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AI-Cube:

AI + Federated Datacubes = Added Value

Geospatial World Forum, Amsterdam, NL, 2022-05-11

S. Ahlswede, P. Baumann, O. Campos, K. Clasen, B. Demir

Jacobs University | TU Berlin | rasdaman GmbH

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des Deutschen Bundestages

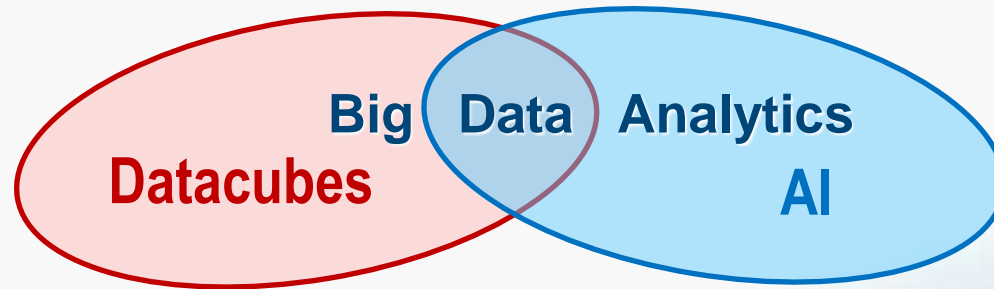
AI-Cube: The Project



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- Mission: combine federated EO datacubes with advanced EO AI
- Partners:
 - [Jacobs University](#), rasdaman GmbH: datacubes
 - TU Berlin: EO AI, BigEarth.Net
- Runtime: Sep 2021, 18 months



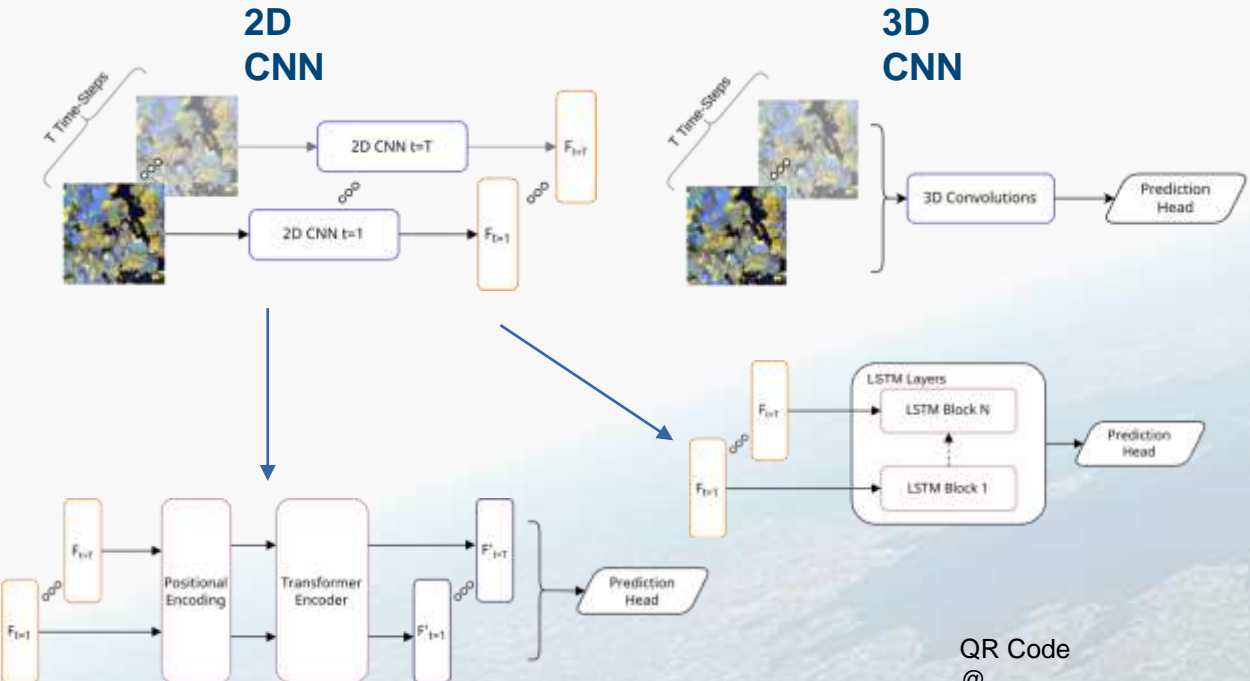
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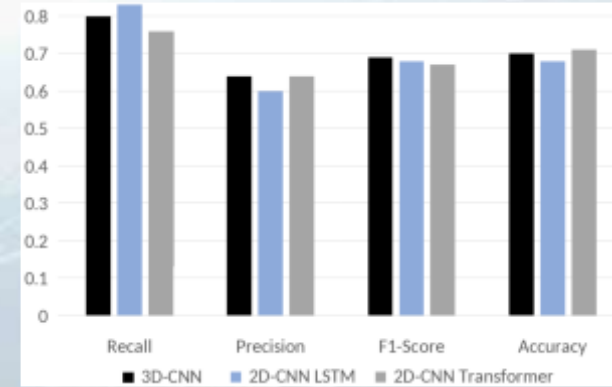
AI-Cube

Time-Series Classification



Results

Sentinel-2 Brandenburg crops dataset



QR Code @



AI Methods VQA Evaluation



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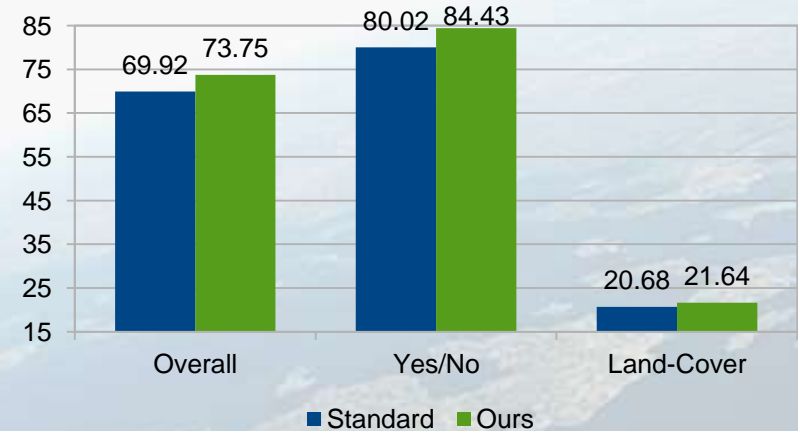
RSVQA dataset based on BigEarthNet



S. Lobry, B. Demir, D. Tuia,
"RSVQA meets BigEarthNet:
A new, large-scale, visual
question answering dataset
for remote sensing", IEEE
IGARSS, 2021



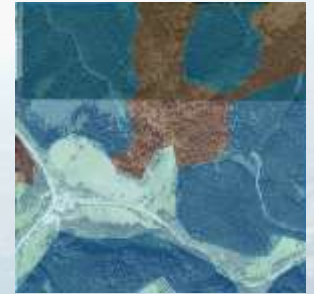
Results



AI Methods

■ Next Steps

- Utilize all spectral bands from Sentinel-2
- Include relational/area based Q&A's
- Balance the Q&A distribution
- Develop efficient VQA models for RS





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AI-Cube

- „raster data manage“: Massively scalable **Datacube Management & Analytics** engine
- pioneer **Actionable Datacubes**: 160+ publications, patents
- Any query, any time – **zero programming**
- Location-transparent **federation & fusion, security**
- **Mature**: 130+ PB; 1000x parallelization, planetary-scale federation
- OGC Reference Implementation, INSPIRE Good Practice, multi-award winning



Defence
Innovation
Challenge

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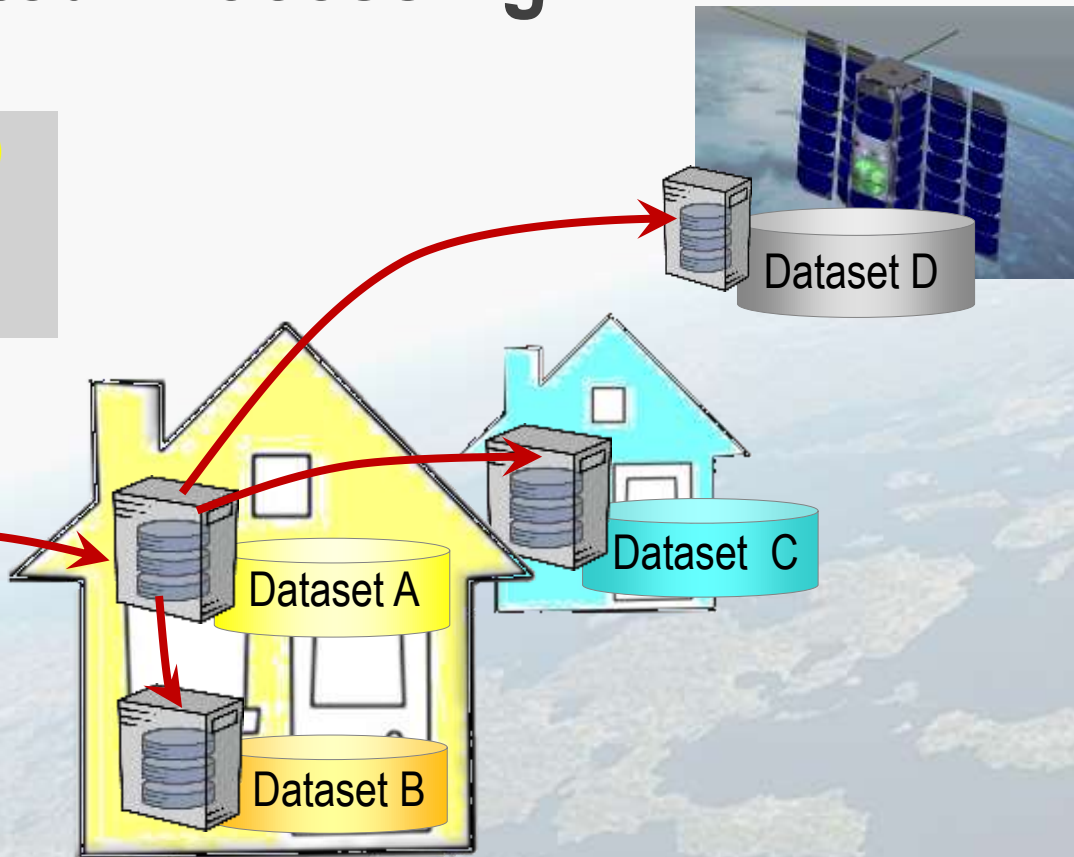


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$\max((A.nir - A.red) / (A.nir + A.red))$
+ $\text{avg}(B.green)$
+ $\max((C.red + C.green + C.blue) / 3)$
+ $\max((D.nir + D.red) / 2)$

1 query \rightarrow 1,000+ cloud nodes

[ACM SIGMOD, VLDB]





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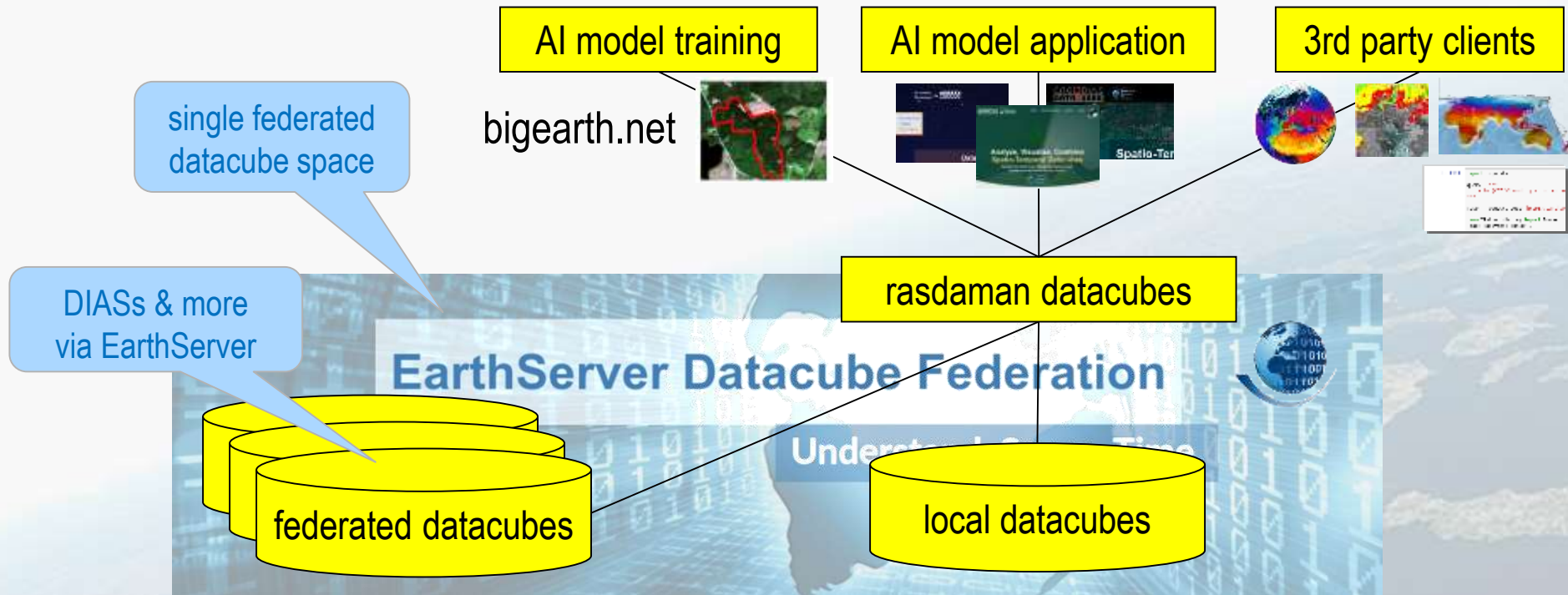
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AI-Cube

AI-Cube High-Level Architecture



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NLP

Natural Language Question Answering



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Examples

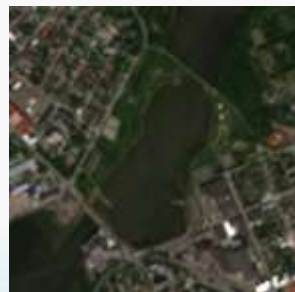


Q: Are there any *coastal lagoons* present?

A: No.

Q: Besides *agricultural areas*, what classes are in the image?

A: Water bodies.



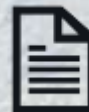
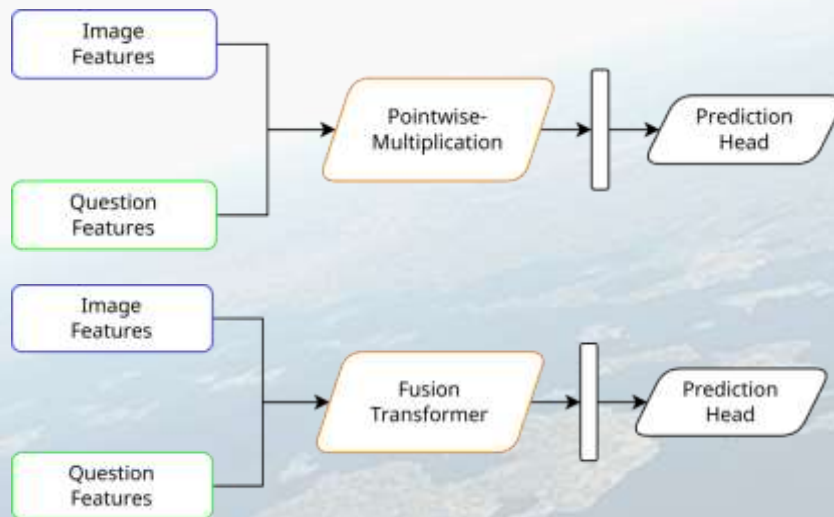
Q: Are there *artificial areas* and *water bodies*?

A: Yes.

Q: Besides *artificial areas* and *water bodies*, what classes are in the image?

A: None.

Models



T. Siebert, K. Clasen, M. Ravanbakhsh, B. Demir,
“Multi-Modal Fusion Transformer for Visual Question
Answering in Remote Sensing”, Submitted to SPIE 2022



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Summary

Summary

- AI-Cube = Novel combination of
 - **Datacubes** = flexibility + scalability + federation
 - **ML** = flexibility + insight + training base
 - **NLP** = ease of use
- Related projects: CENTURION, DynAWI, Cube4EnvSec
- User benefits:
 - Reduced expert barrier = **easier + more efficient** EO insight
 - New **scales**: training set, application size
 - **integration**: queries + AI intermixed
 - Space + **time**

