Automatic Map Registration and Change Detection

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ESRI International User Conference, July 14-18, 2014

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Agenda

1 Introduction & Motivation

2 Methodology

3 Experimental Results

4 Summary

5 Future Work

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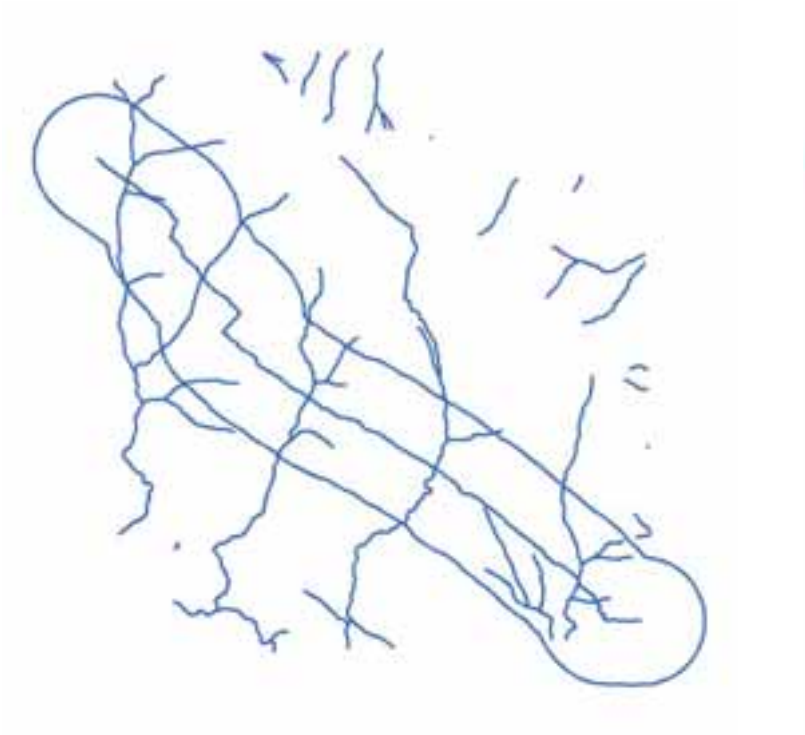
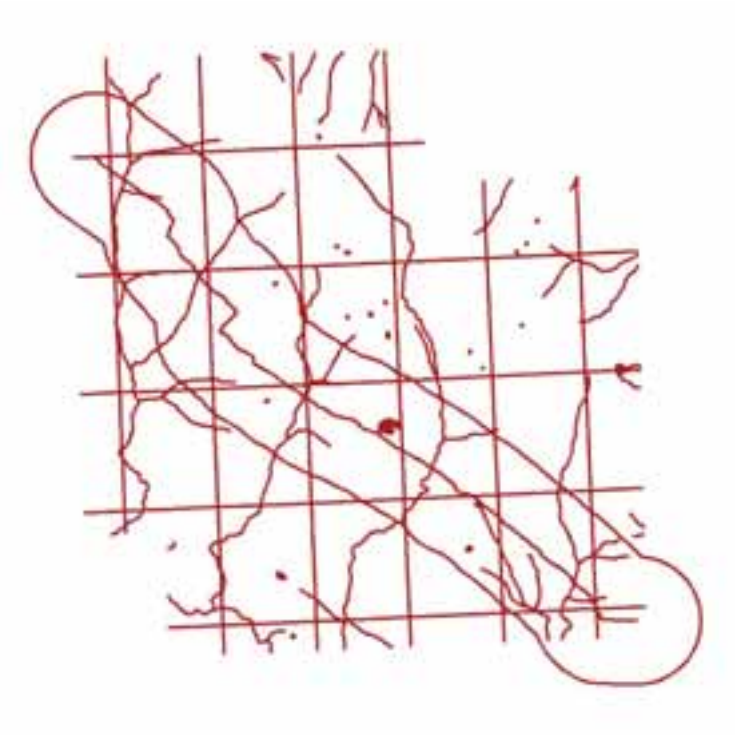
1. Introduction

Example: We've got 2 Datasets



2014 (GIS Data)



2009 (PDF)

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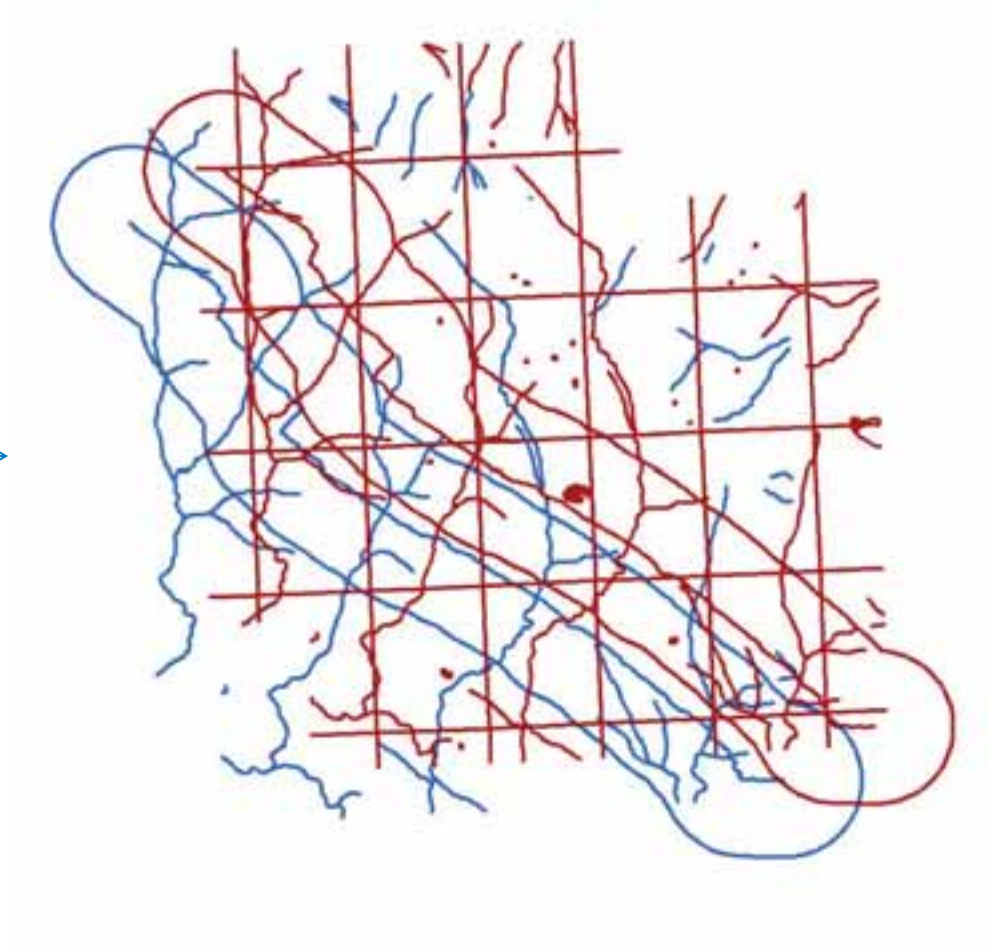
Problem 1: Datasets Do NOT Line Up !

2014 (GIS Data)



2009 (PDF)

GDAL/OGR

GIS/CAD

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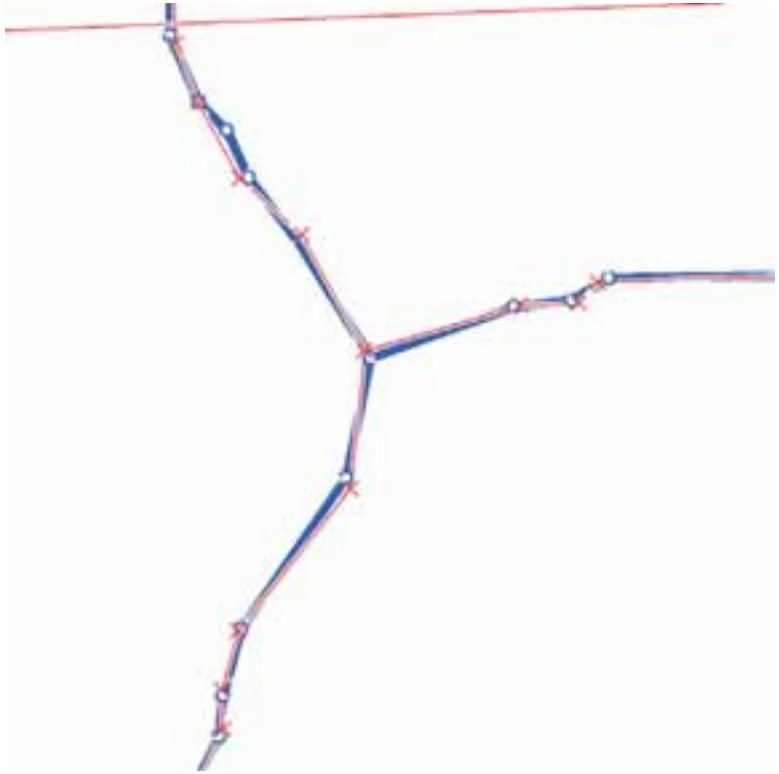
Problem 2: No 1-to-1 Point Correspondence!



- The Notion of “Corresponding Points” Does NOT Exist.
- Using “Apparently Corresponding Points” for Co-Registration Would be a Mistake!

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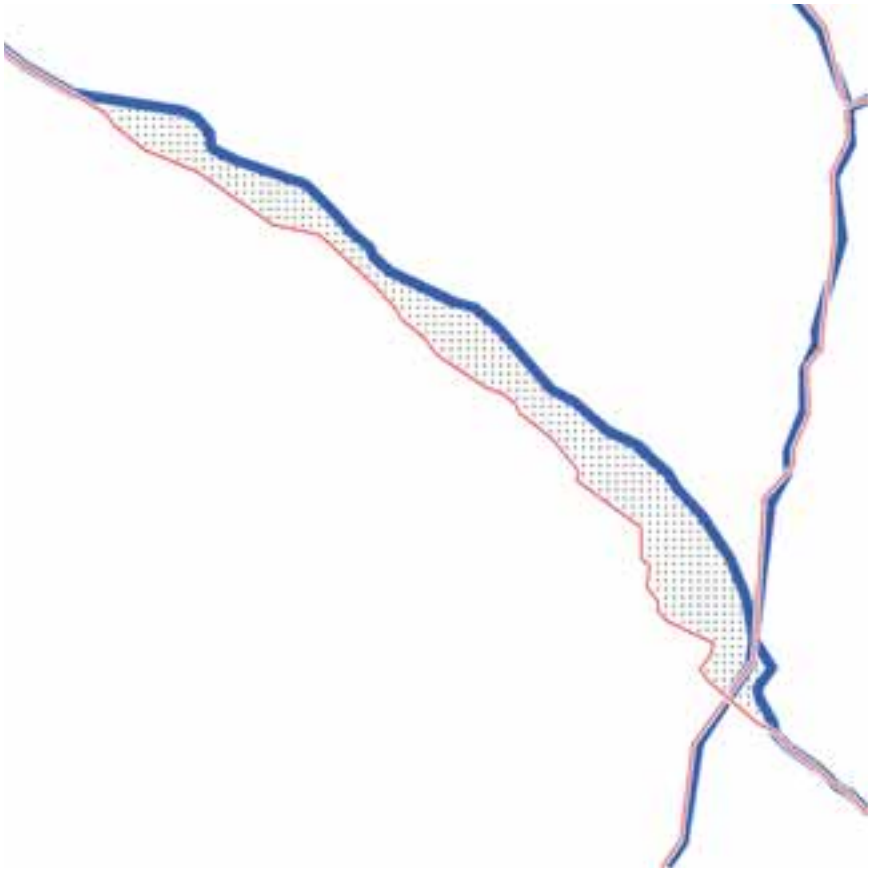
Problem 3: Real Changes!



- The Notion of “Corresponding Points” Does NOT Exist.
- Using “Apparently Corresponding Points” for Co-Registration Would be a Mistake!

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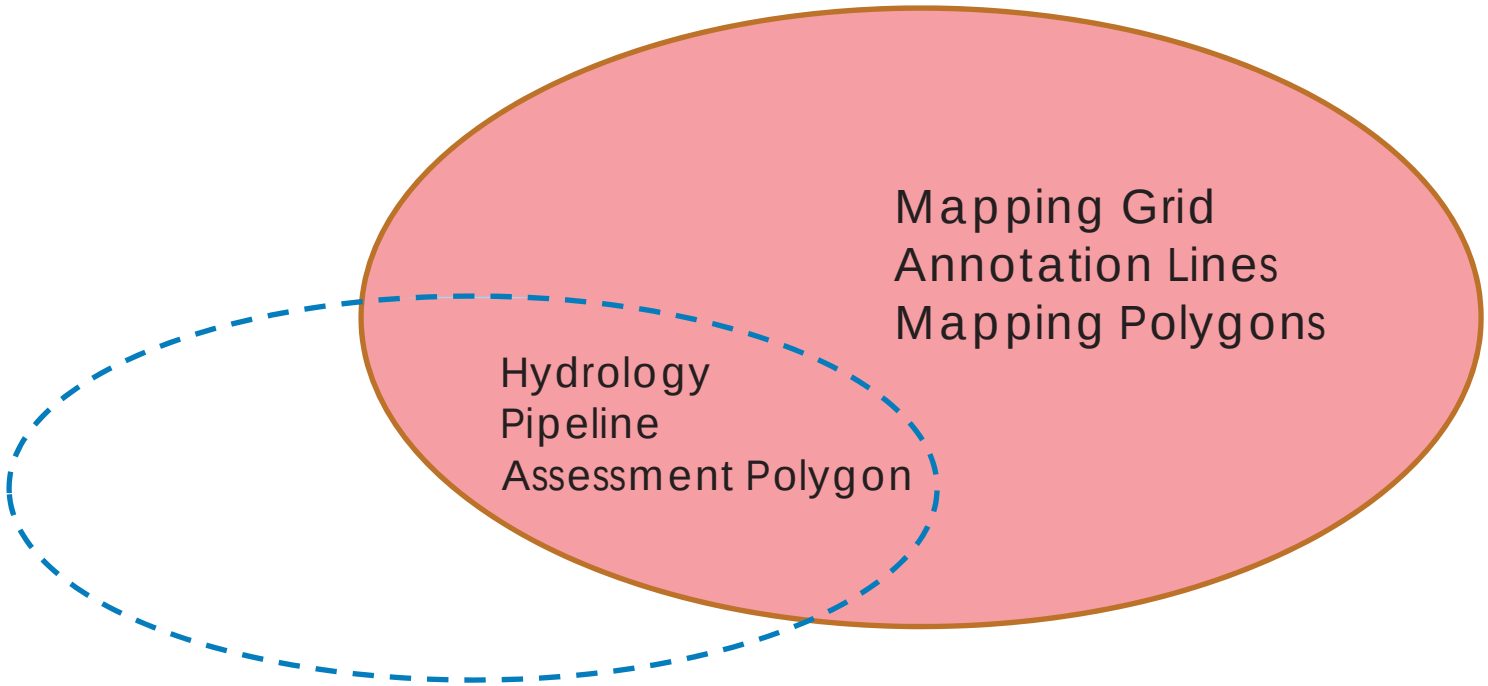
Other Problems

- Datasets vary in size
- Datasets vary in context
- Some datasets are inseparable



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(Some) Causes for Data Mismatches / Misalignment

- Lack of geo-referencing information
- Improper geo-referencing information
- Data compression issues

- Different interpretations
- Different generalizations

- Changes that we do not know of yet!

We need to:

- Bring datasets into alignment in spite of the changes/generalization levels
- Detect the changes

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2. Methodology

- **Minimize distances between lines, not points**
  - Adaptive transformation and sequential estimation
  - Parameter estimation established through accumulative arrays and parametric 0-crossing curve

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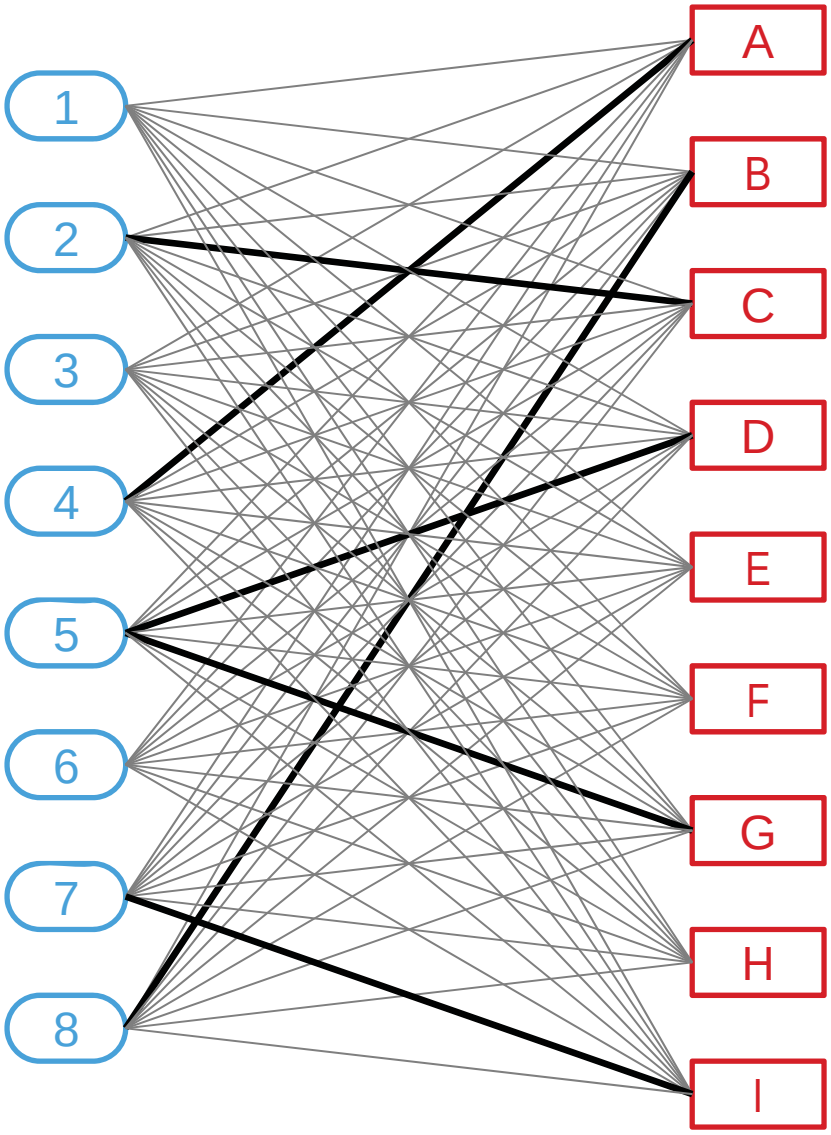
Hypothesis Generation



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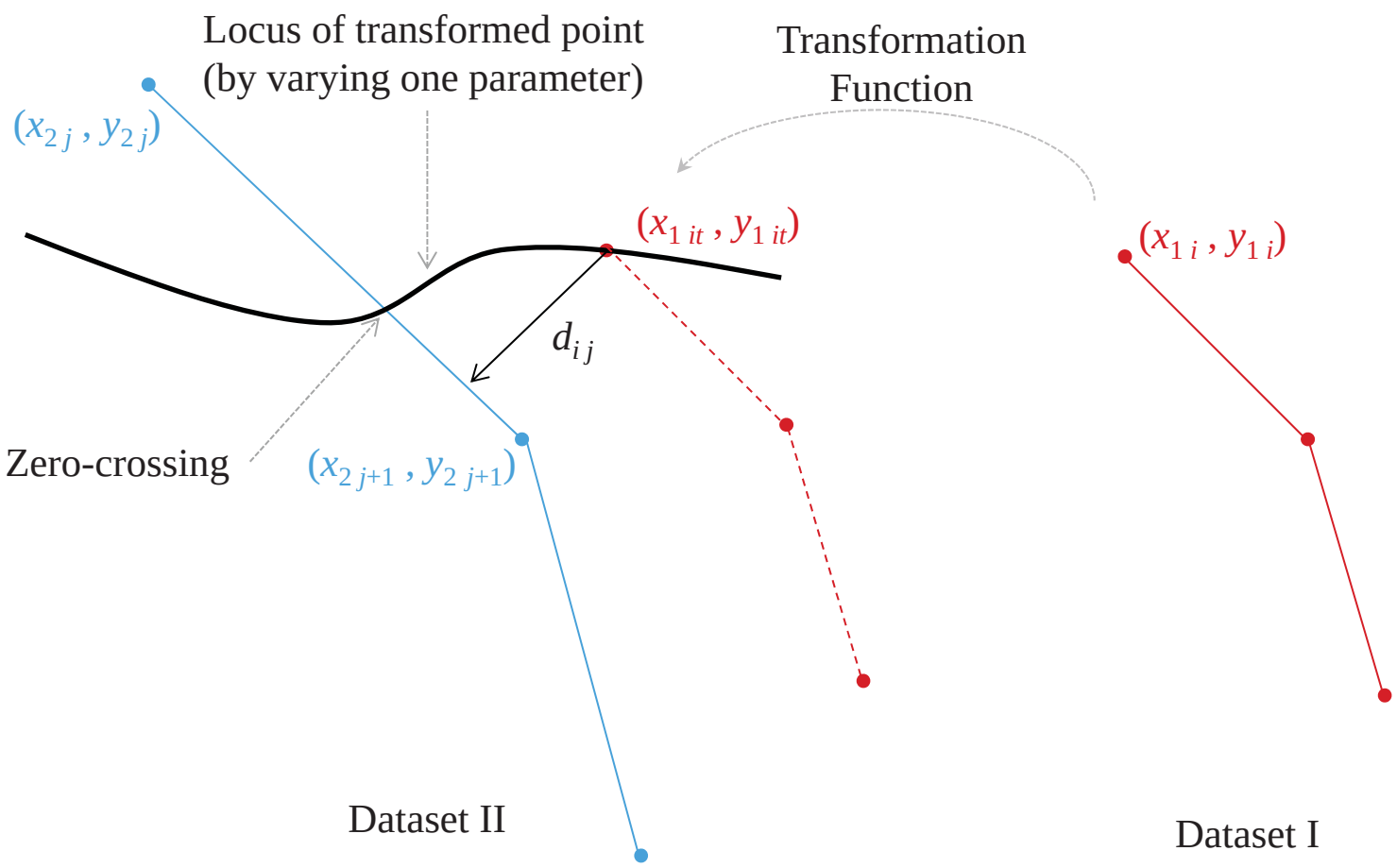
Mathematical Model



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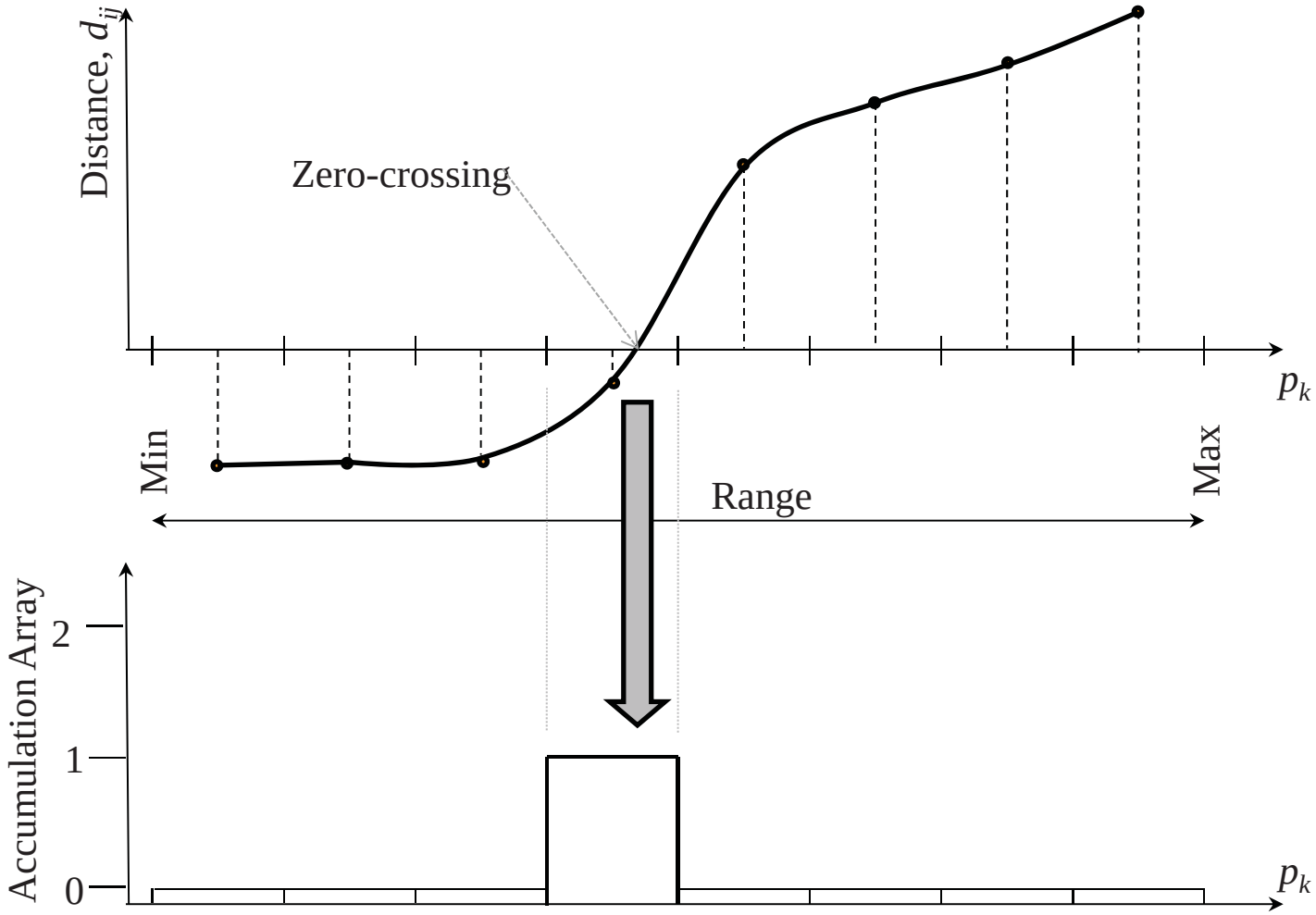
Mathematical Model



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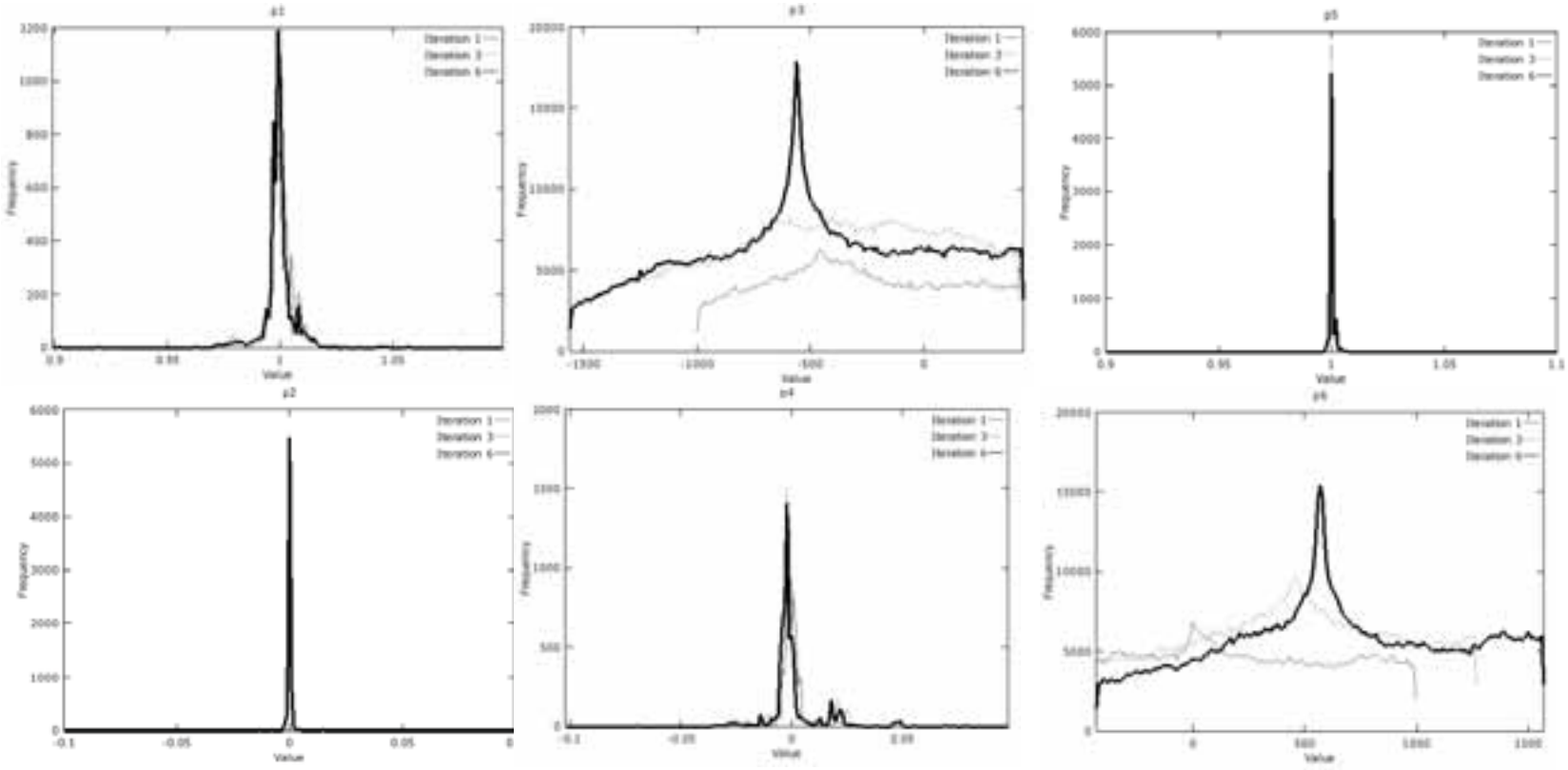
3. Experimental Results

Accumulation Arrays

- Only few iterations were needed!
- Less than 1 minute to converge



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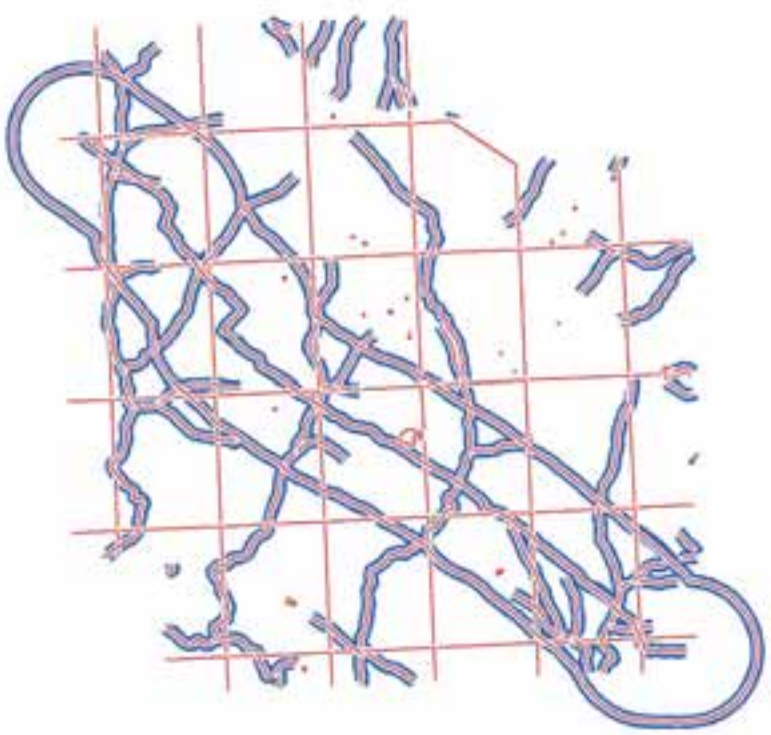
Intermediate Iterations



Final Registration

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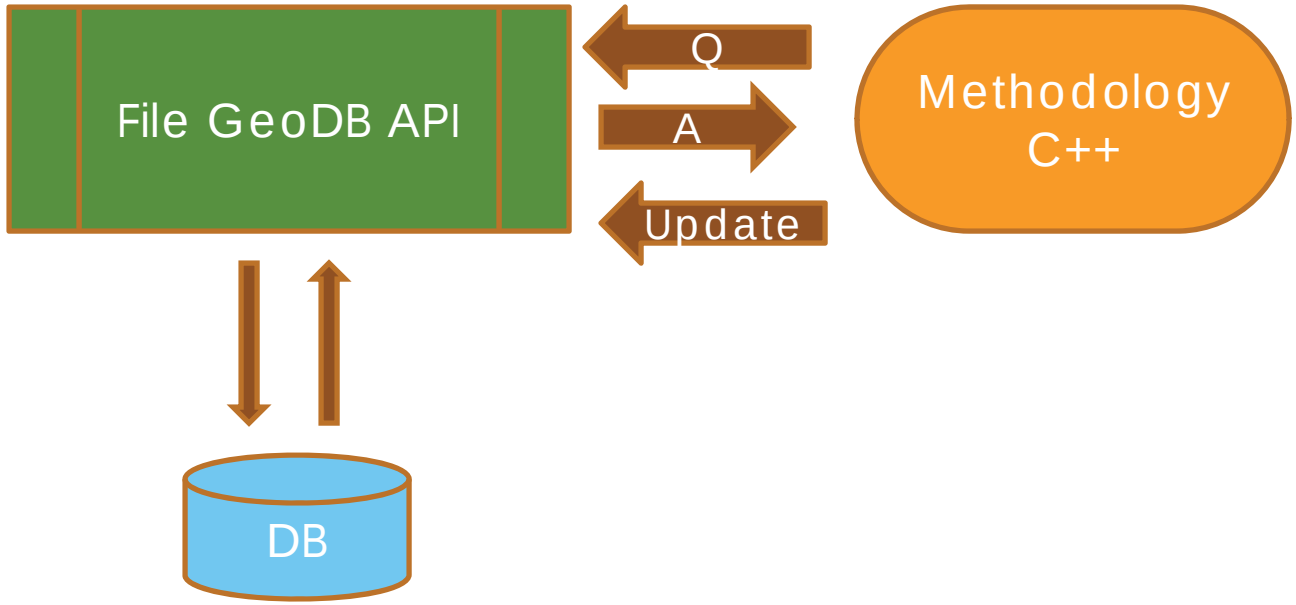
The ESRI Connection

File Geo DB API (1.3)

- Very fast in I/O operations
- Efficient in query processing
- Utilizing spatial indexing



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4. Summary

- **A methodology for automatic registration of vector datasets has been established**
  - No point-to-point correspondences is assumed
  - Robust against changes & generalization
  - Changes are easily detected
- **File Geo DB API is fast, efficient and FREE to use**
- **Further information and details:**
  - **Morgan, M. and L. Giles (2014), *A Novel Approach for Automatic Matching and Updating Pipeline Data*, The 10th International Pipeline Conference, The American Society of Mechanical Engineering (Available October 2014)**

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5. Future Work

- **Quantification/categorization of changes**
- **Raster (image/video) matching & sensor integration**
  - Photogrammetry, Mobile devices, UAVs
- **Hybrid vector-raster matching**
- **Assessing different interpretations of the same phenomena**
- **Exploring other application areas**

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Questions ?
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