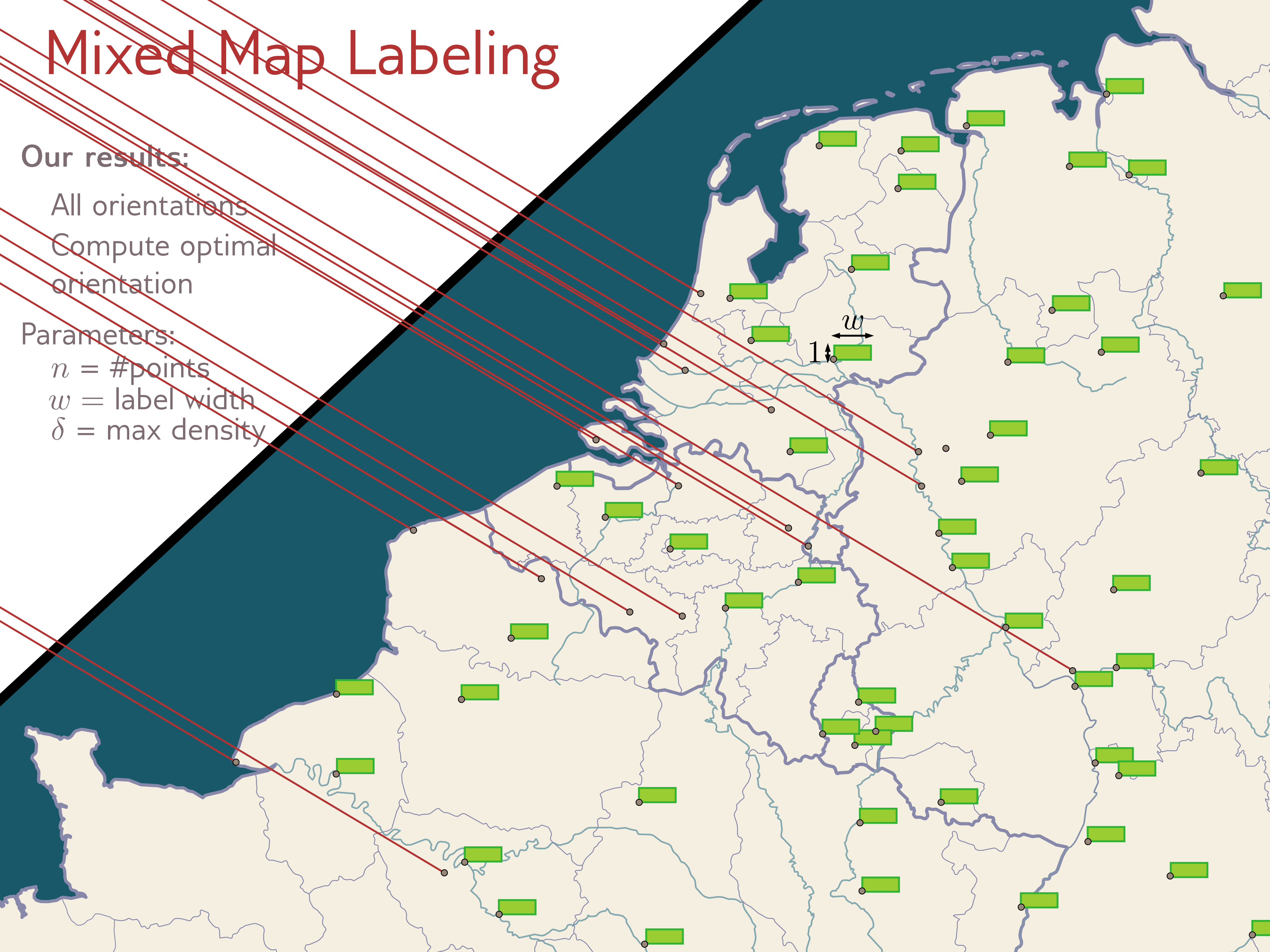

Mixed Map Labeling

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All orientations
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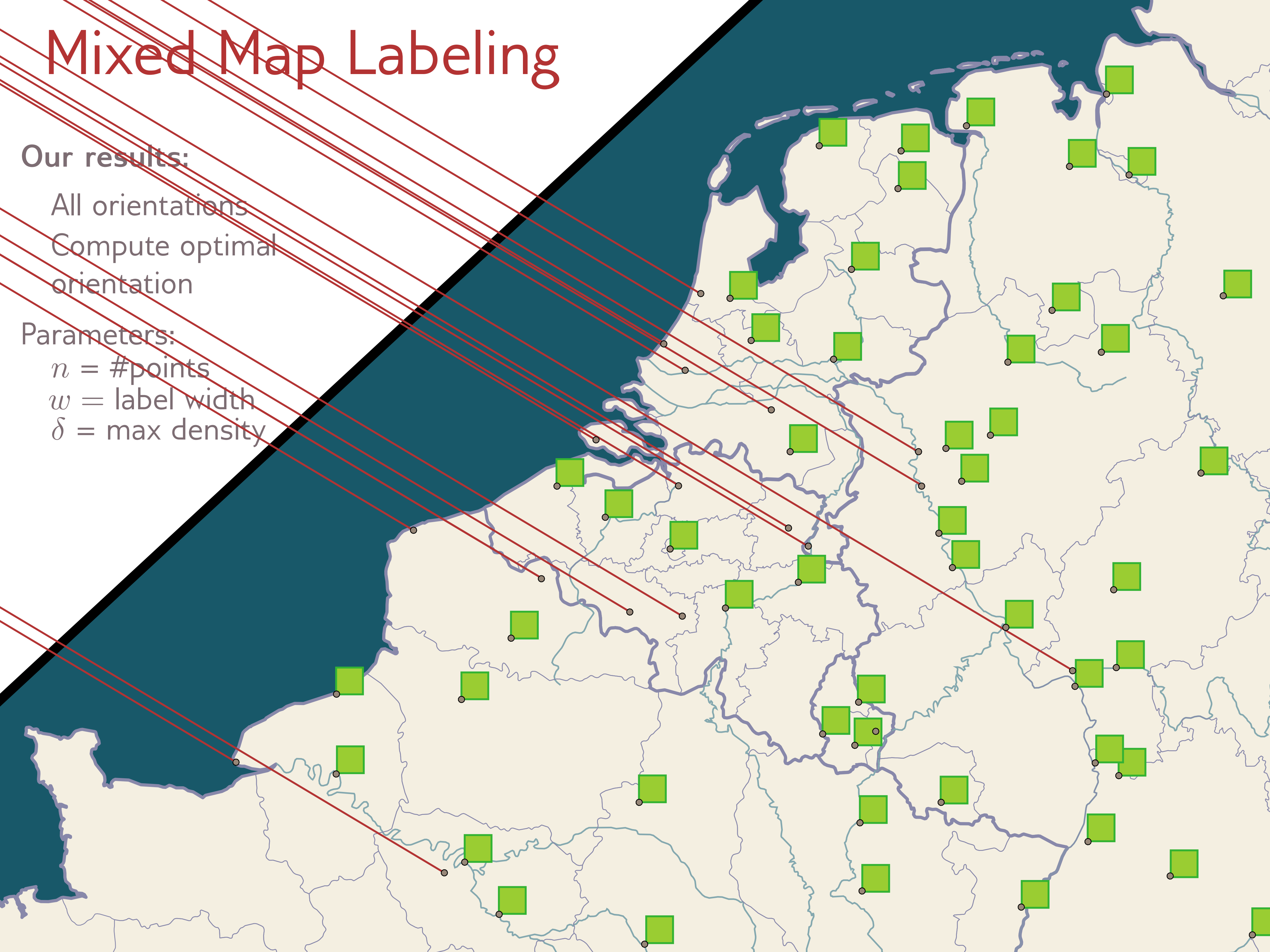
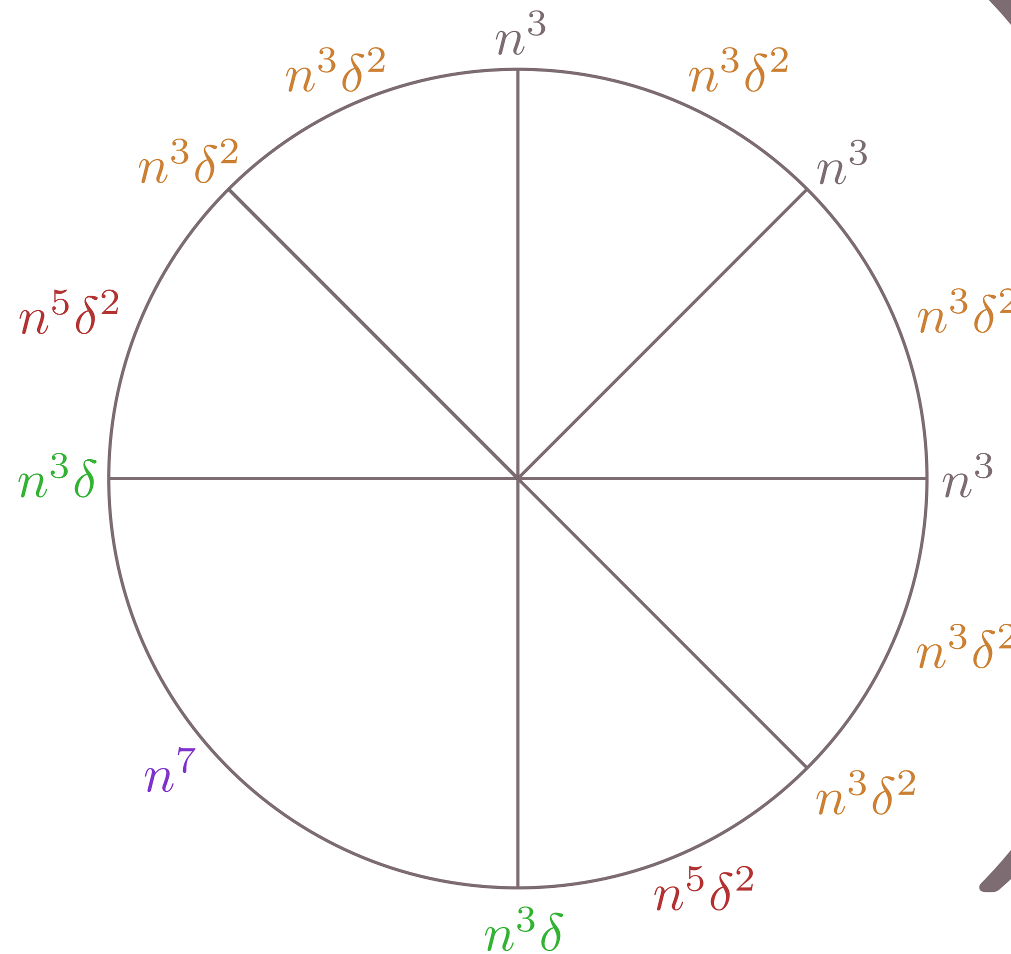


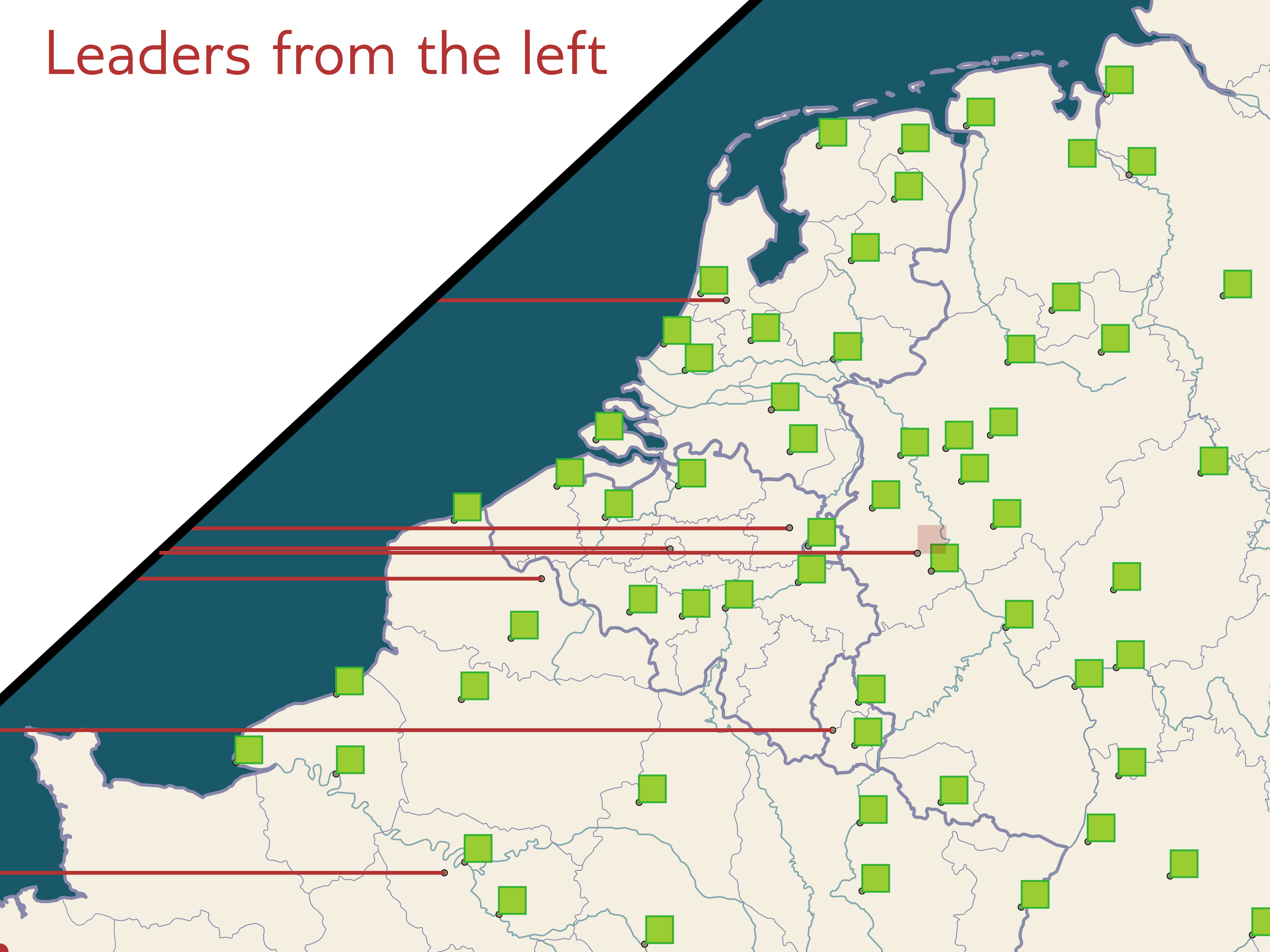
Mixed Map Labeling

$$O\left(n^3 \log n + \right.$$



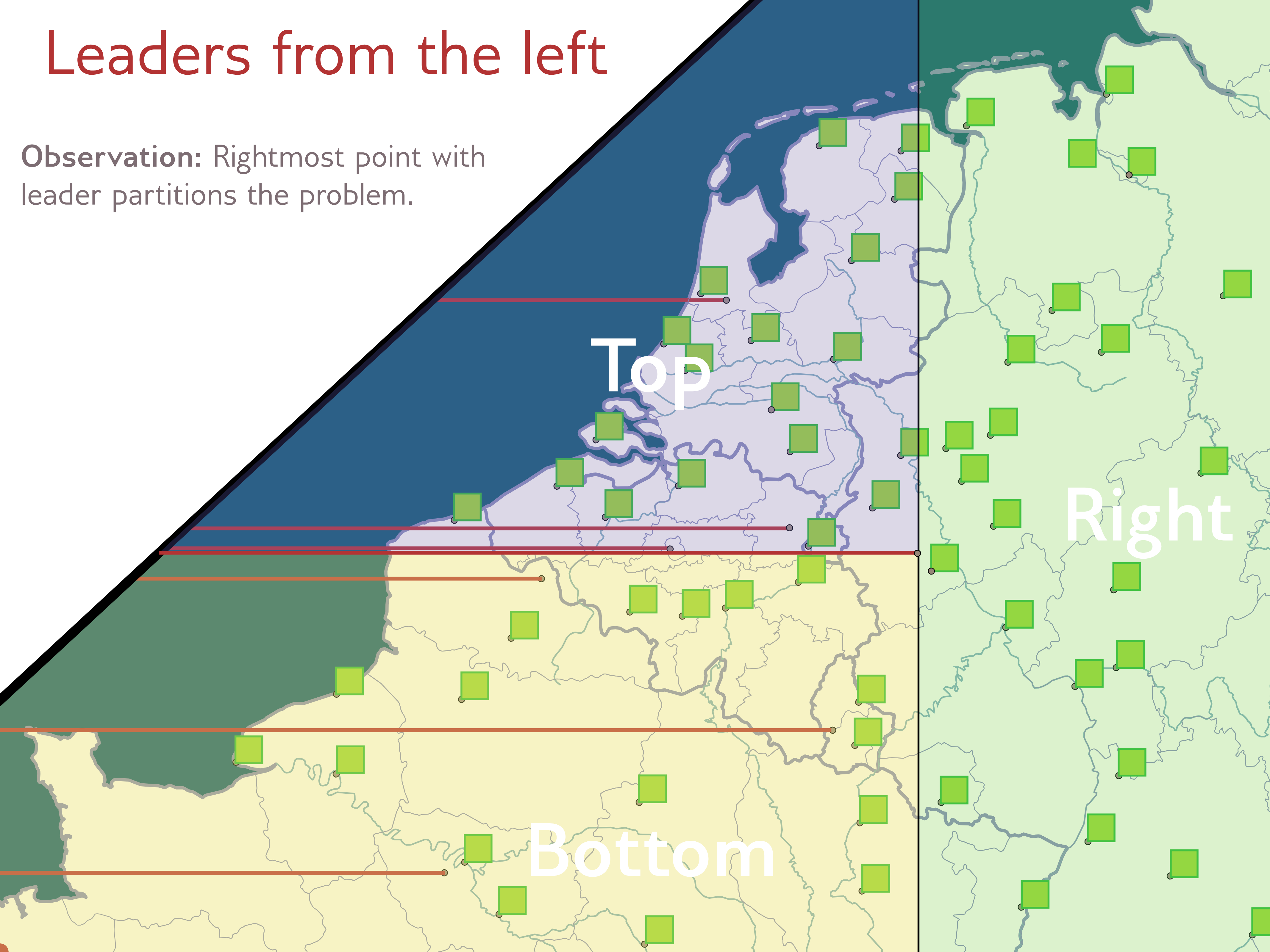
$$\left. \right)$$

Leaders from the left



Leaders from the left

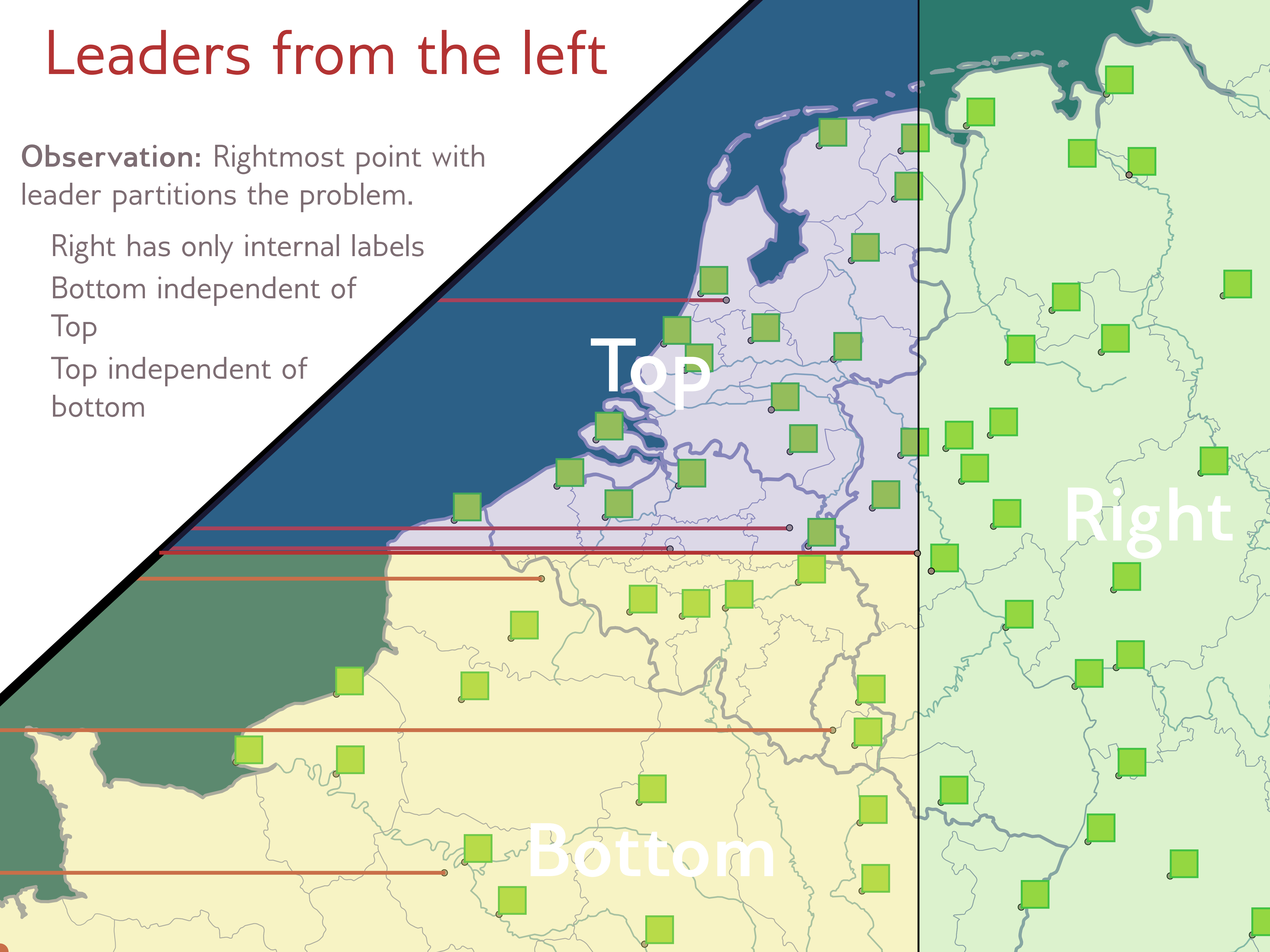
Observation: Rightmost point with leader partitions the problem.



Leaders from the left

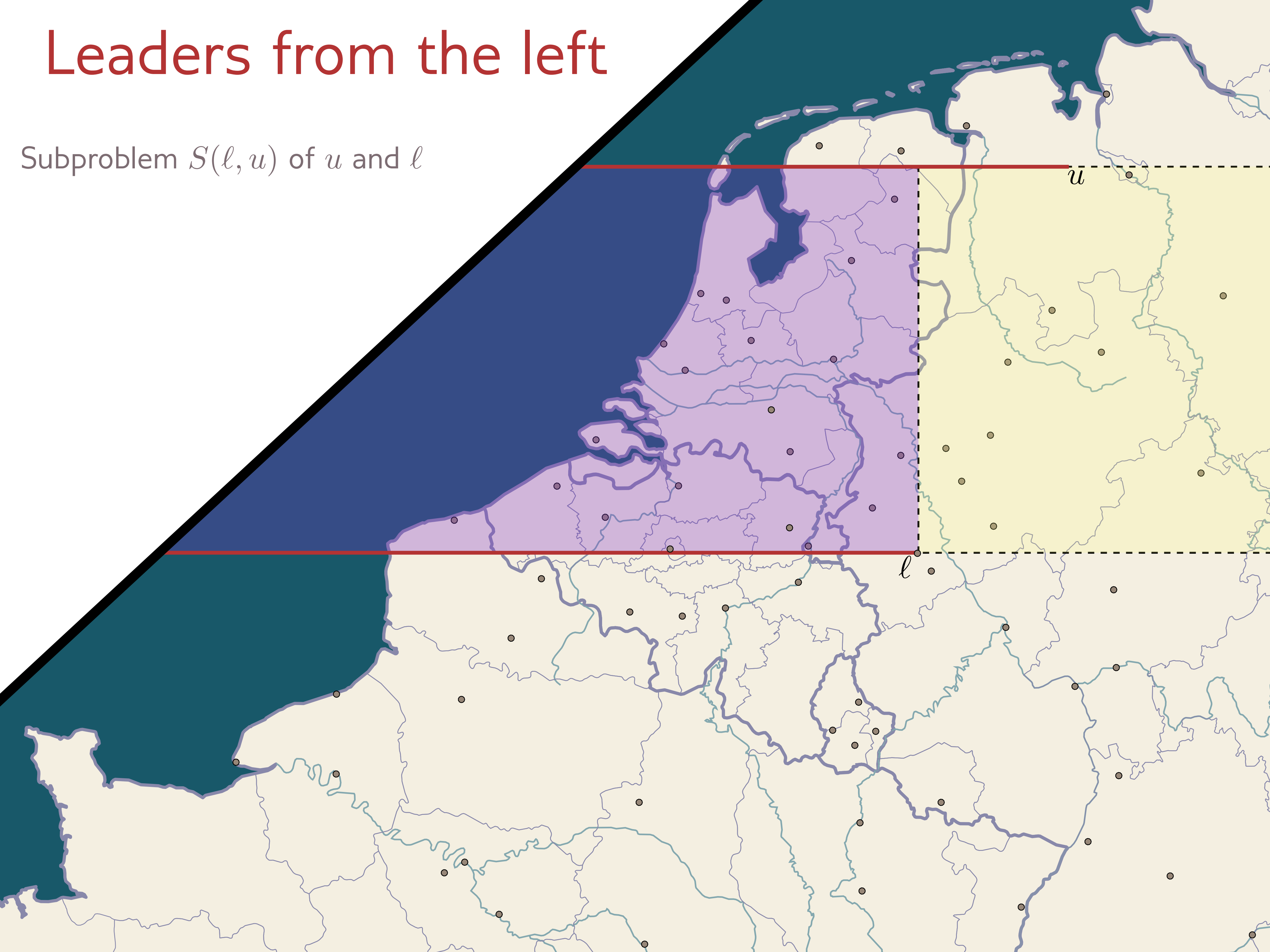
Observation: Rightmost point with leader partitions the problem.

- Right has only internal labels
- Bottom independent of Top
- Top independent of bottom



Leaders from the left

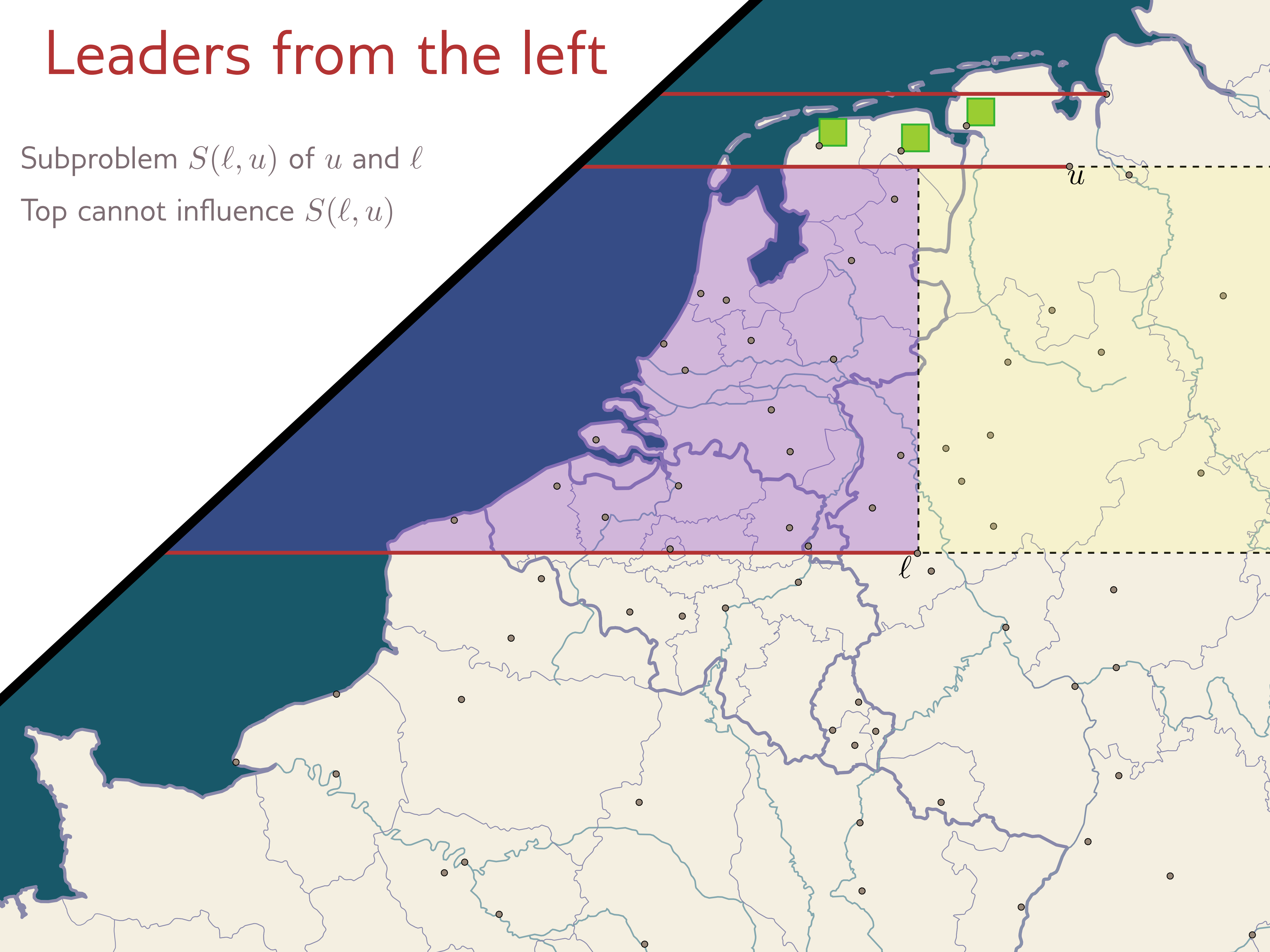
Subproblem $S(\ell, u)$ of u and ℓ



Leaders from the left

Subproblem $S(\ell, u)$ of u and ℓ

Top cannot influence $S(\ell, u)$

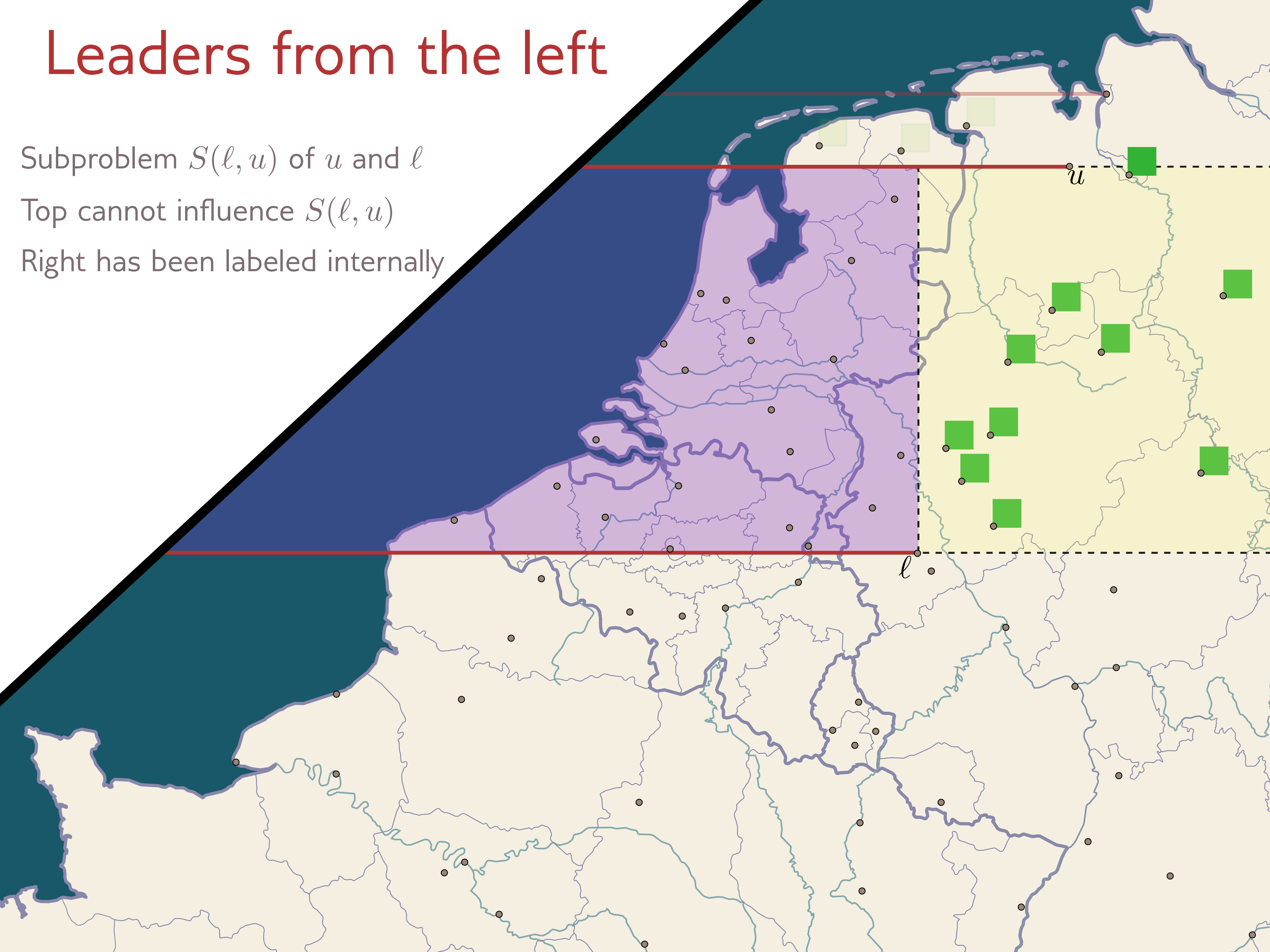


Leaders from the left

Subproblem $S(\ell, u)$ of u and ℓ

Top cannot influence $S(\ell, u)$

Right has been labeled internally



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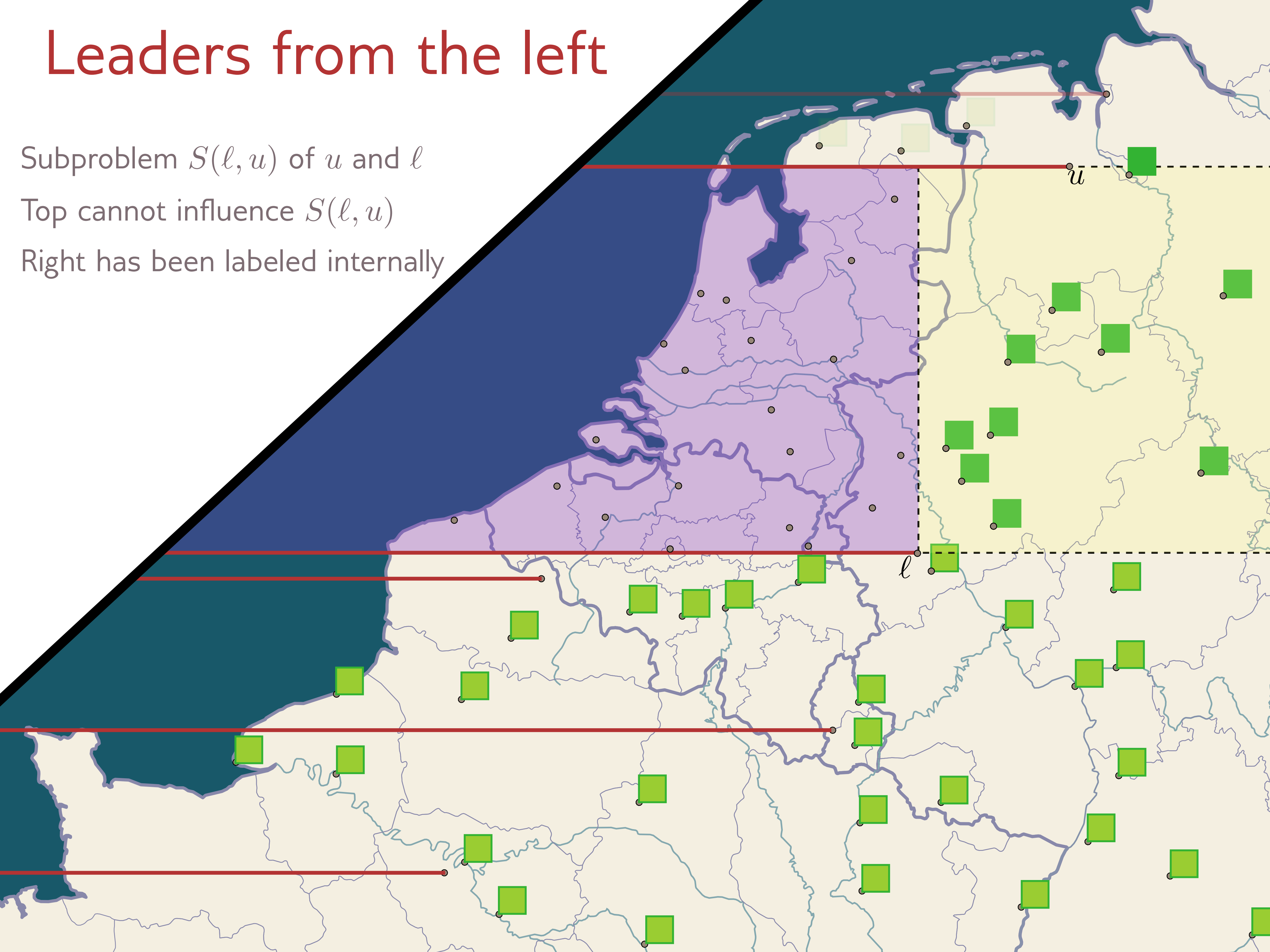

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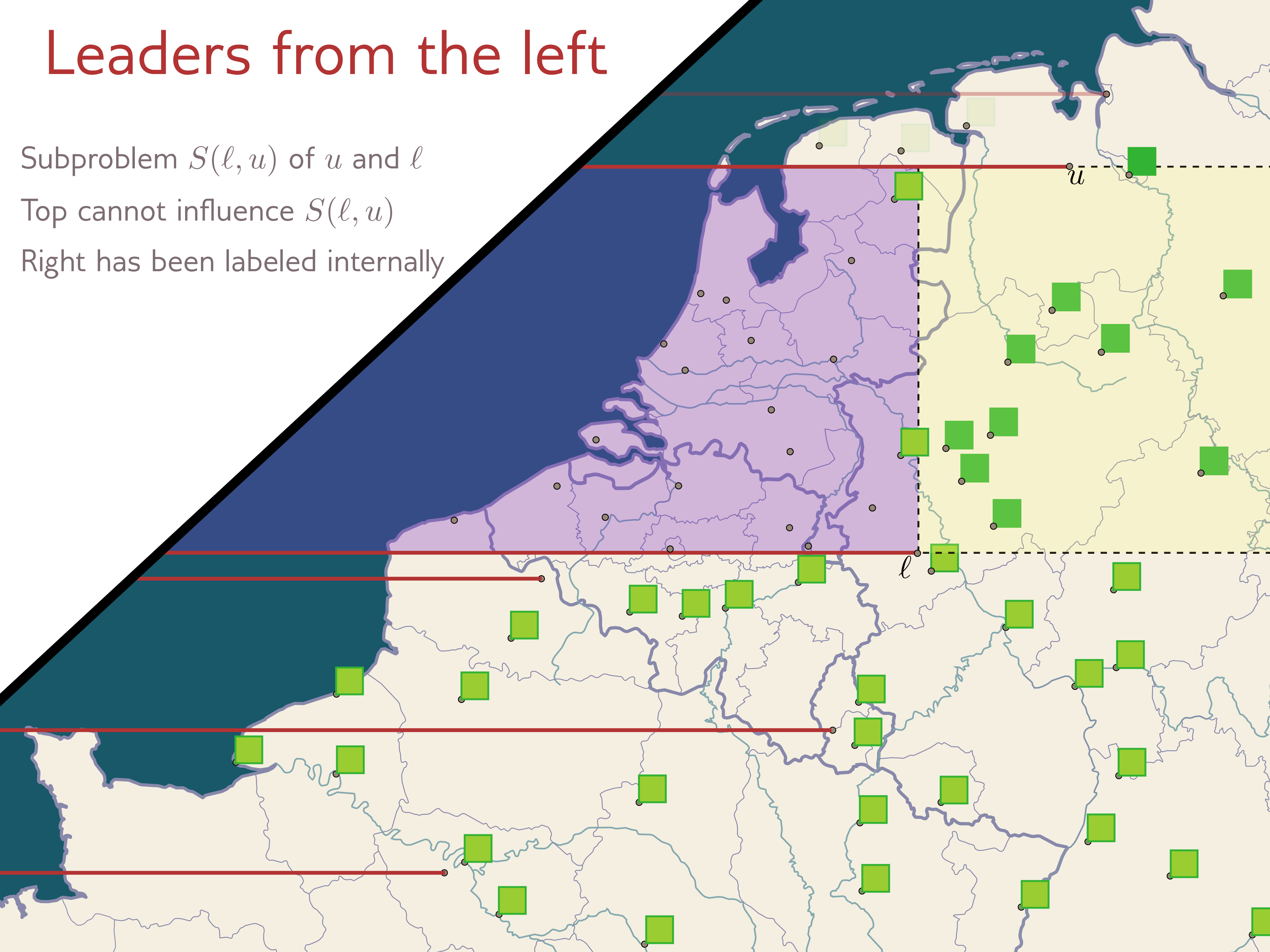

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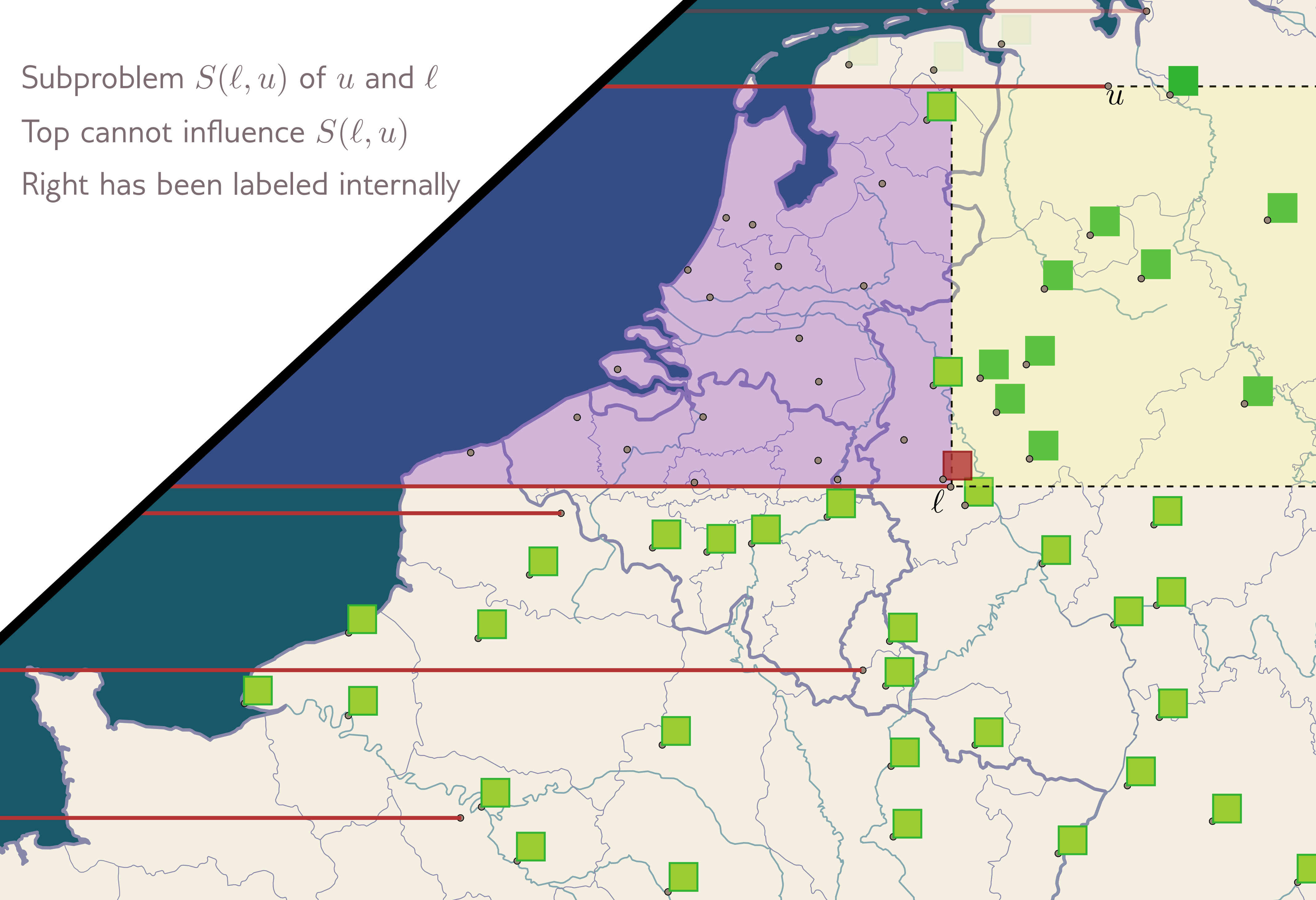

Leaders from the left

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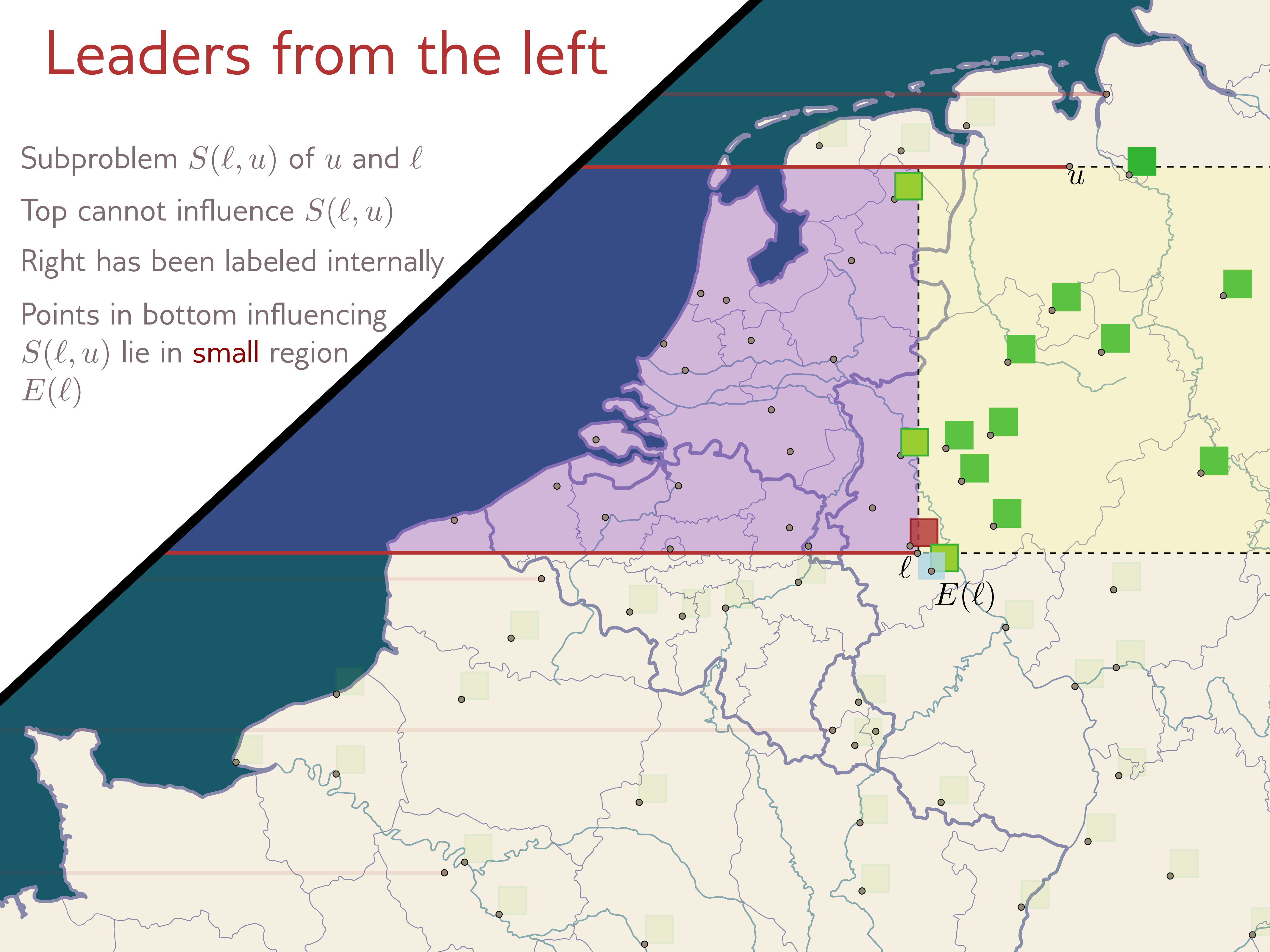
Points in bottom influencing $S(\ell, u)$ lie in small region $E(\ell)$



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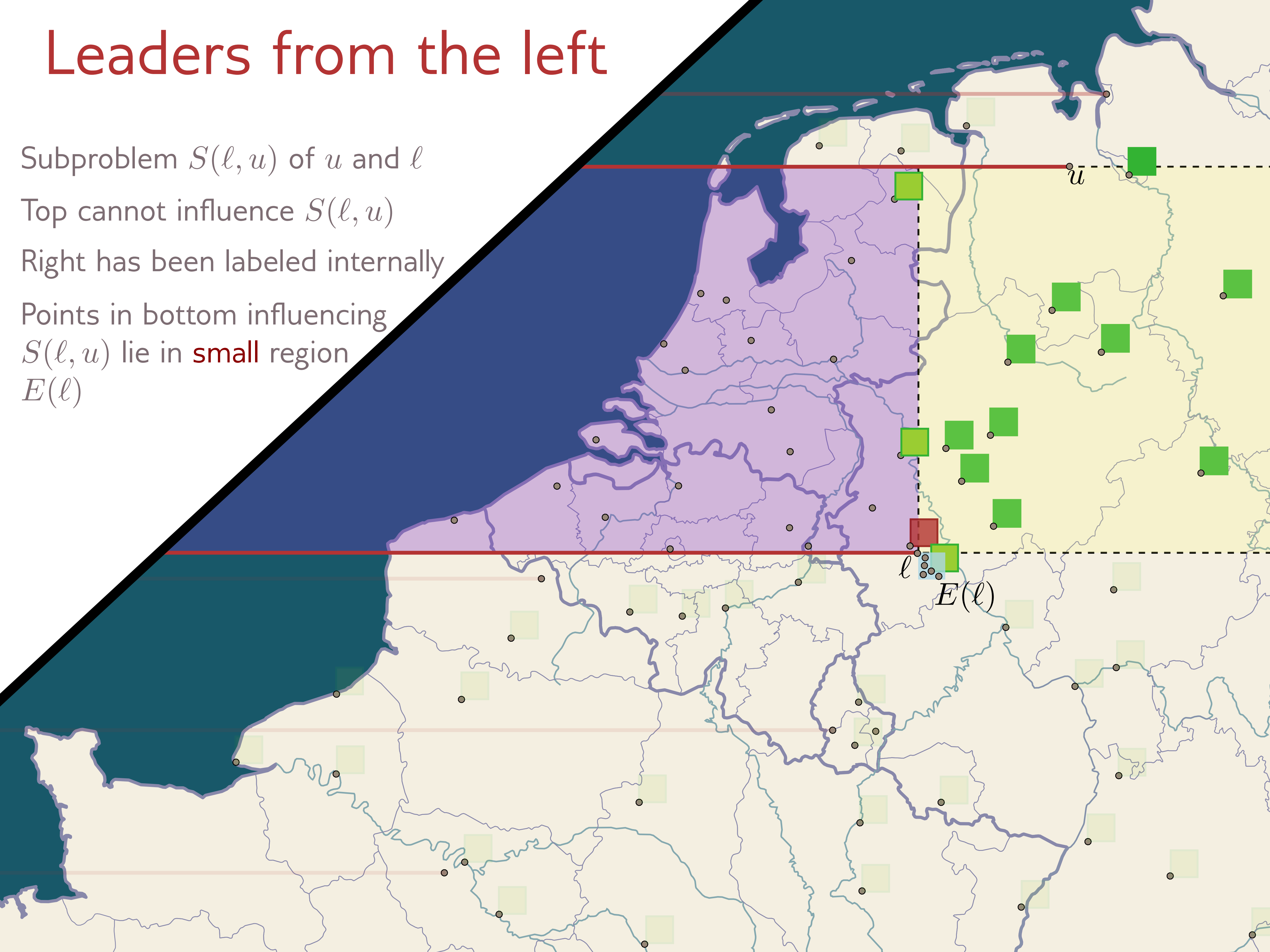

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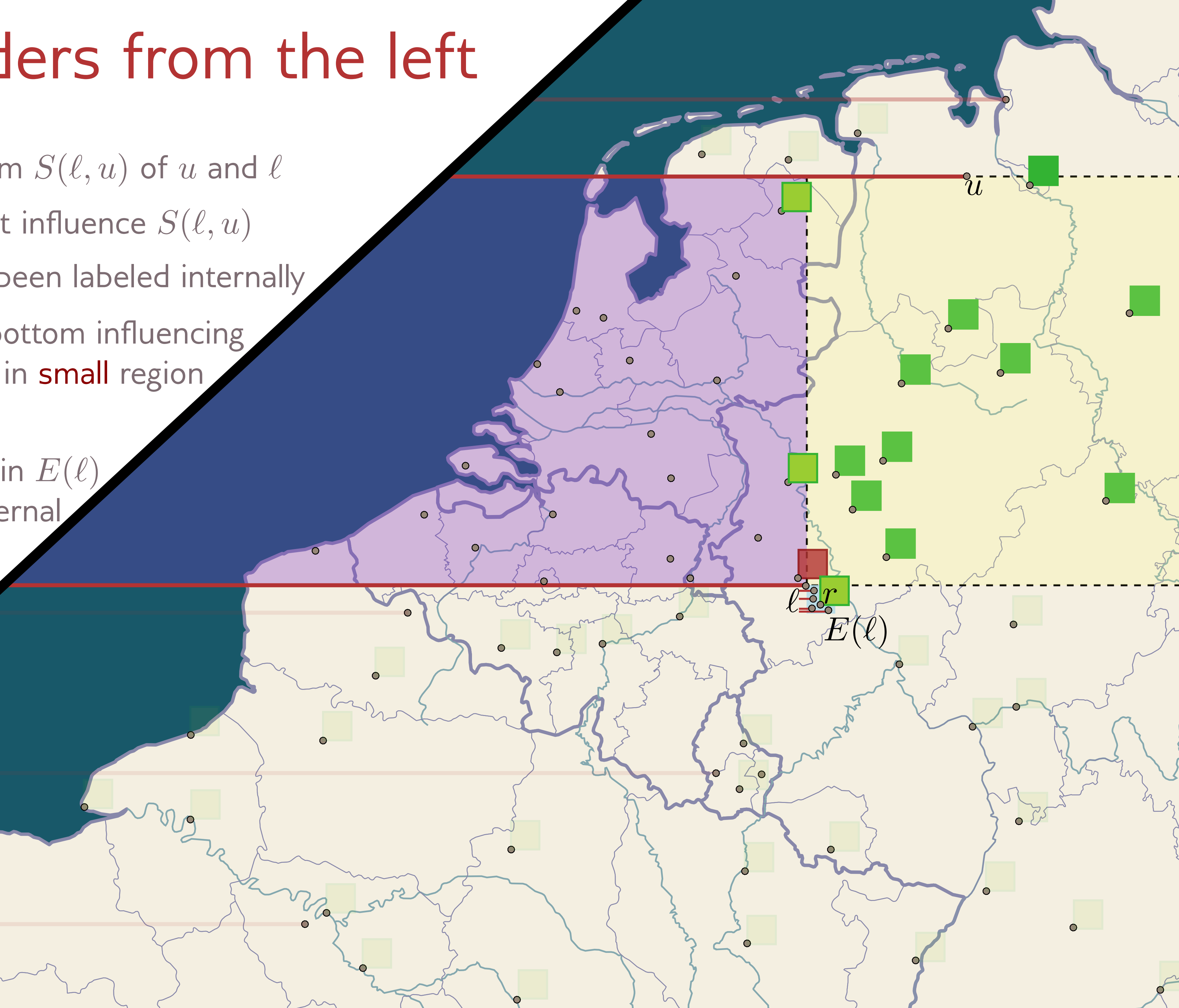
≤ 1 point in $E(\ell)$ has an internal label

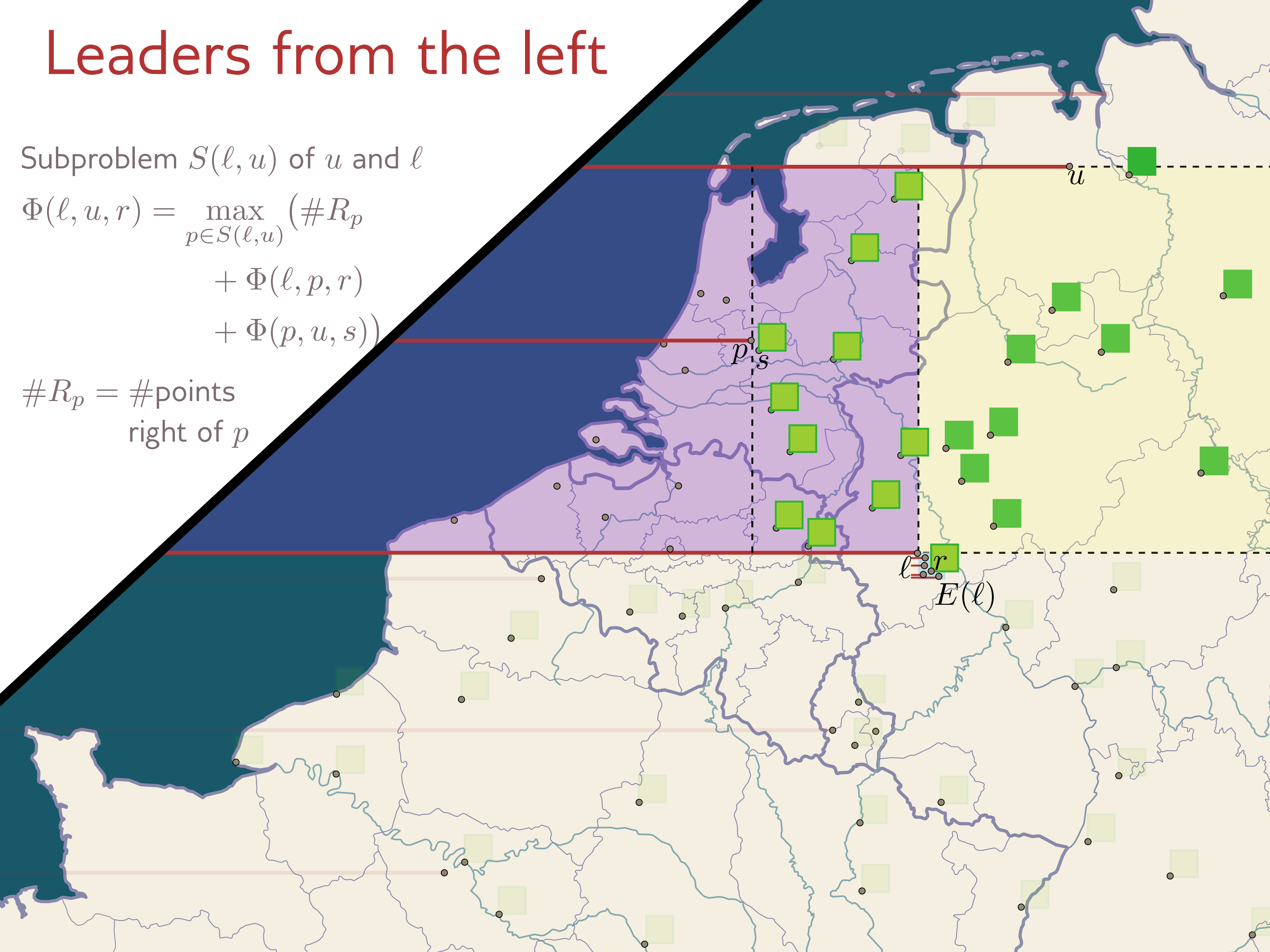


Leaders from the left

Subproblem $S(\ell, u)$ of u and ℓ

$$\Phi(\ell, u, r) = \max_{p \in S(\ell,u)} \big(\#R_p + \Phi(\ell, p, r) + \Phi(p, u, s)\big)$$

$\#R_p = \#$points right of p



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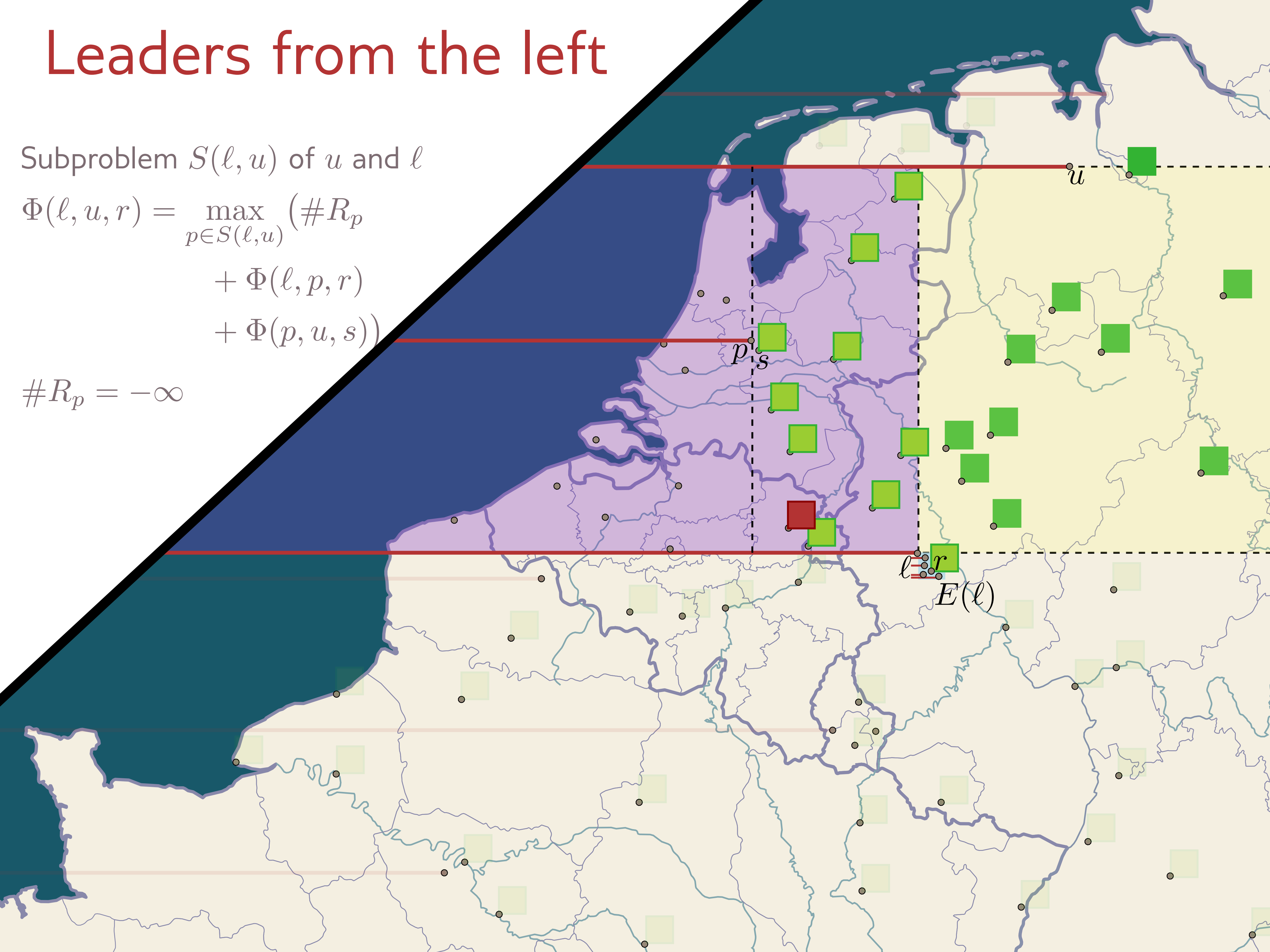
$$\#R_p = -\infty$$



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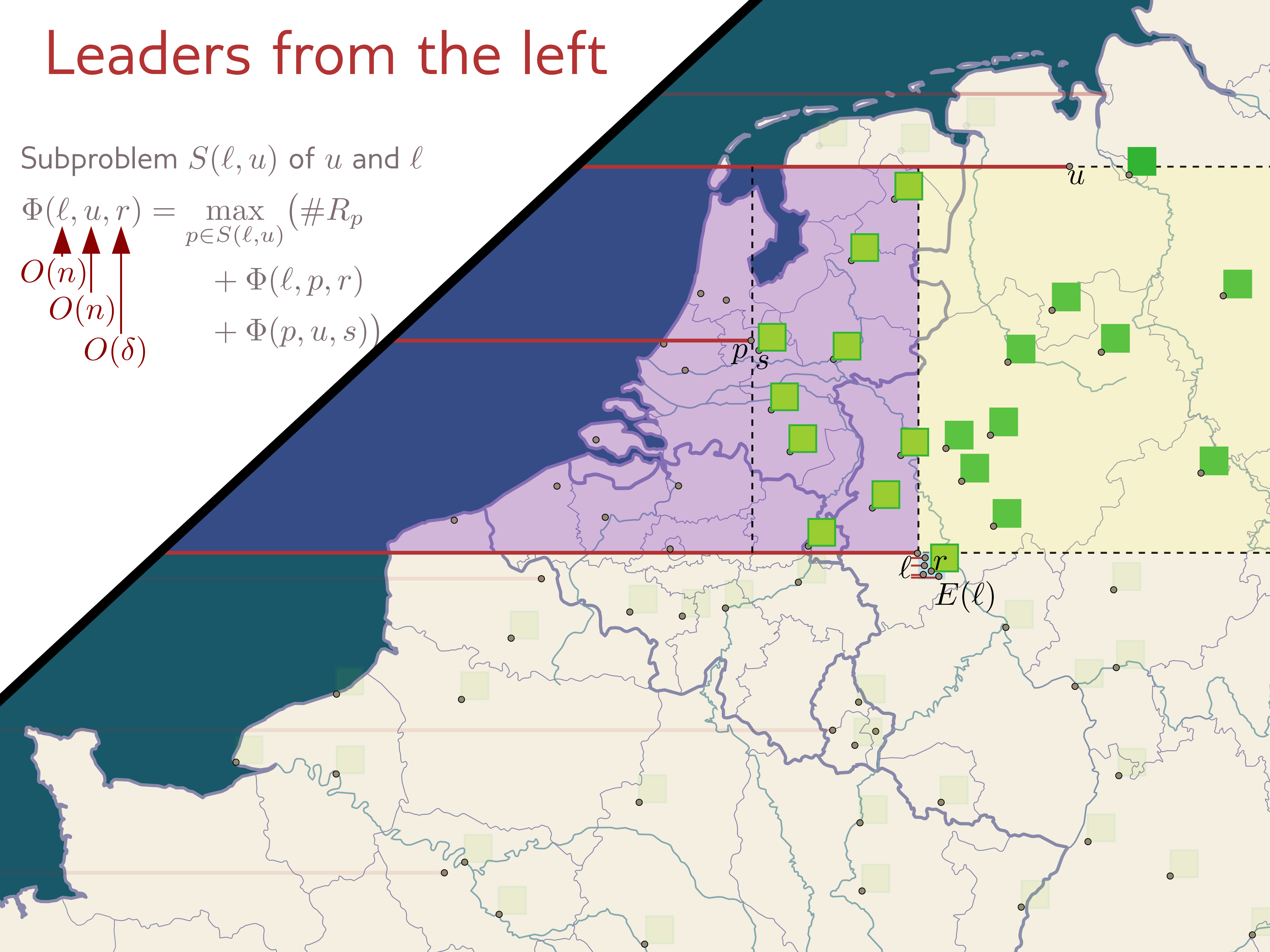
$O(n)$ $O(n)$ $O(\delta)$



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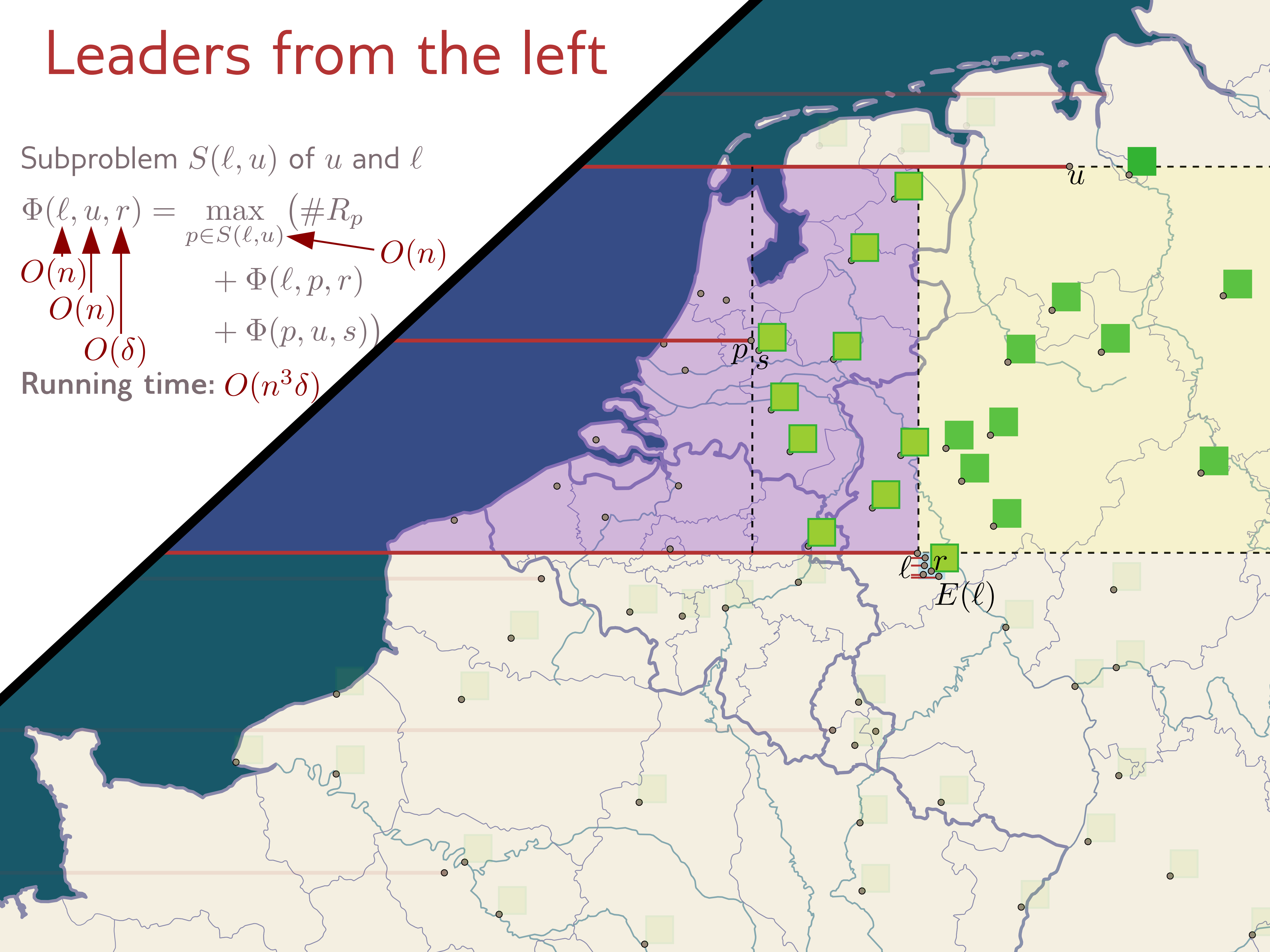
$O(n)$ $O(n)$ $O(\delta)$ $O(n)$

Running time: $O(n^3\delta)$



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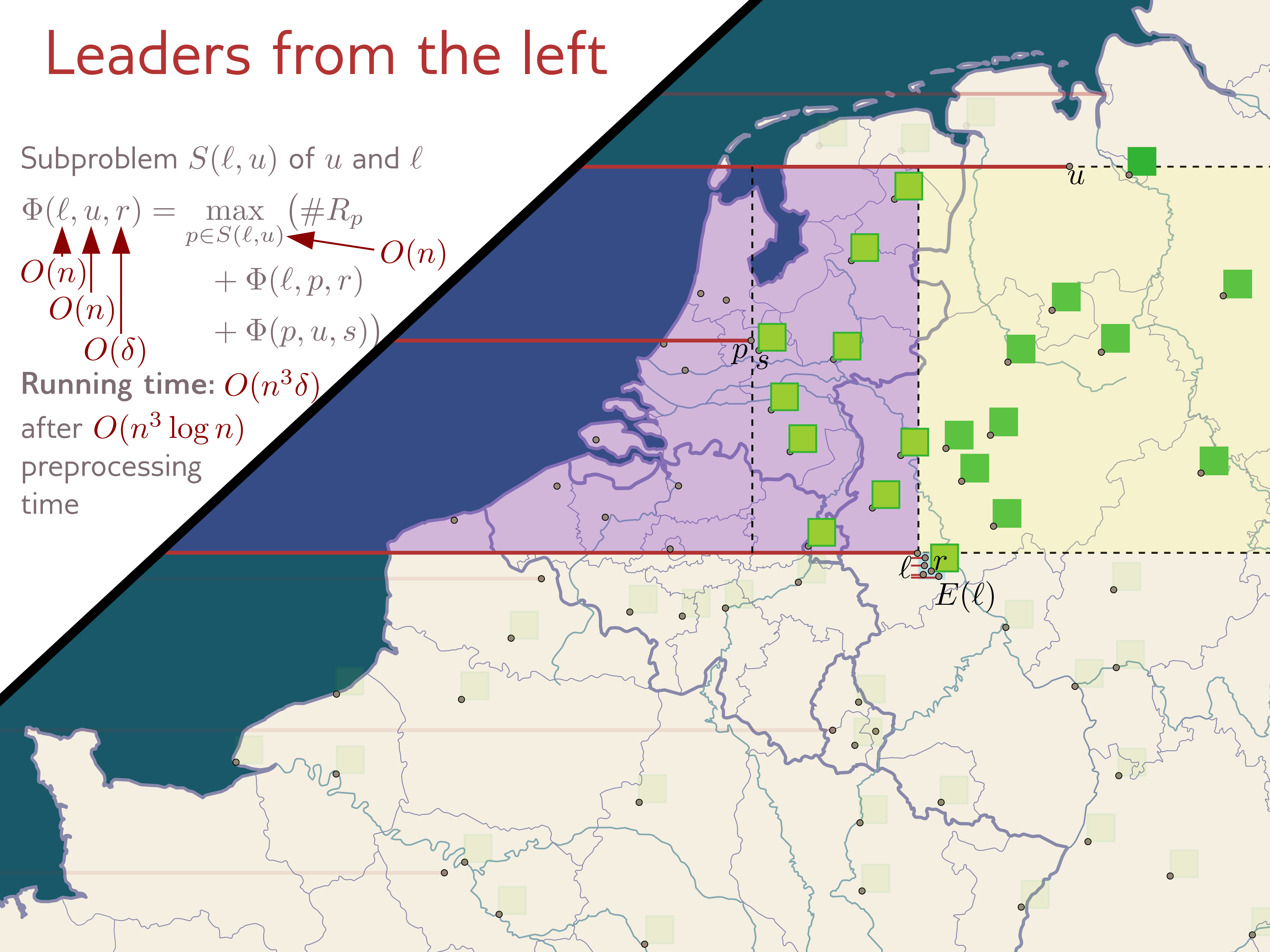
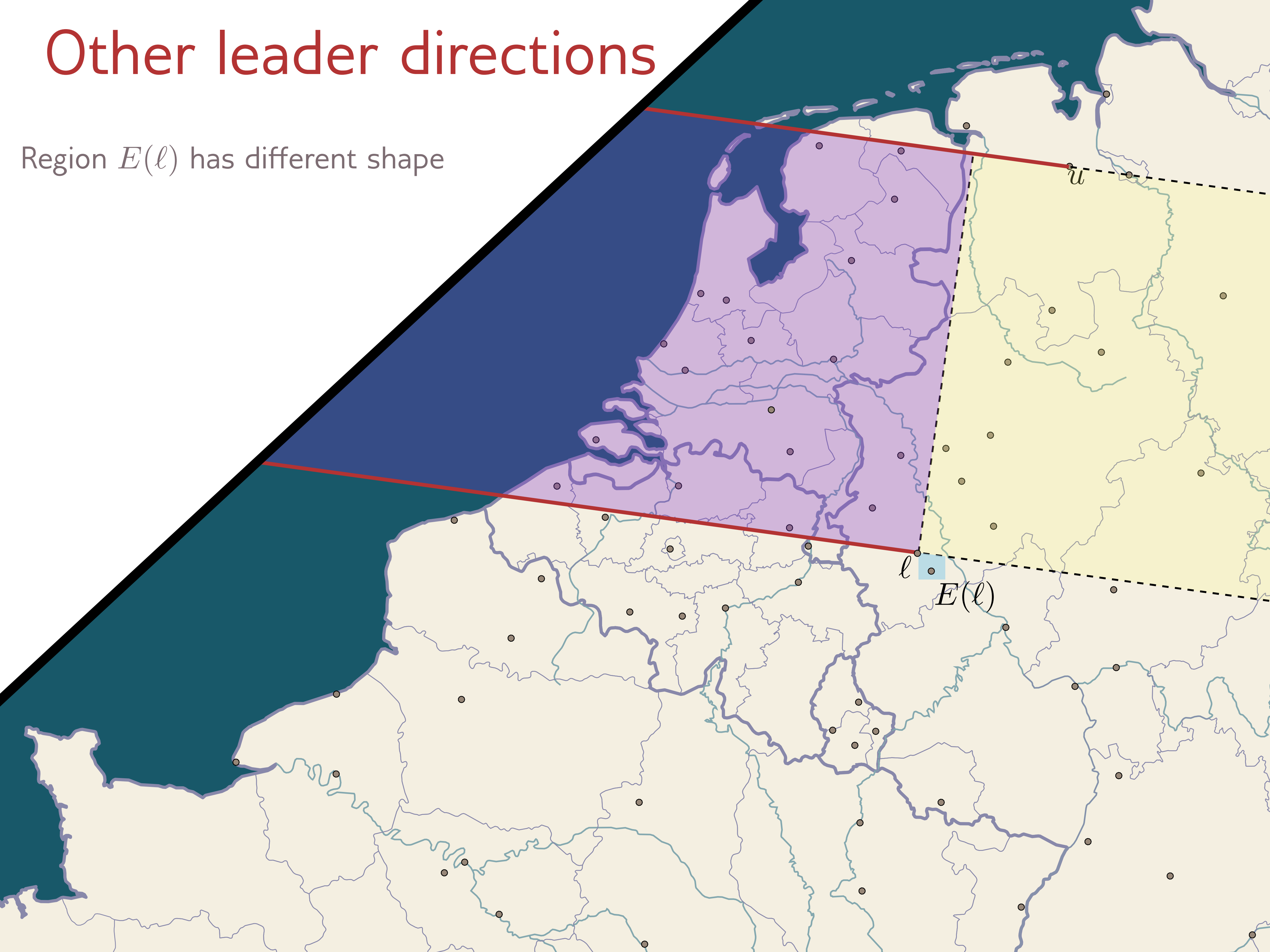
$O(n)$ $O(n)$ $O(\delta)$ $O(n)$

Running time: $O(n^3\delta)$ after $O(n^3 \log n)$ preprocessing time



Other leader directions

Region $E(\ell)$ has different shape



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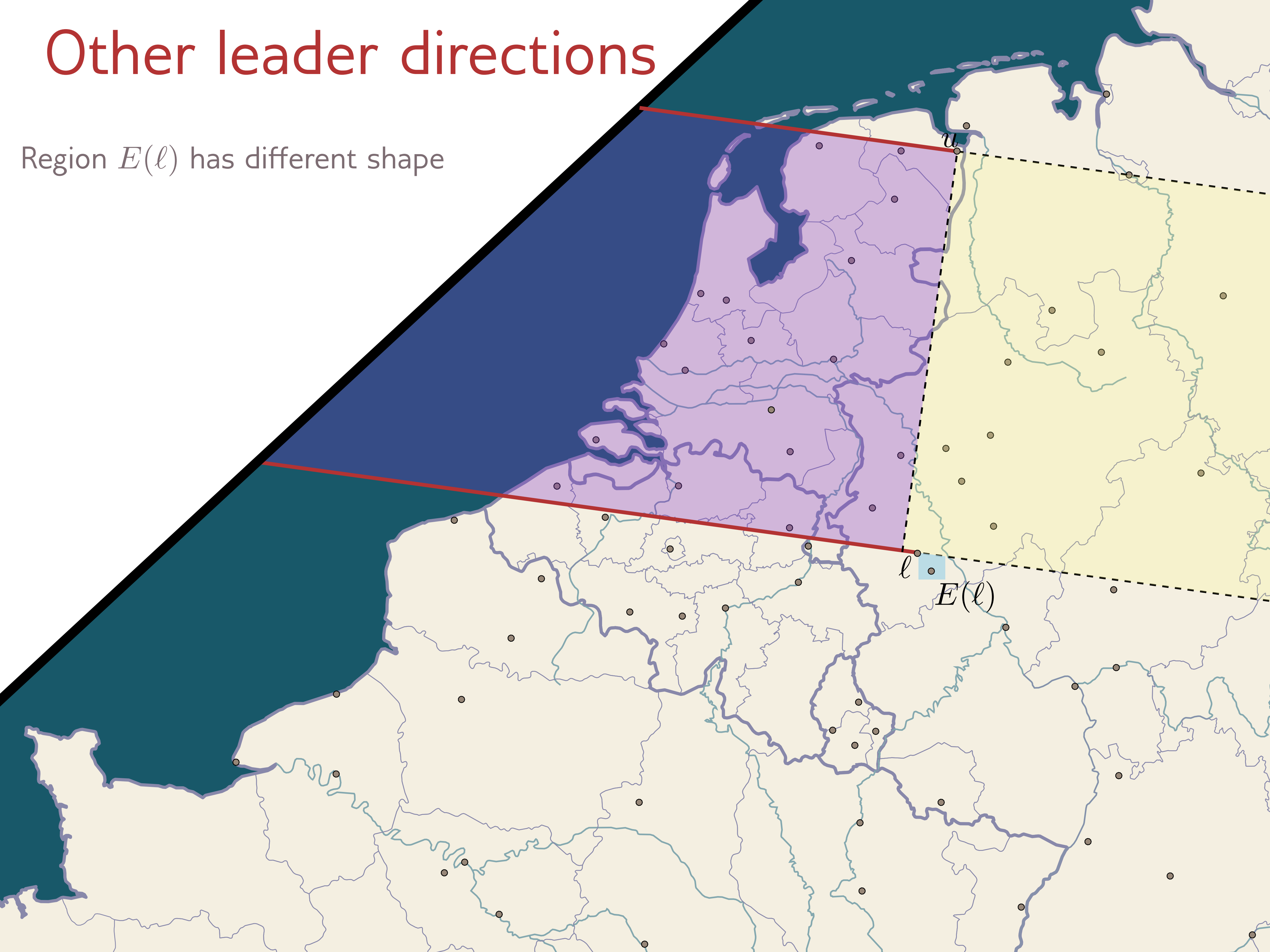
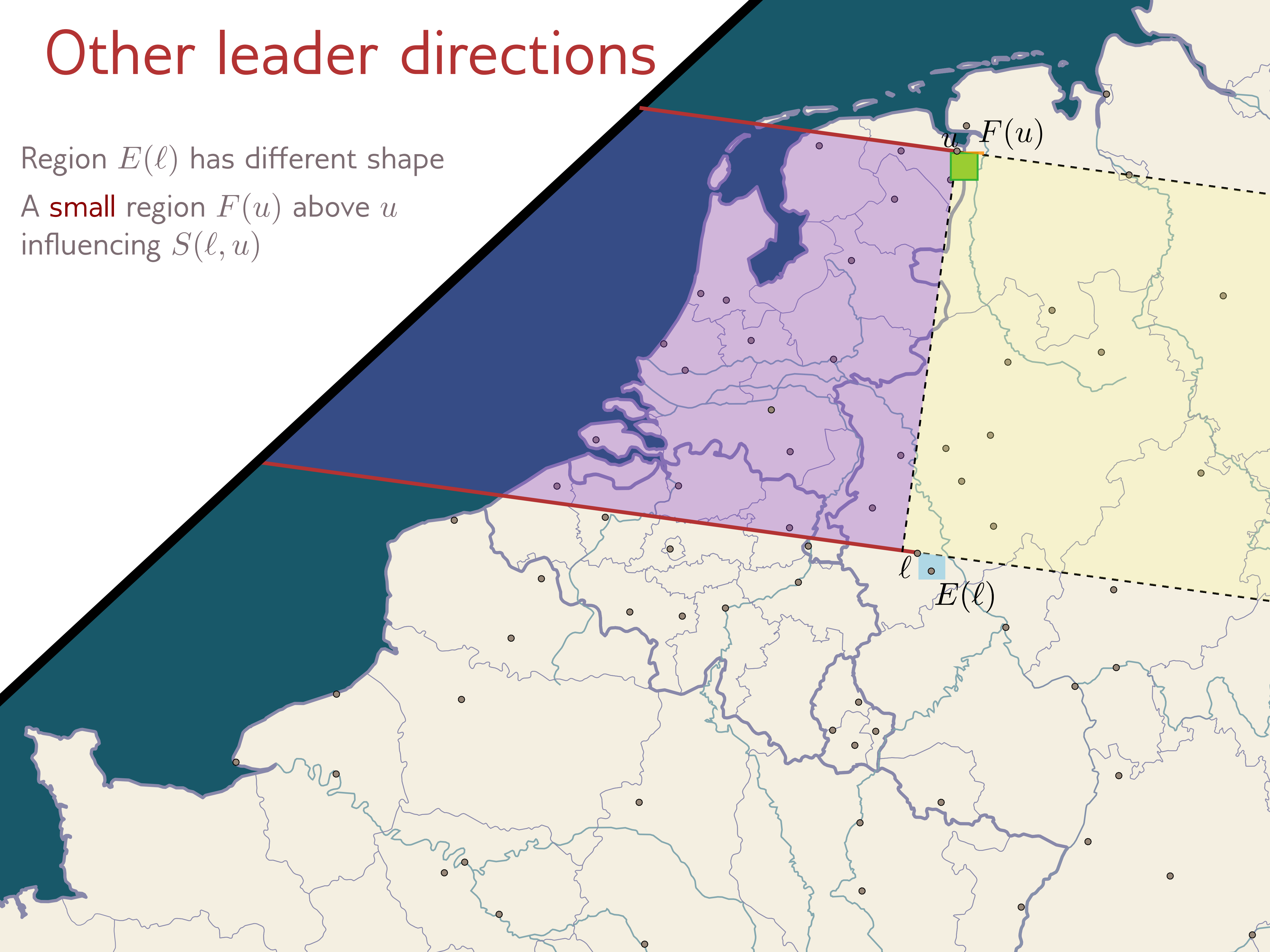


Other leader directions

Region $E(\ell)$ has different shape

A small region $F(u)$ above u influencing $S(\ell, u)$



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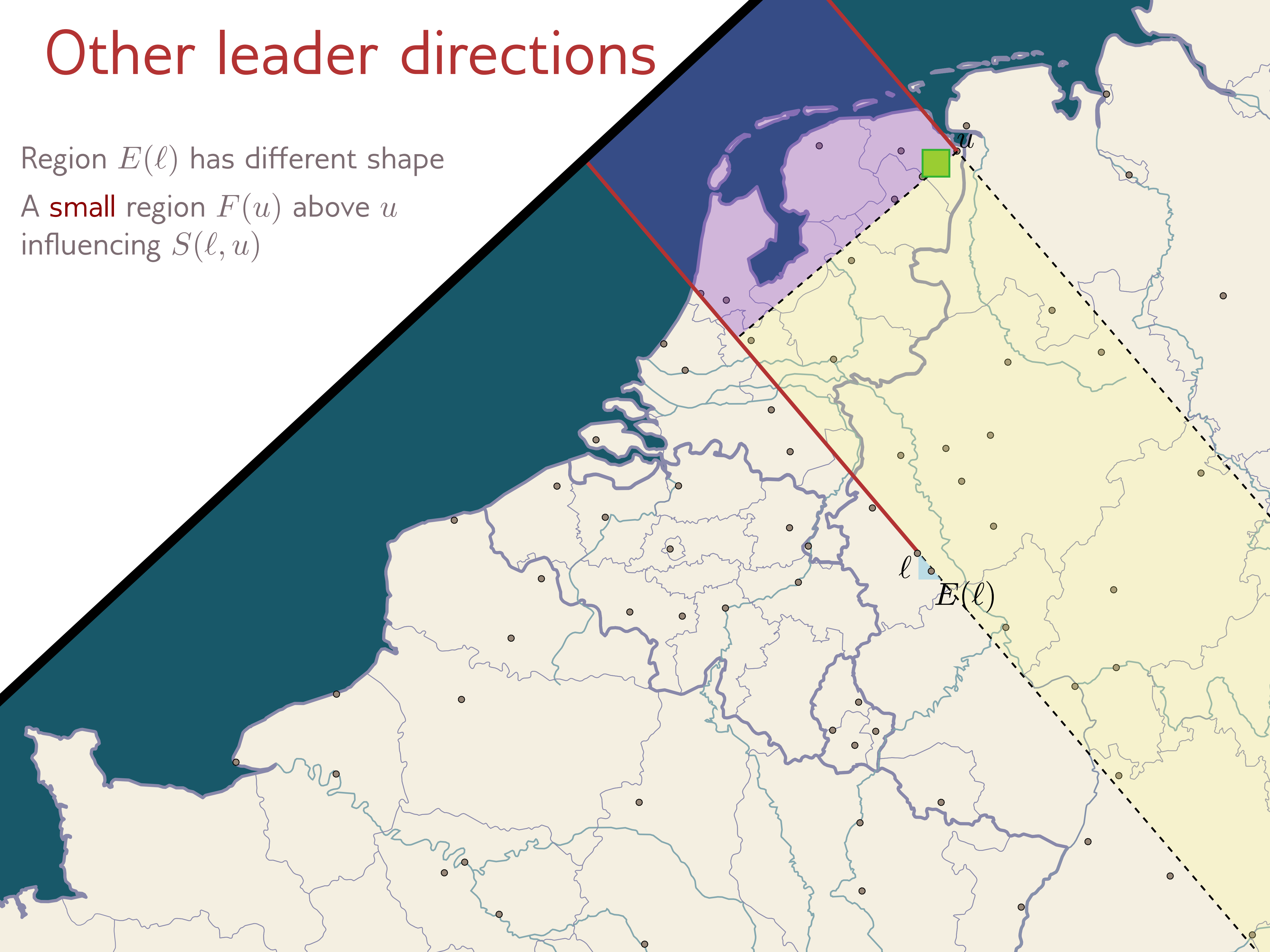

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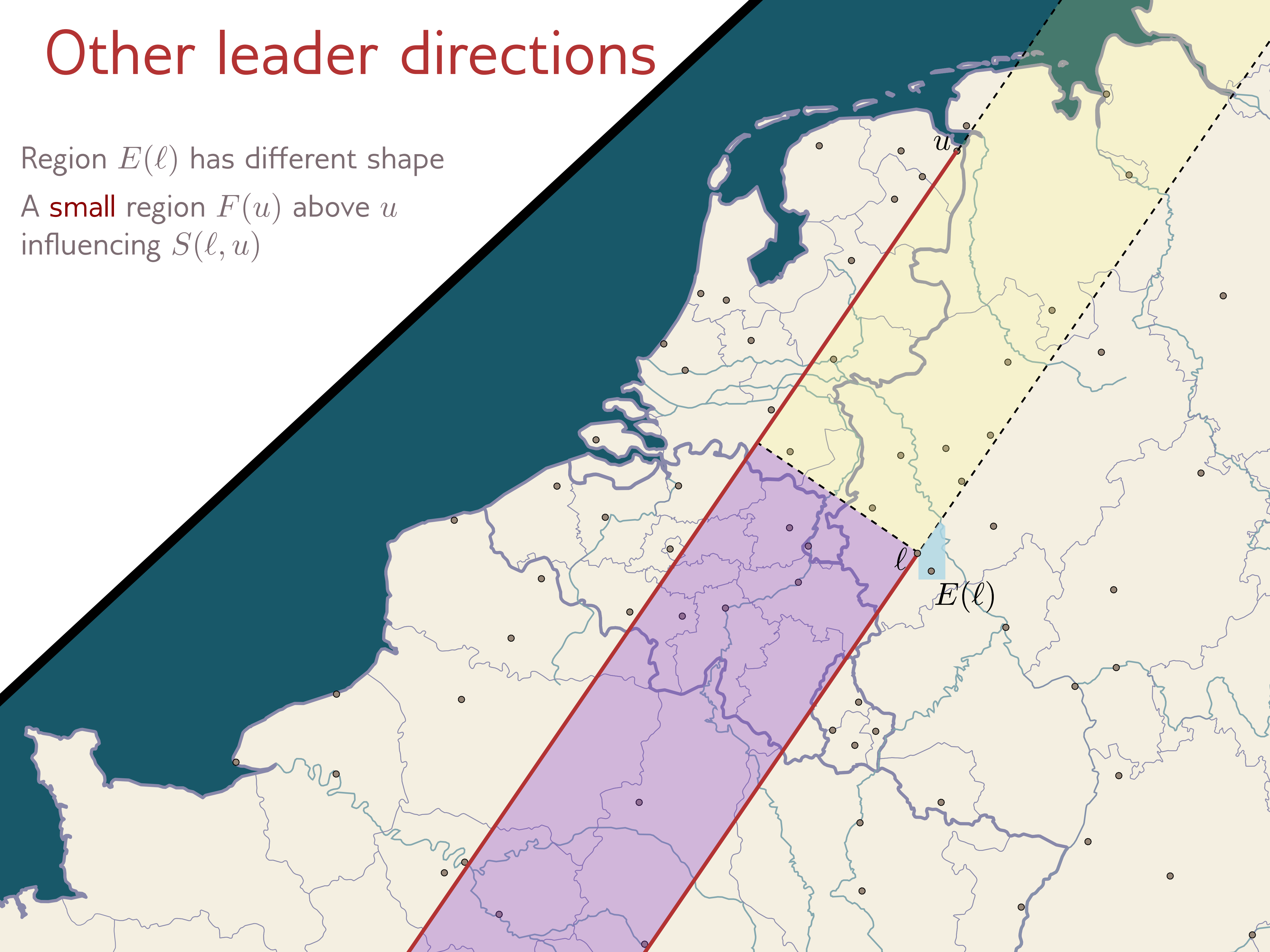

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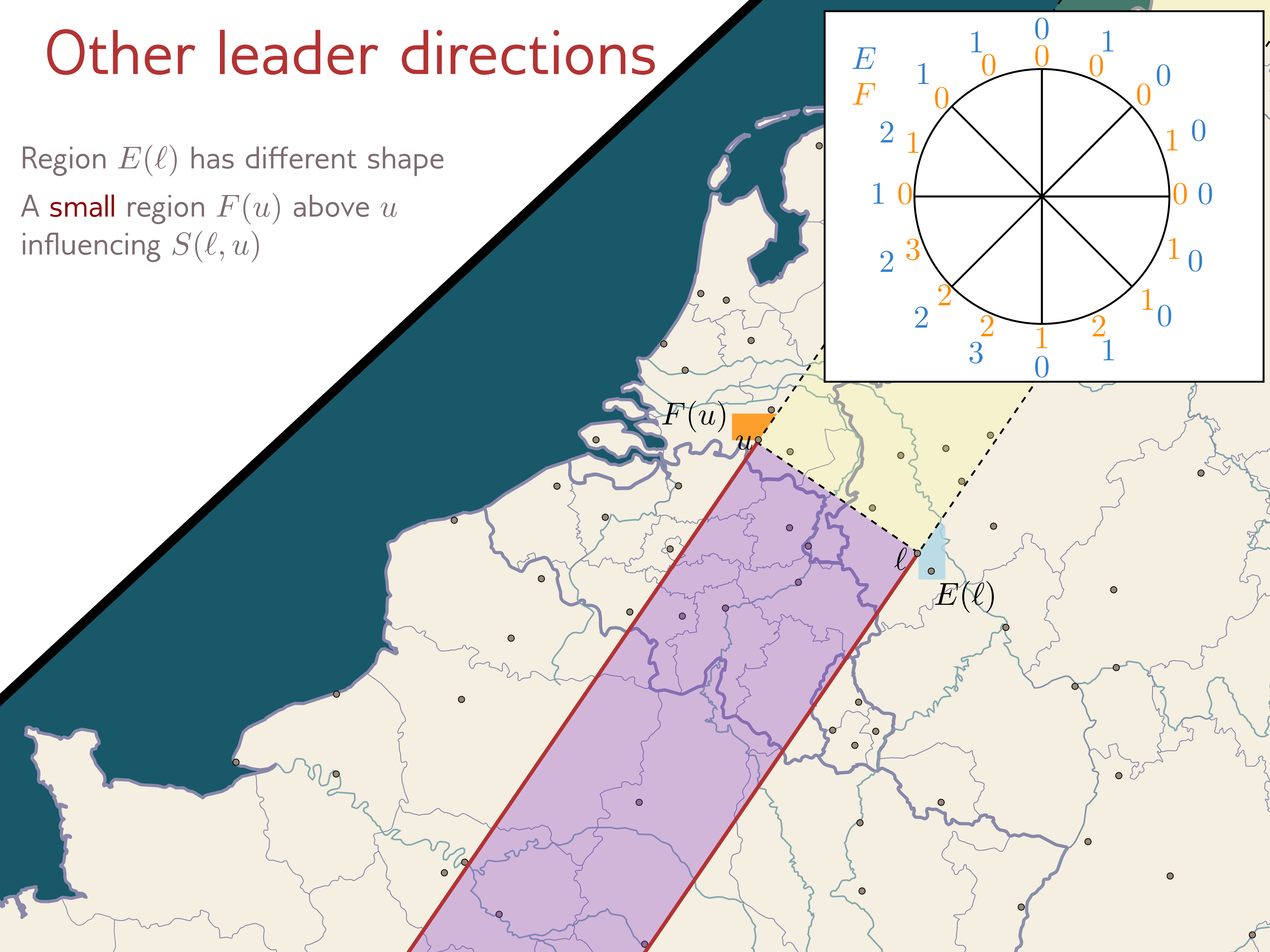

Other leader directions

Region $E(\ell)$ has different shape

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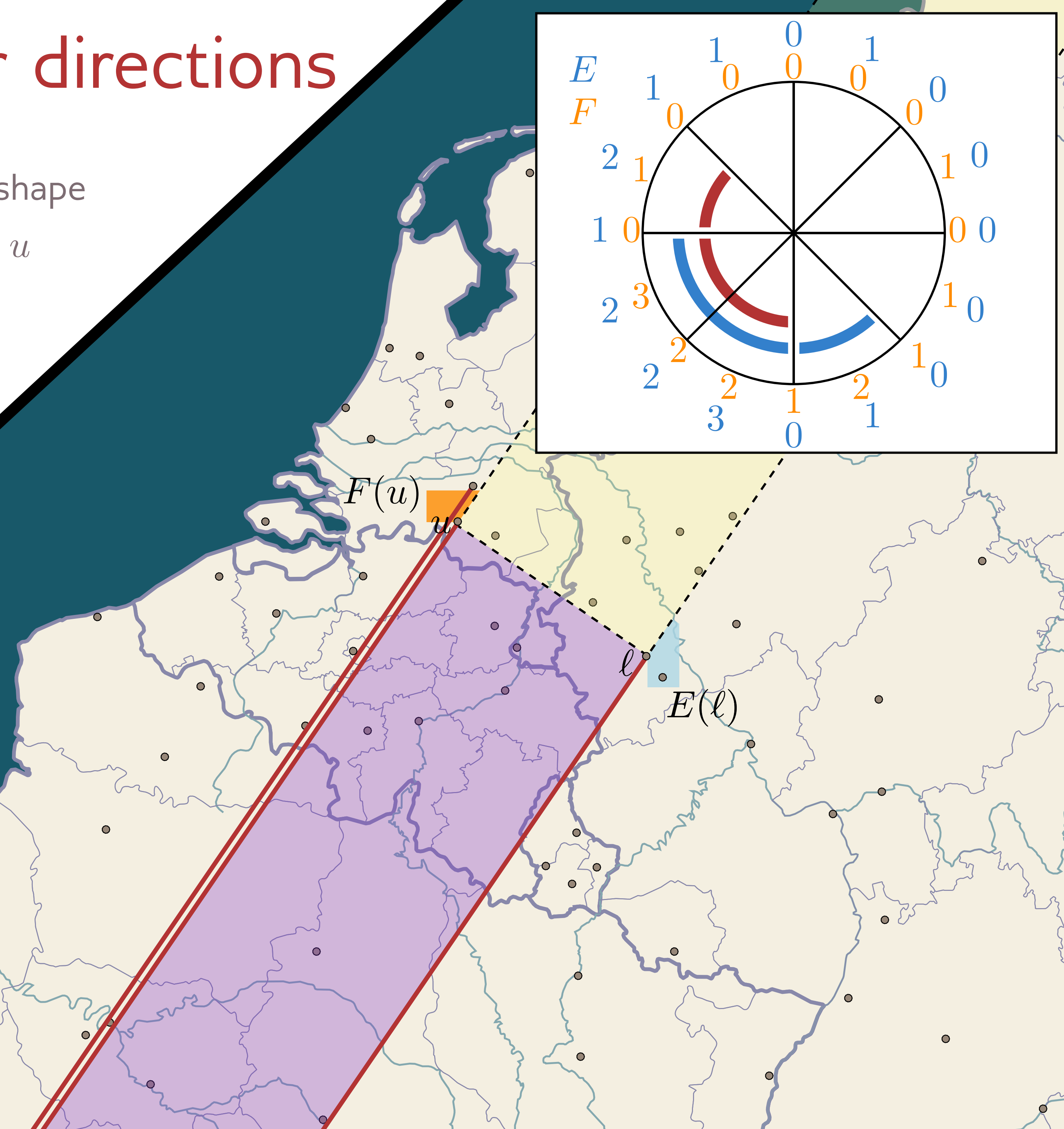
Labels not inside slab, so they may intersect leaders outside slab.



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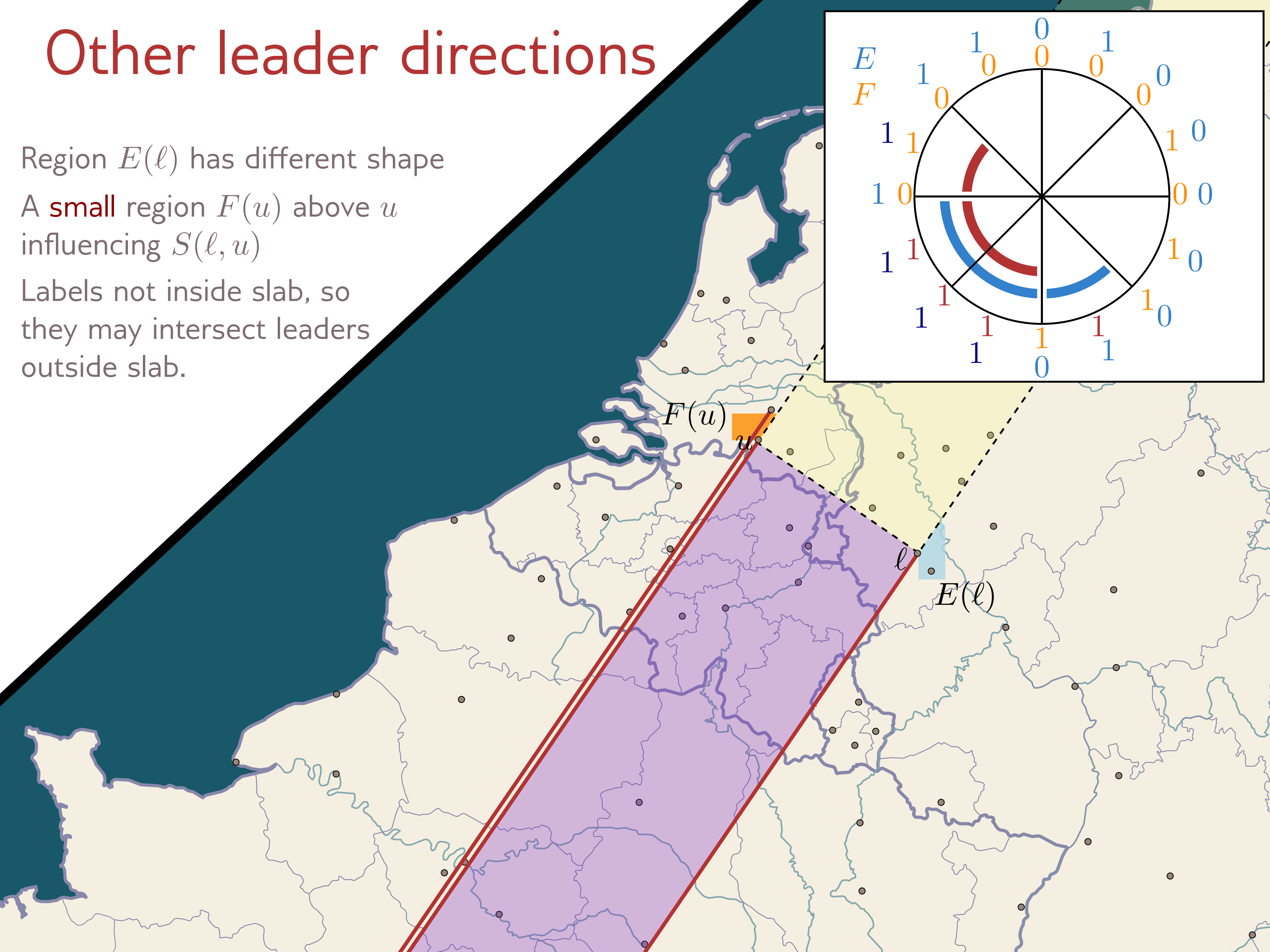
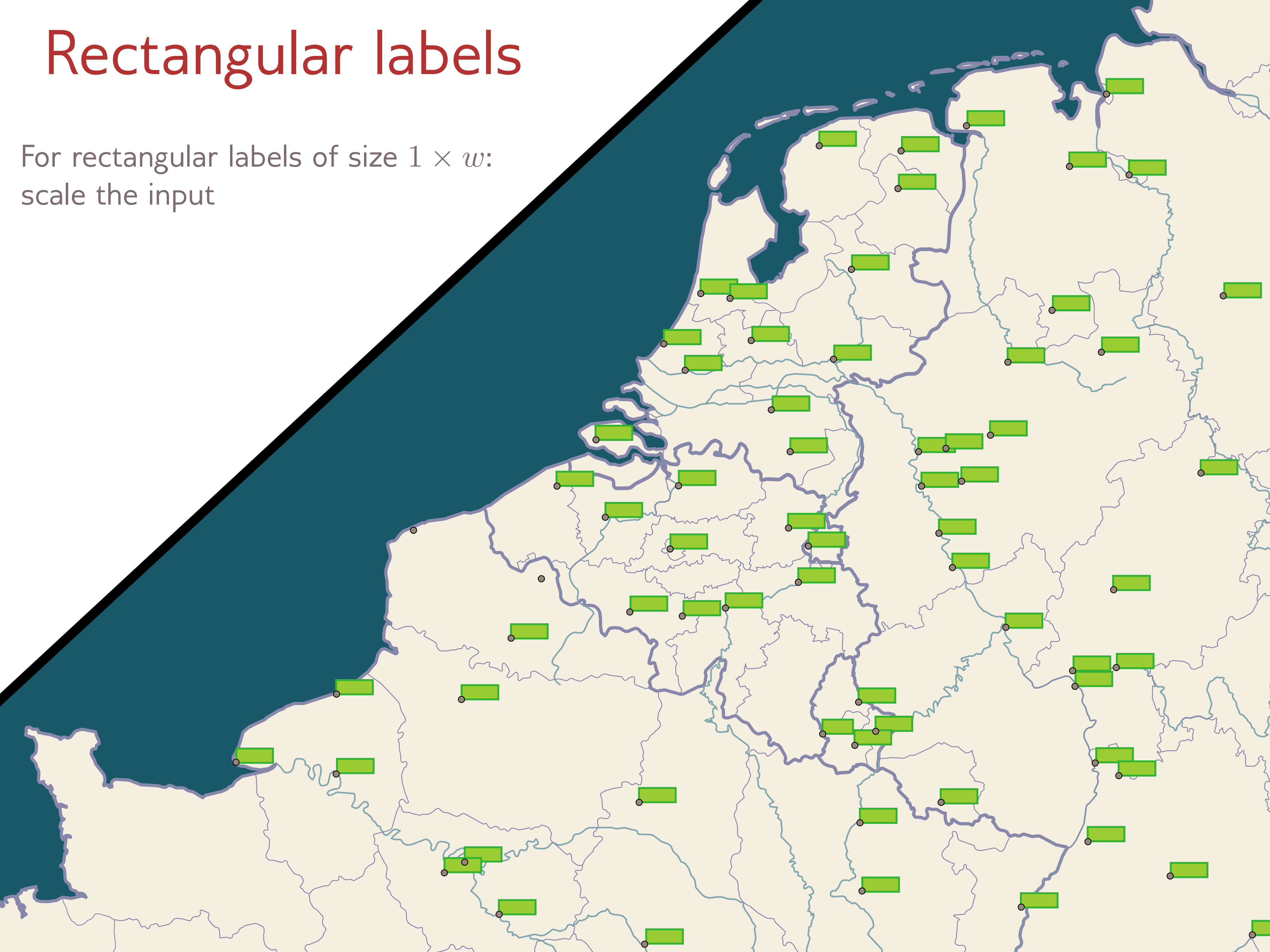


Rectangular labels

For rectangular labels of size $1 \times w$:
scale the input



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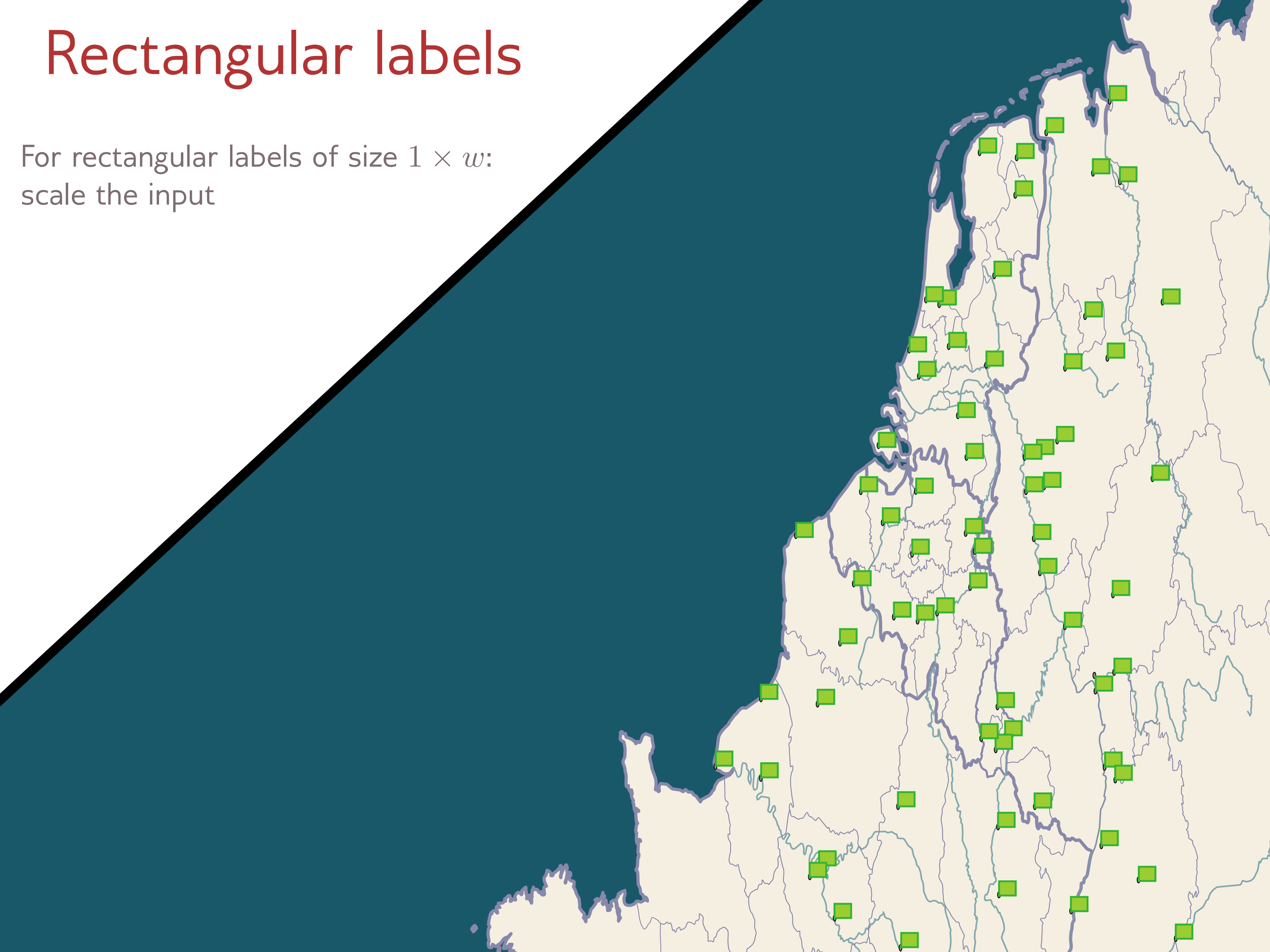

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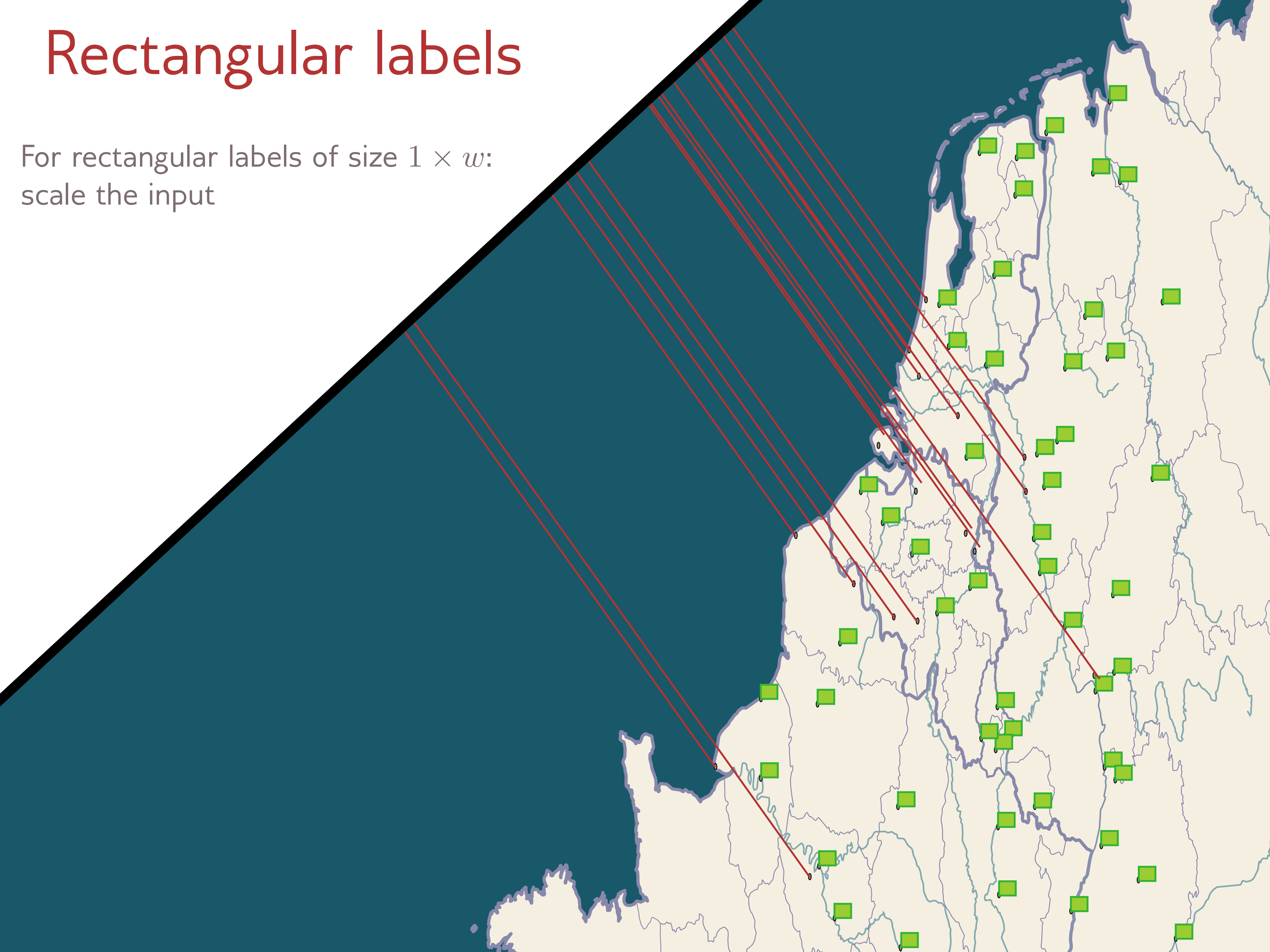

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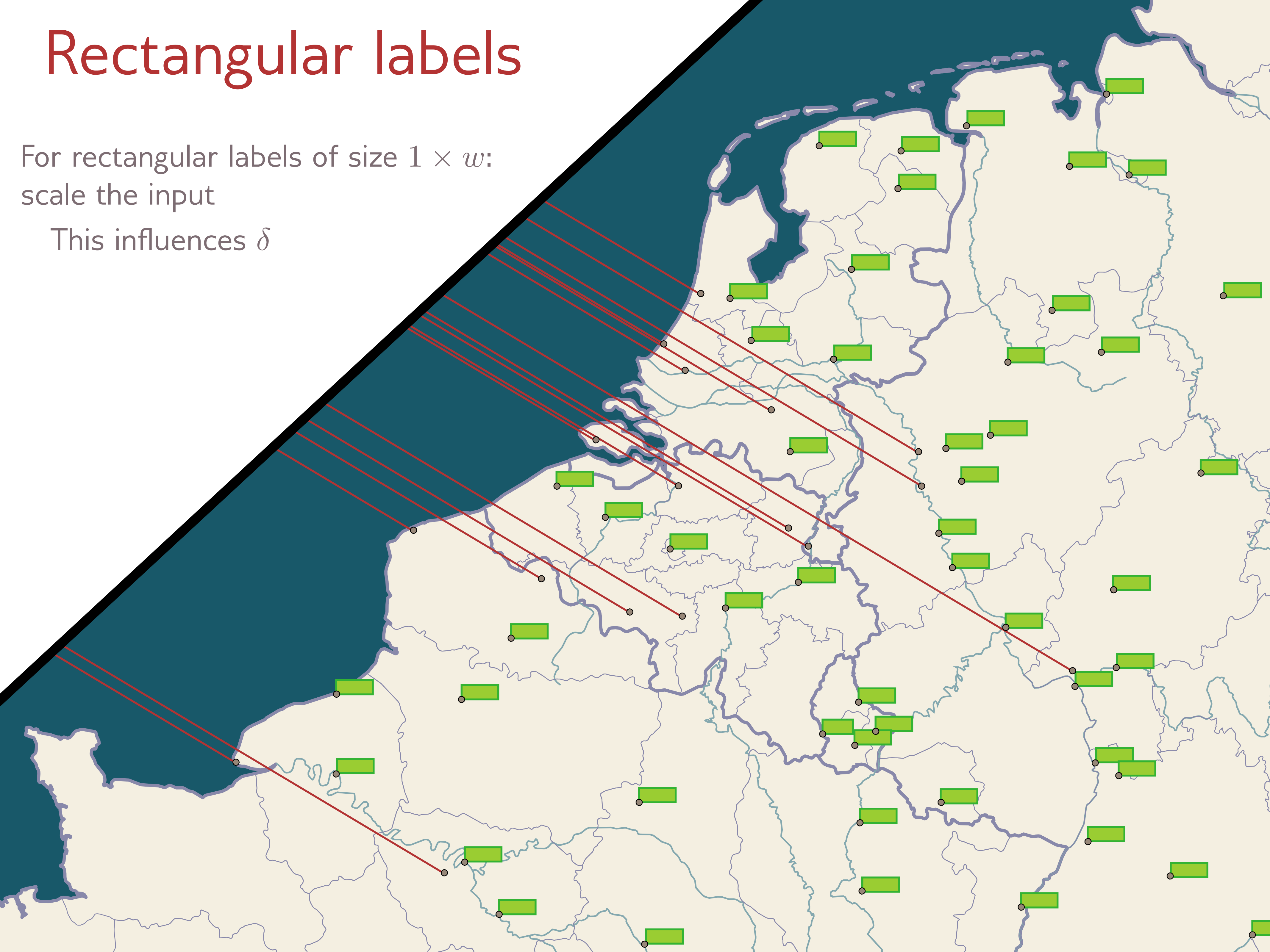
This influences δ

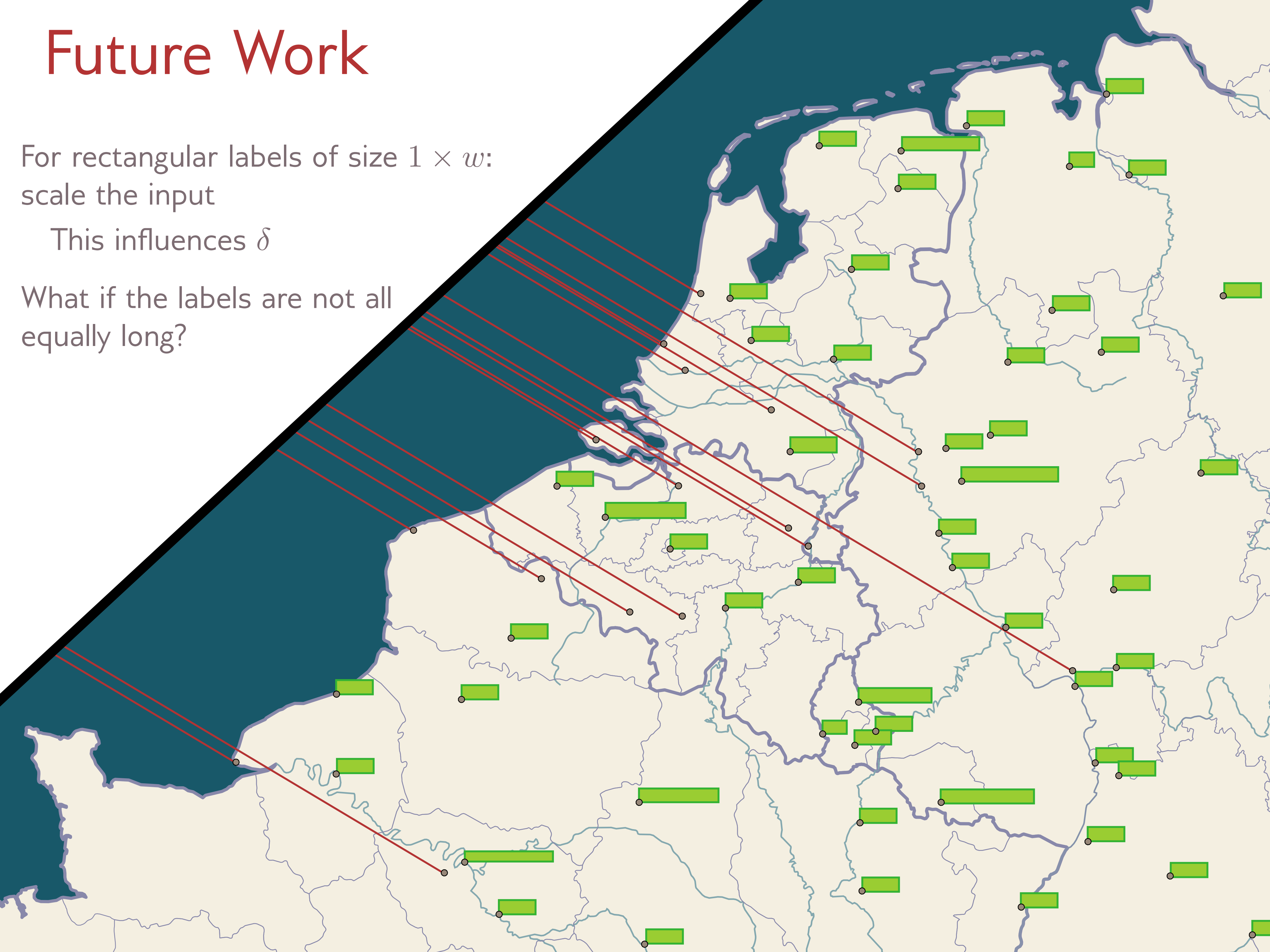


Future Work

For rectangular labels of size $1 \times w$: scale the input

This influences δ

What if the labels are not all equally long?



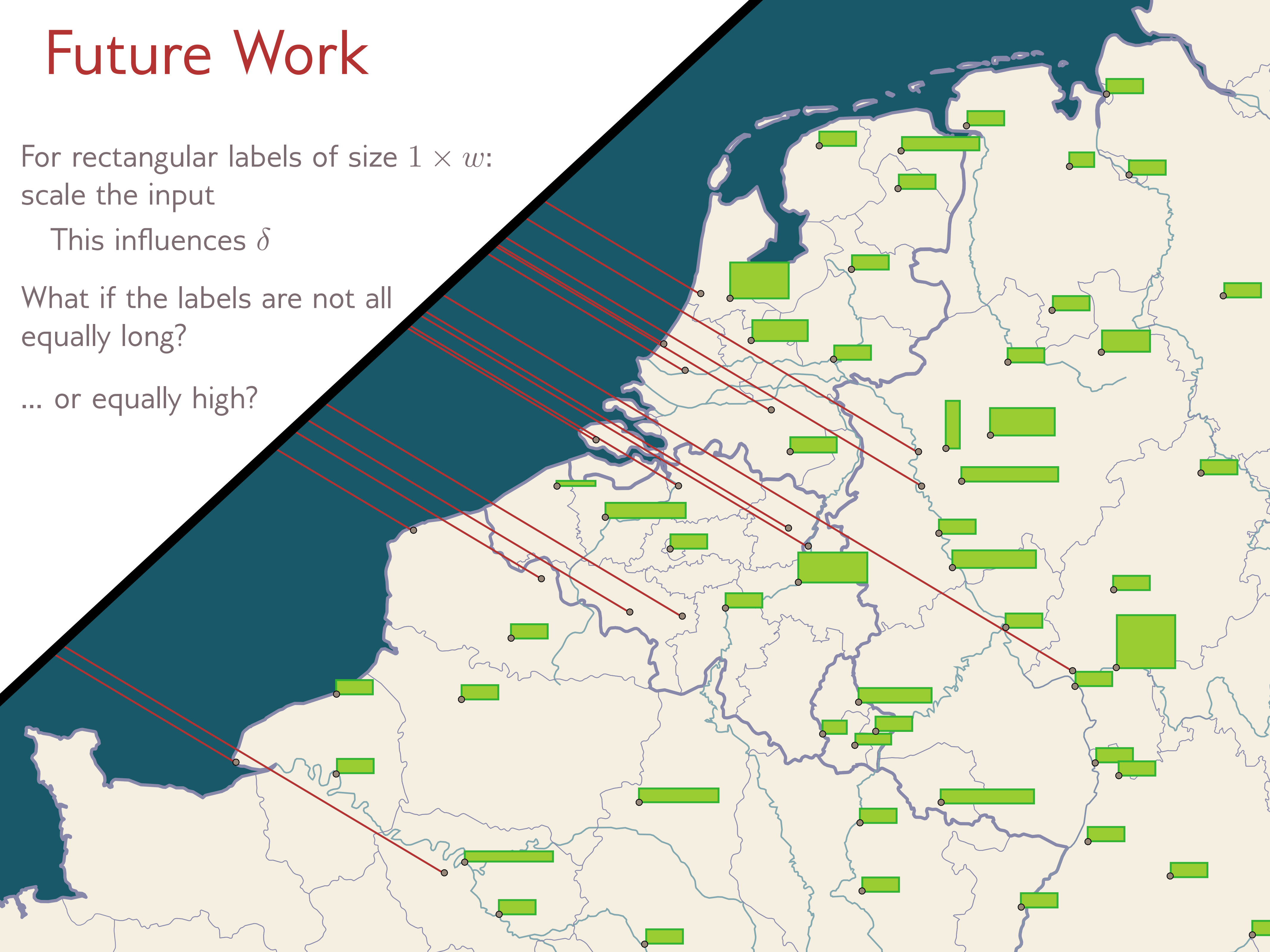
Future Work

For rectangular labels of size $1 \times w$: scale the input

This influences δ

What if the labels are not all equally long?

... or equally high?



Kingston upon Hull
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Utrecht
Arnhem
Zwolle
Leeuwarden
Groningen
Assen
Emden
Bremerhaven
Oldenburg
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Osnabrück
Hannover
Bielefeld
Münster
Dortmund
Essen
Duisburg
Düsseldorf
Wuppertal
Cologne
Bonn
Kassel
Giessen
Koblenz
Wiesbaden
Frankfurt
Mainz
Diekirch
Arlon
Grevenmacher
Luxembourg
Mannheim
Heidelberg
Saarbrucken
Metz
Karlsruhe
Stuttgart
Nancy
Strasbourg
Ulm

Thank You!


Bremerhaven
Emden
Leeuwarden
Groningen
Oldenburg
Bremen
Assen
Zwolle
Hannover
Haarlem
Amsterdam
Osnabrück
The Hague
Utrecht
Bielefeld
Arnhem
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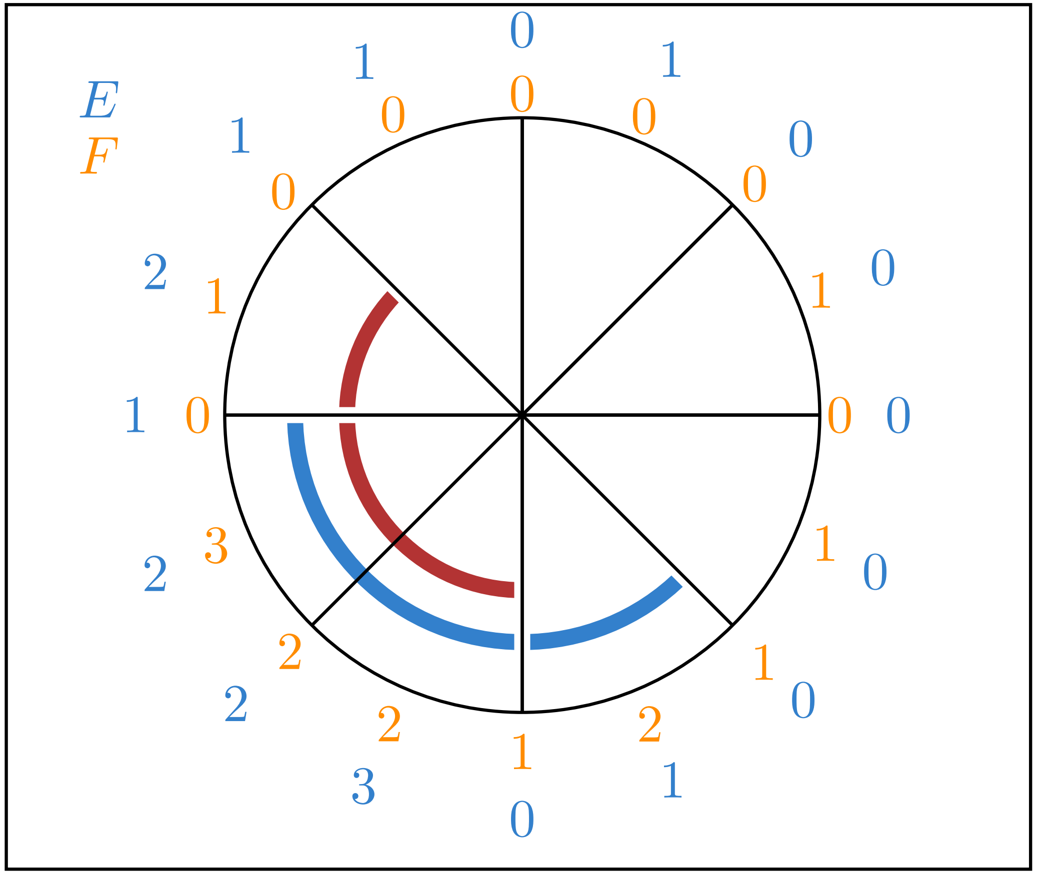

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All orientations
Compute optimal orientation

Parameters:

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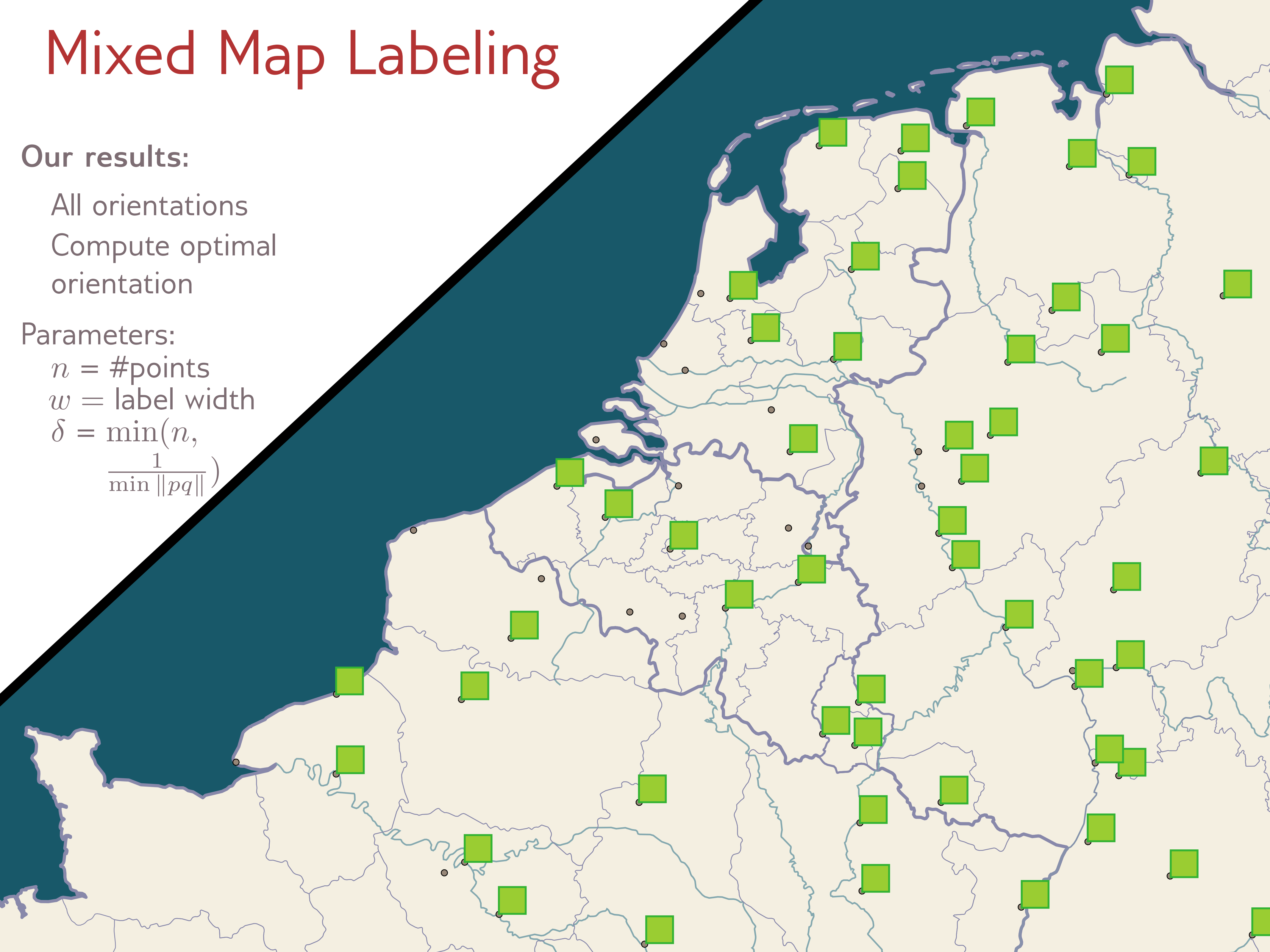
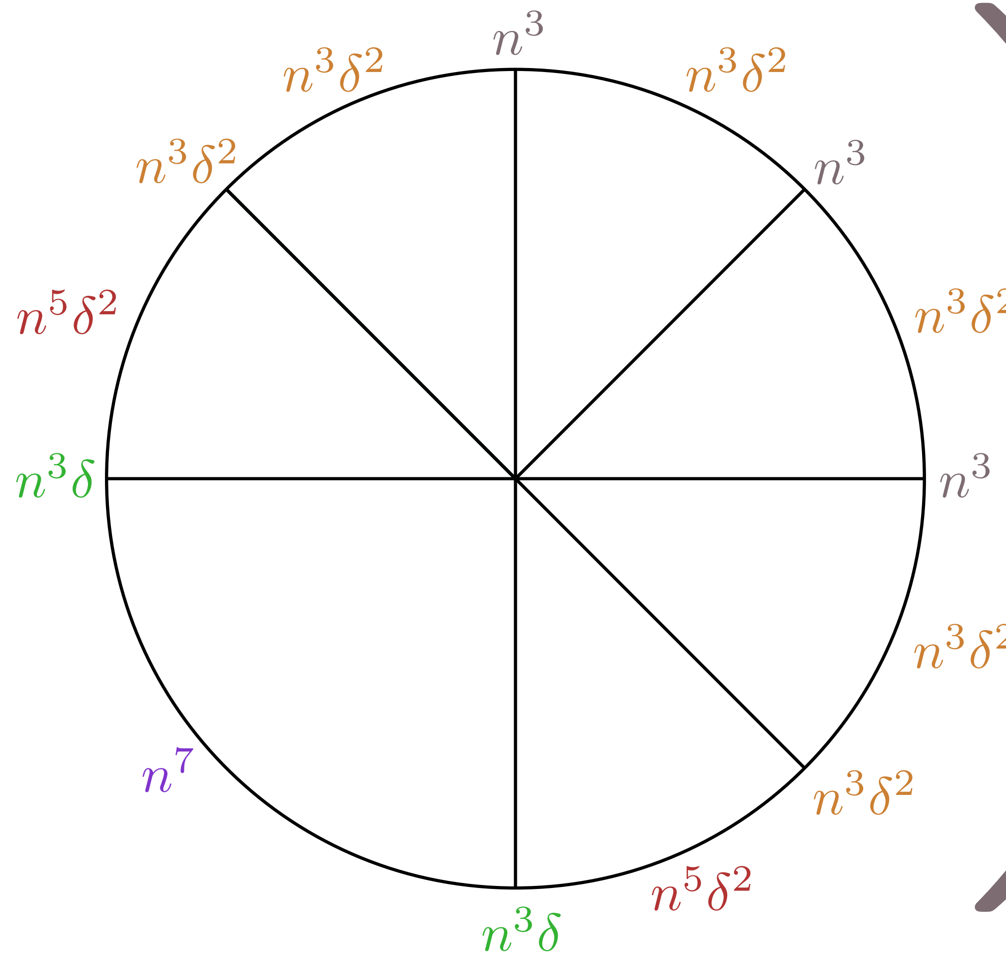


$O\Big(n^3 \log n +$



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