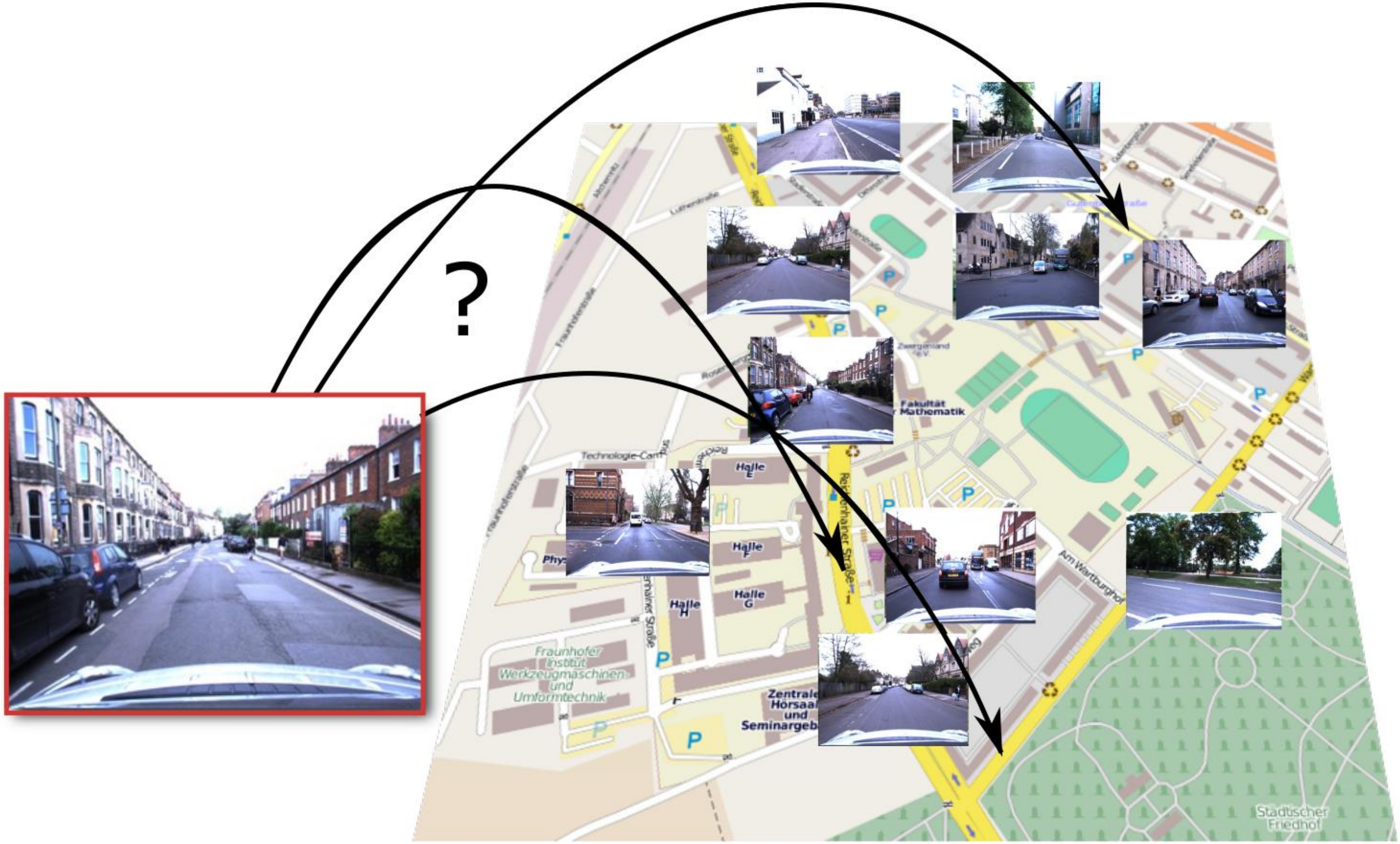
Teaser application 2: Place recognition in changing environments

The Nordland dataset – a 3000 km journey across all four seasons

Sünderhauf, N., Neubert, P. & Protzel, P. (2013) Are We There Yet? Challenging SeqSLAM on a 3000 km Journey Across All Four Seasons. In Proc. of Workshop on Long-Term Autonomy at Int. Conf. on Rob. a. Autom. (ICRA)

http://nrkbeta.no/2013/01/15/nordlandsbanen-minute-by-minute-season-by-season/

Teaser application 2: Place recognition in changing environments



Teaser application 2: Place recognition in changing environments

Is this the same place?

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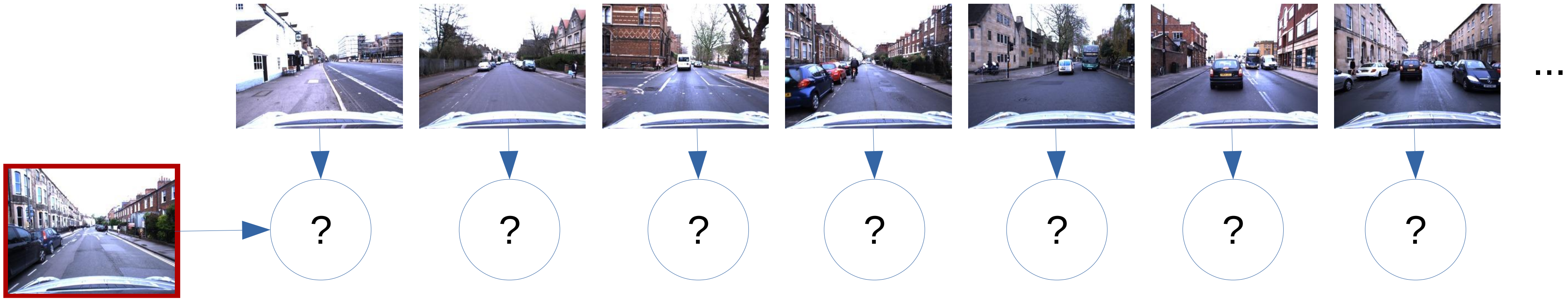

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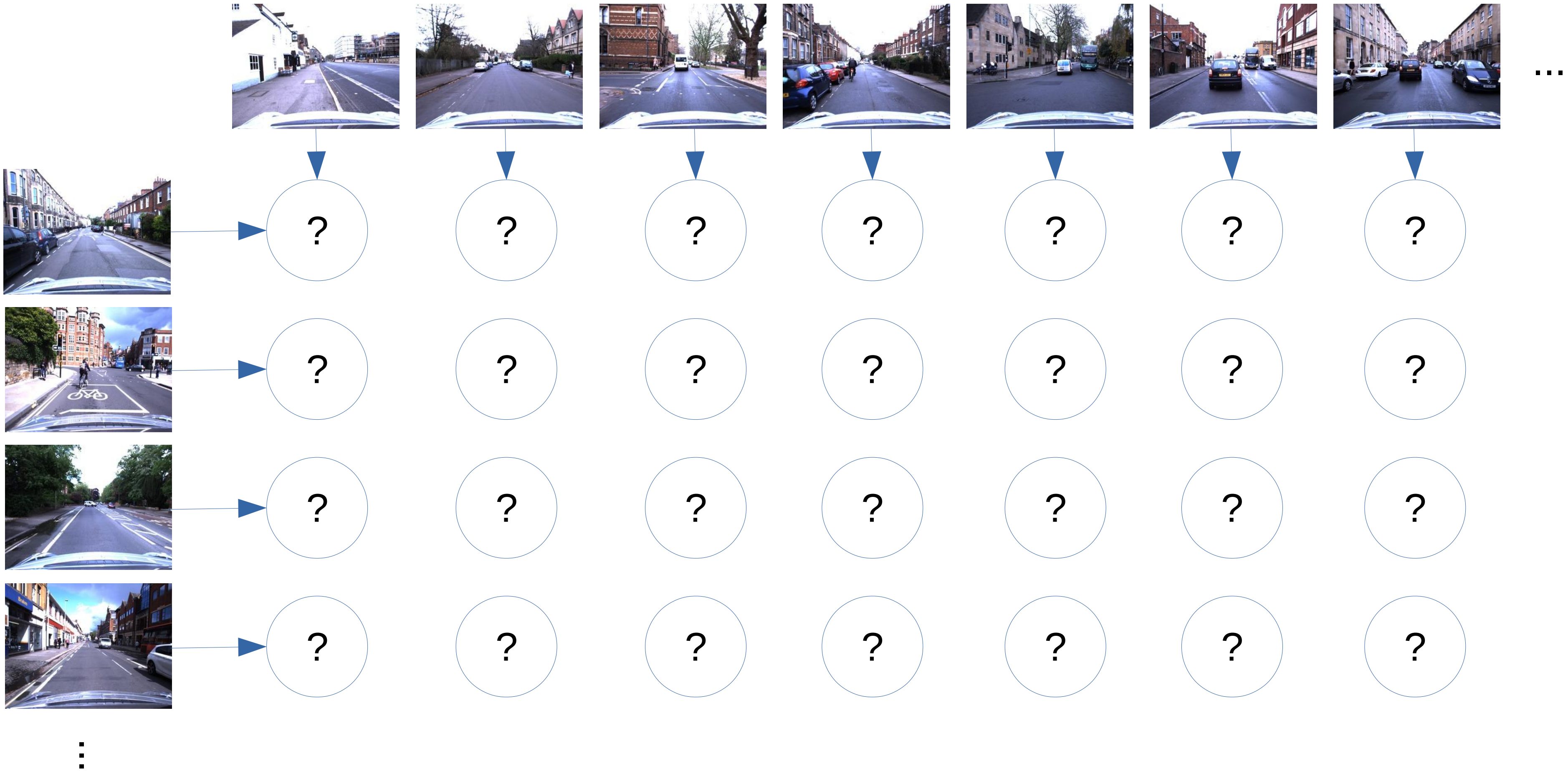

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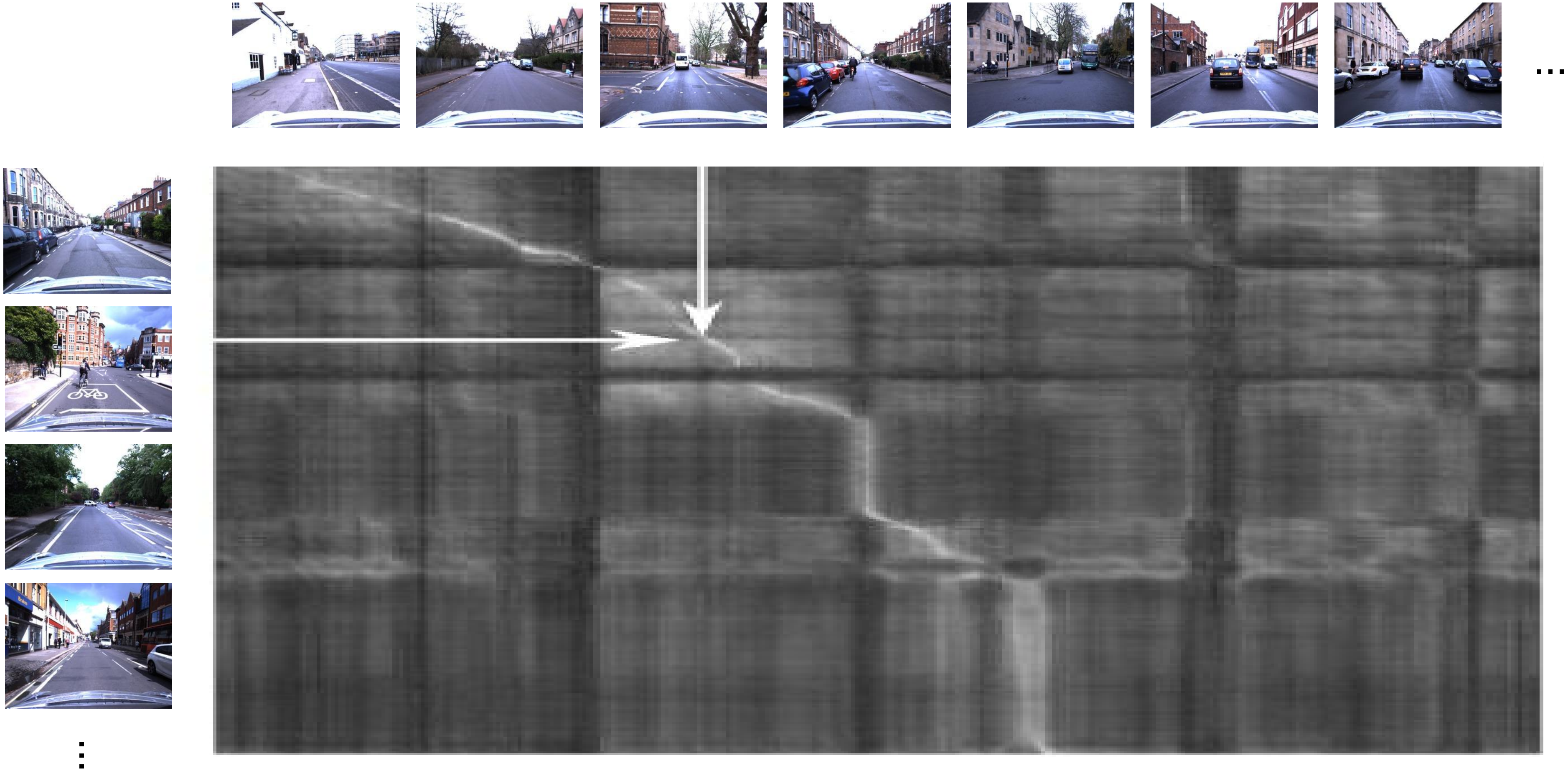

A simple approach: Pairwise descriptor matching

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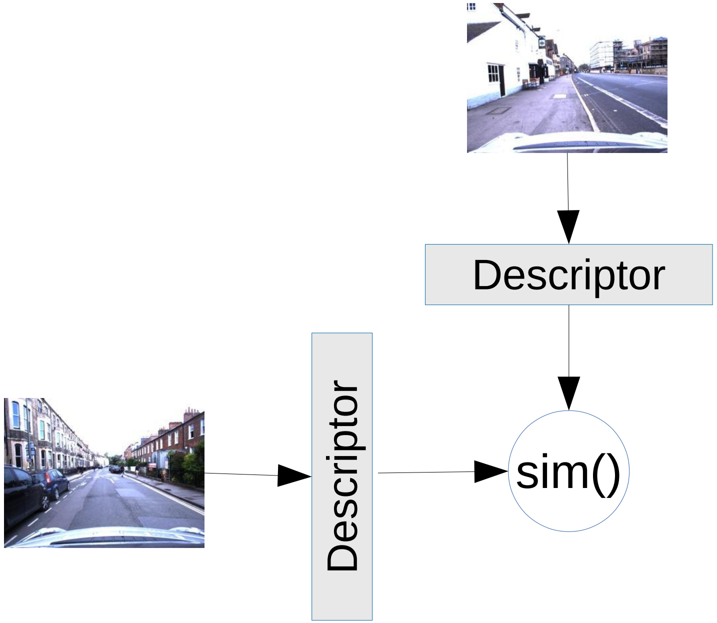

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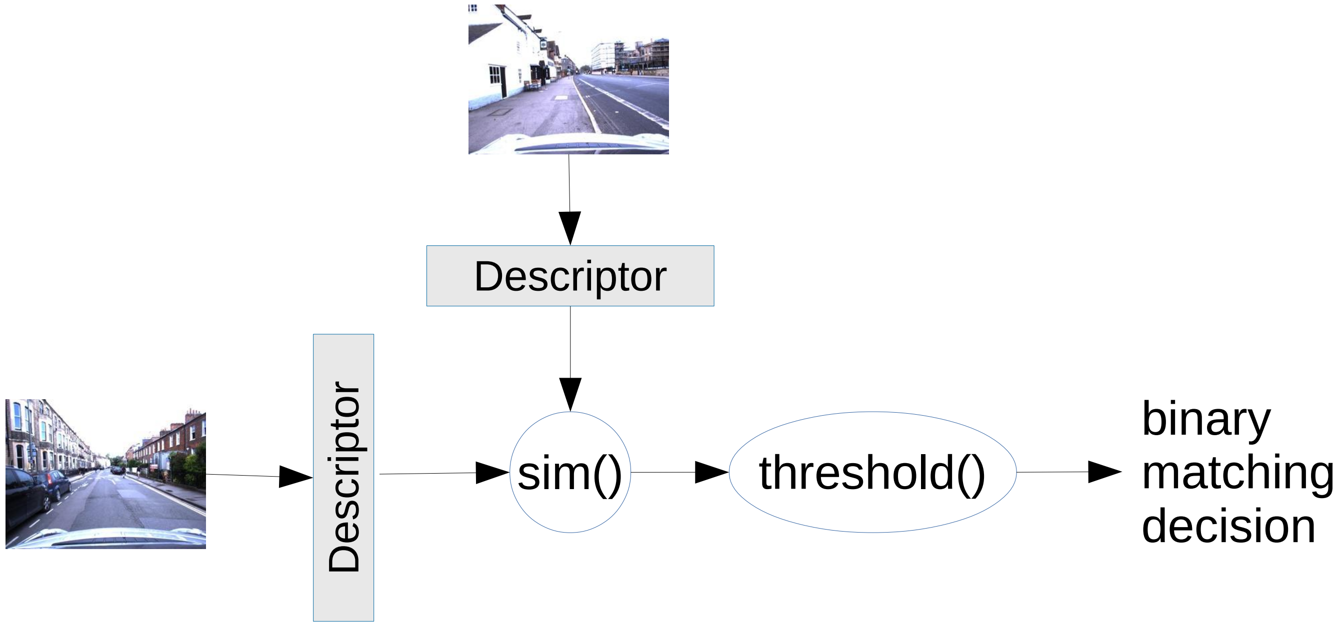

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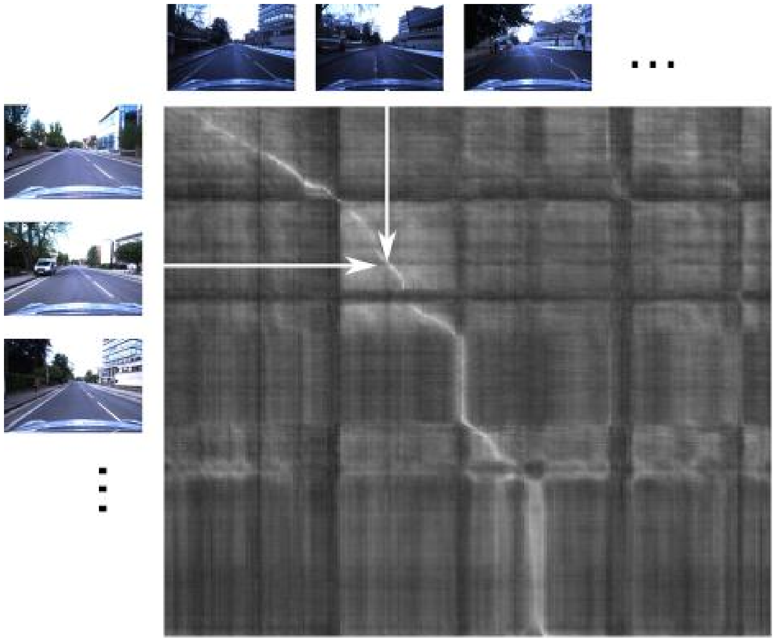

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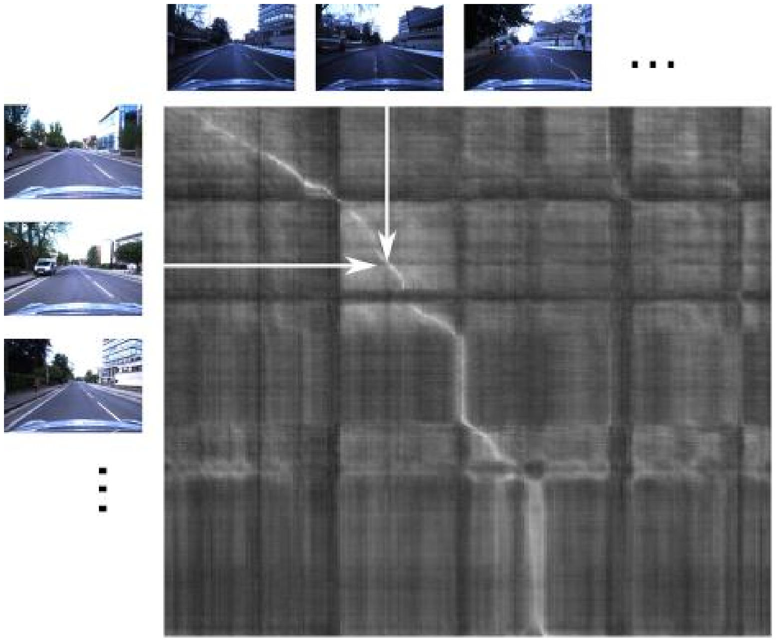
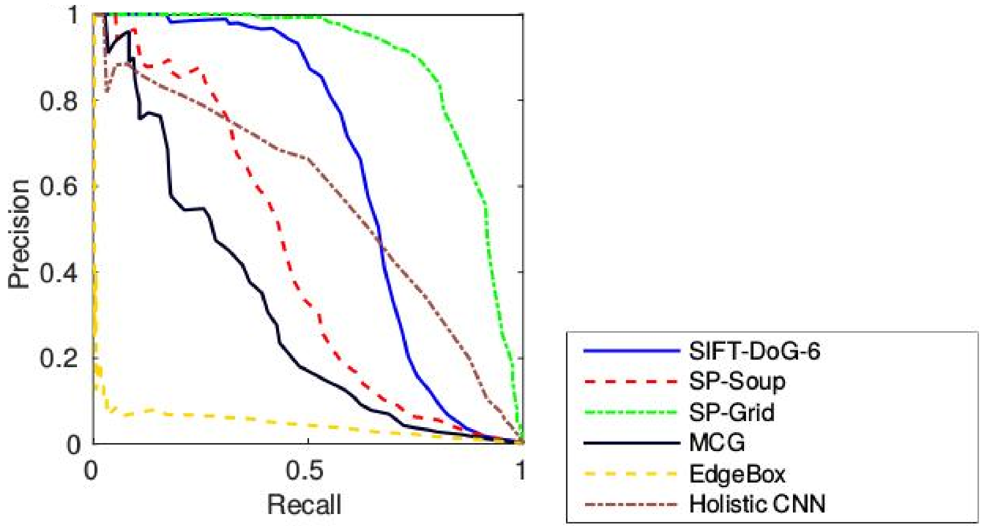


Evaluation based on
Precision-Recall curves



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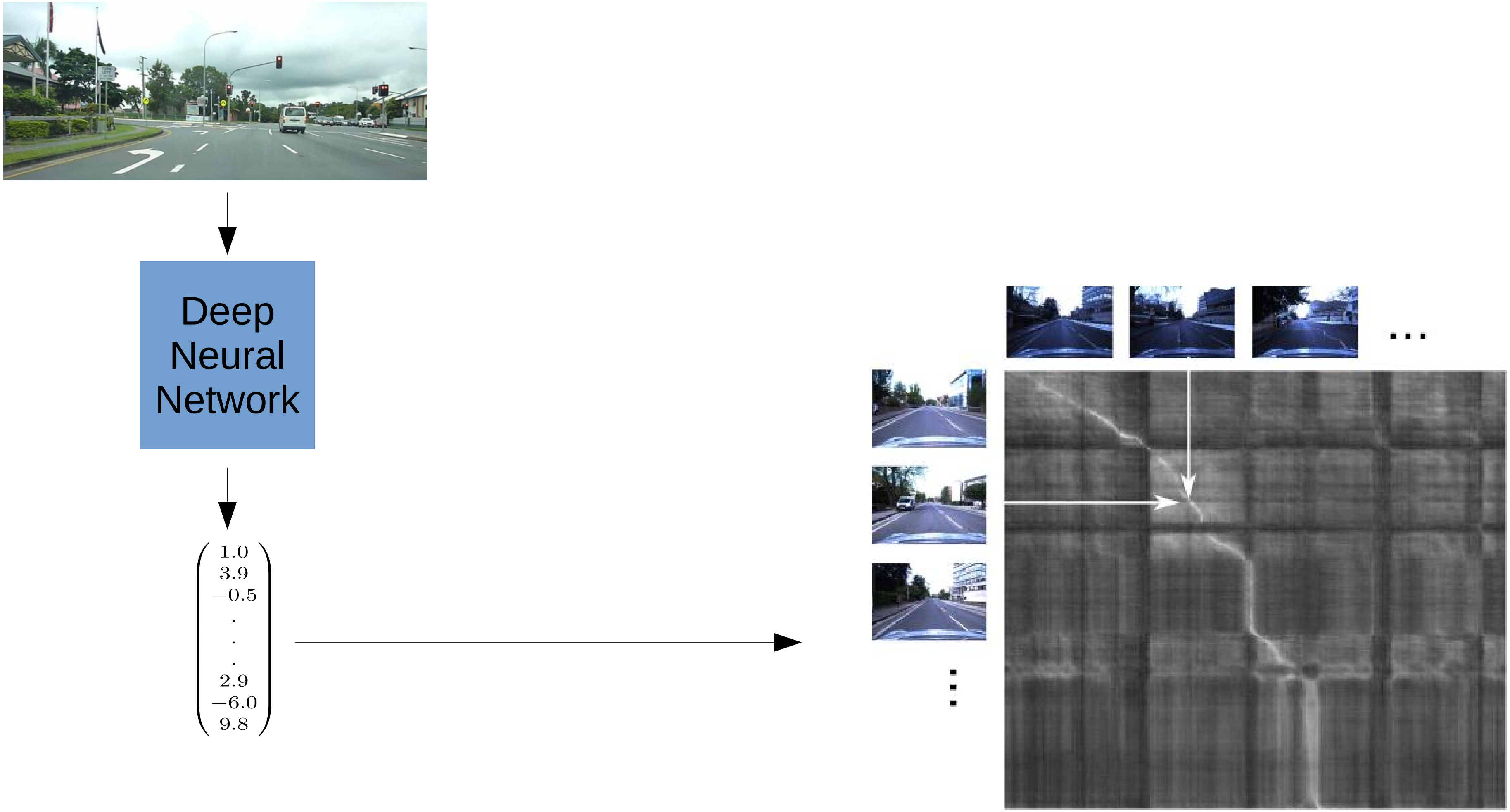
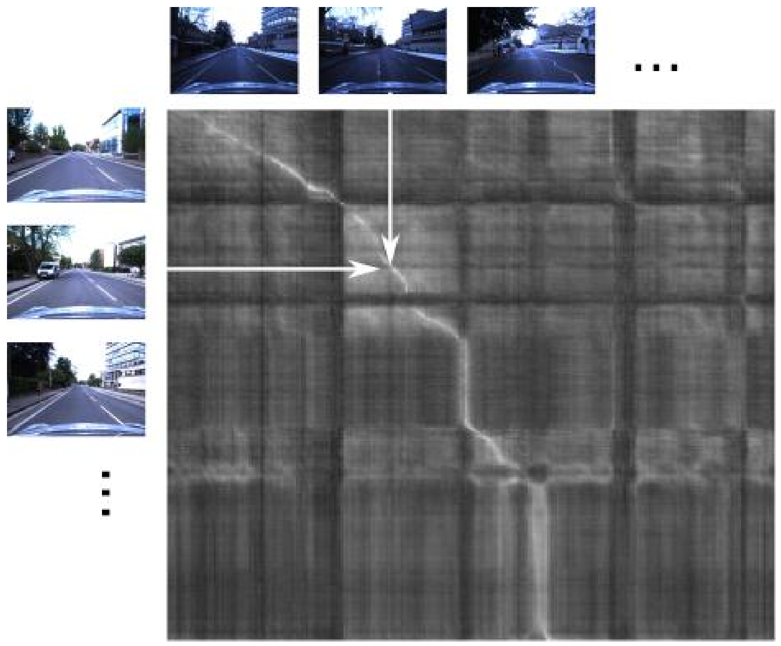
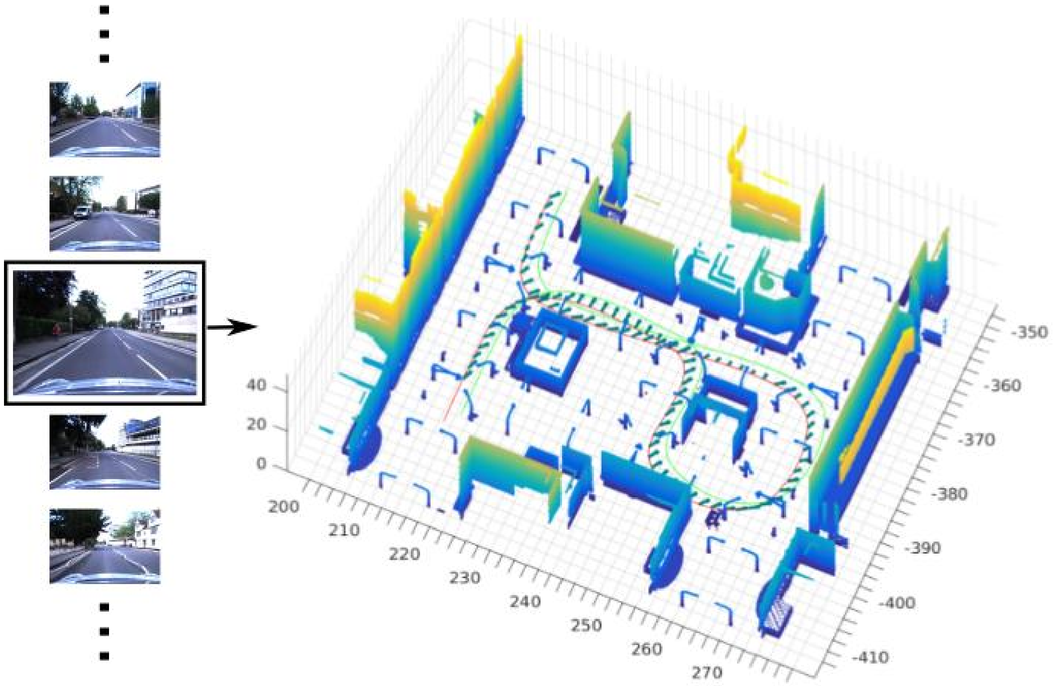


Approaches to place recognition

Pairwise image comparison



Metric SLAM



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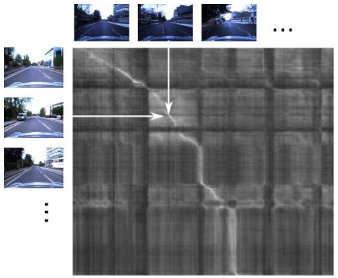
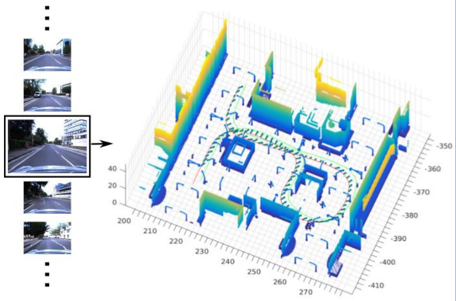
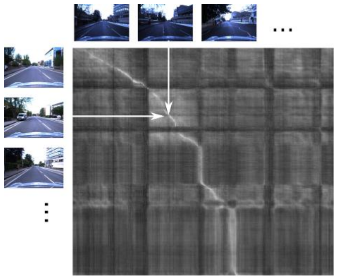


Metric SLAM

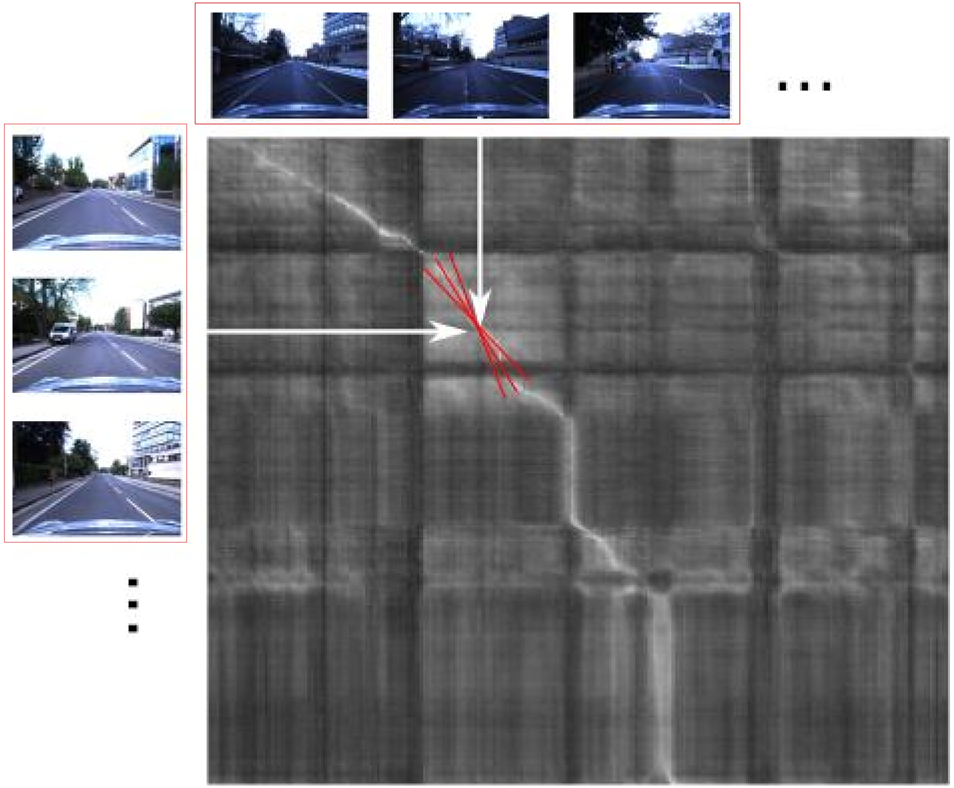


Approaches to place recognition

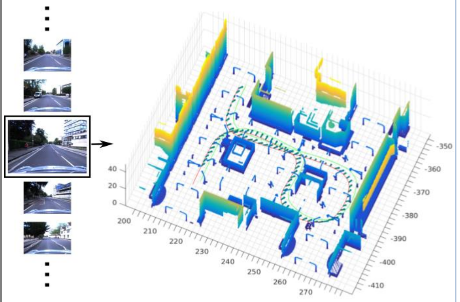
Pairwise independently



In between, e.g. **SeqSLAM**



Metric SLAM



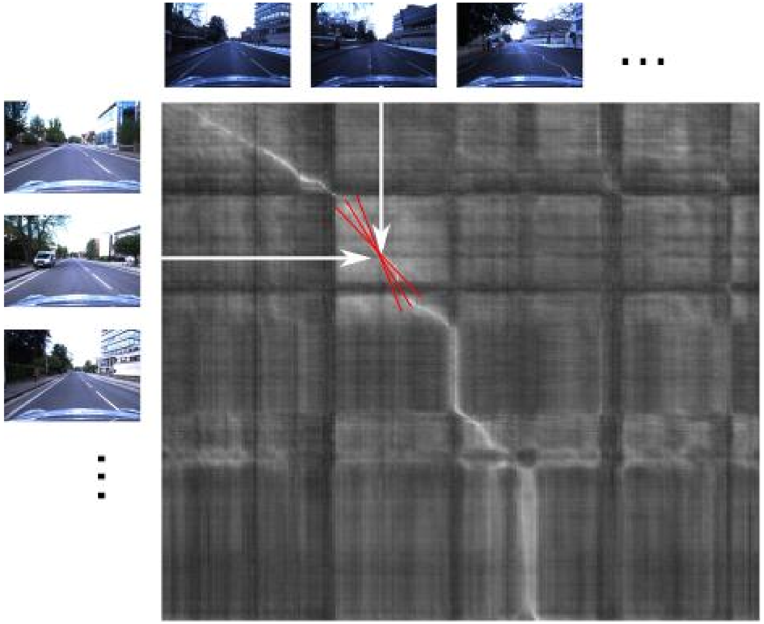
Teaser application 2: Place recognition in changing environments

Deep Neural Network

$$\begin{pmatrix} 1.0 \\ 3.9 \\ -0.5 \\ \cdot \\ \cdot \\ \cdot \\ 2.9 \\ -6.0 \\ 9.8 \end{pmatrix}$$

This is where the hyperdimensional magic happens

$$Y_i = \bigoplus_{k=0}^{d} (X_{i-k} \otimes P_{-k})$$



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Simplified SeqSLAM core:

input: distance matrix D

for each summer image idx j in S

  for each winter image idx i in W

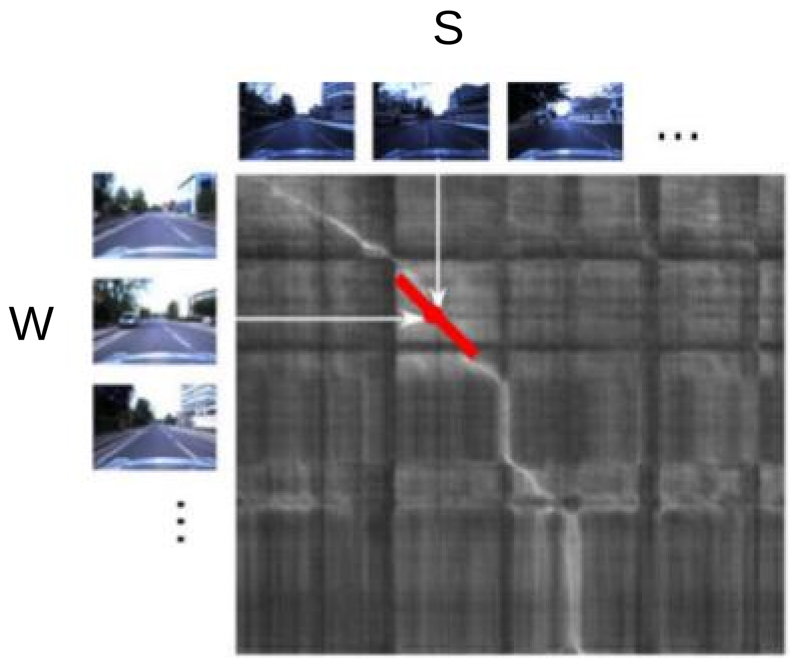
    accDist = 0

    for k=-d:1:d

      accDist = accDist + D(i+k, j+k)

    R(i,j) = accDist / (2*d+1)

output: resulting distance matrix R



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VSA appoach

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– Use this vector for the direct **pairwise** comparison

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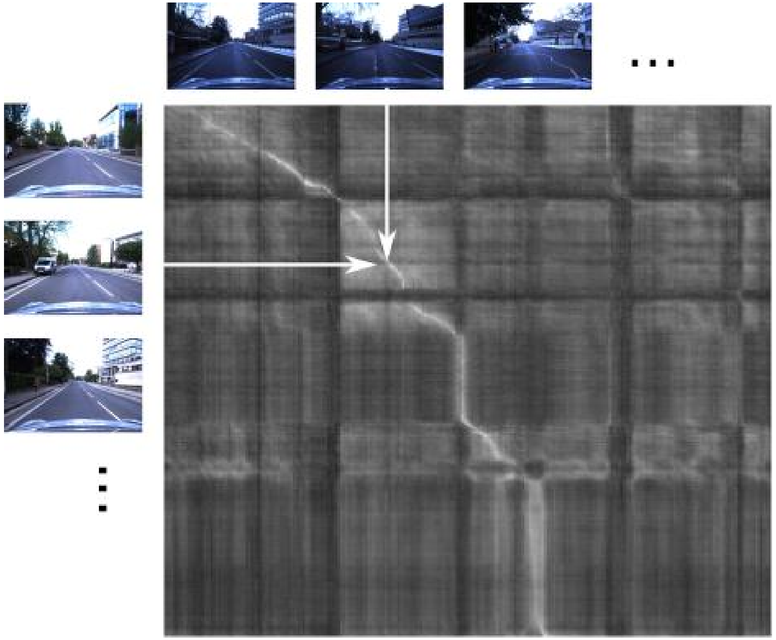
$$Y_i = \mathop{+}\limits_{k=-d}^{d} (X_{i+k} \otimes P_k)$$

position in the sequence



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position in the sequence

$$Y_i = \sum_{k=-d}^{d} (X_{i+k} \otimes P_k)$$

Why does this work?

e.g. comparing two 2-element sequences $A = (X_{a_1} X_{a_2})$

$B = (X_{b_1} X_{b_2})$

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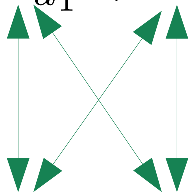
Without binding to position

$$Y_A = X_{a_1} + X_{a_2}$$



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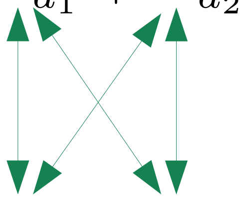

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With binding to position

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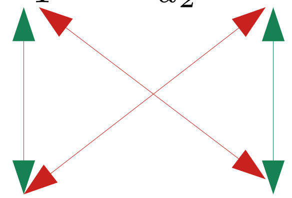

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Hands-on