Chapter 02
Flowchart of Panorama Stitching (Theme 1)

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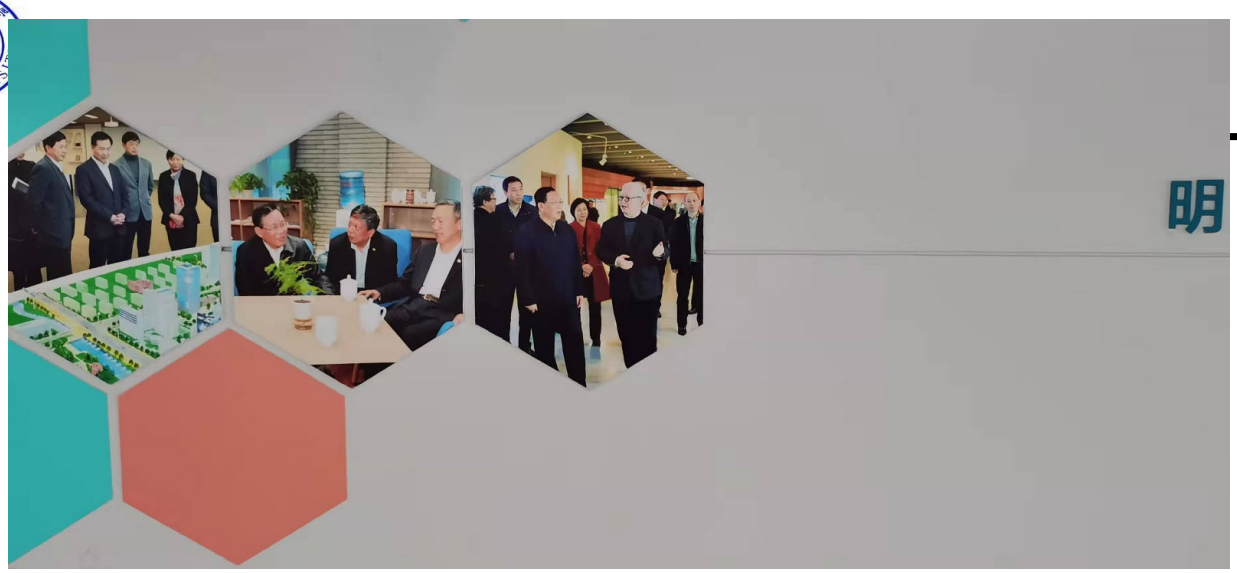
Problem definition of panorama stitching

Panorama stitching is the process of combining **multiple** photographic images with **overlapping fields of view** to produce a panorama or a high-resolution image

Let's see an example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明确发展定位

Panorama stitching result using the techniques introduced in this course

Problem definition of panorama stitching

- In this course, when we combine two images $\boldsymbol{I}_1$ and $\boldsymbol{I}_2$, actually we have some assumptions about $\boldsymbol{I}_1$ and $\boldsymbol{I}_2$ to make sure that they can be stitched theoretically
  - $\boldsymbol{I}_1$ and $\boldsymbol{I}_2$ should have common-view areas
  - The physical planes they imaged are coplanar
  - The two cameras do not have lens distortions

Implying that the two images can be linked via a linear geometric transformation, i.e.,

$$\exists \boldsymbol{H},\ \forall \boldsymbol{x} \in \boldsymbol{I}_1, \boldsymbol{x}' \in \boldsymbol{I}_2, \text{ if } \boldsymbol{x} \text{ and } \boldsymbol{x}' \text{ is a } \textbf{correspondence pair}, \text{ then, } \boldsymbol{x}' = \boldsymbol{H}\boldsymbol{x}$$

So the core problem for panorama stitching is to find such an $\boldsymbol{H}$

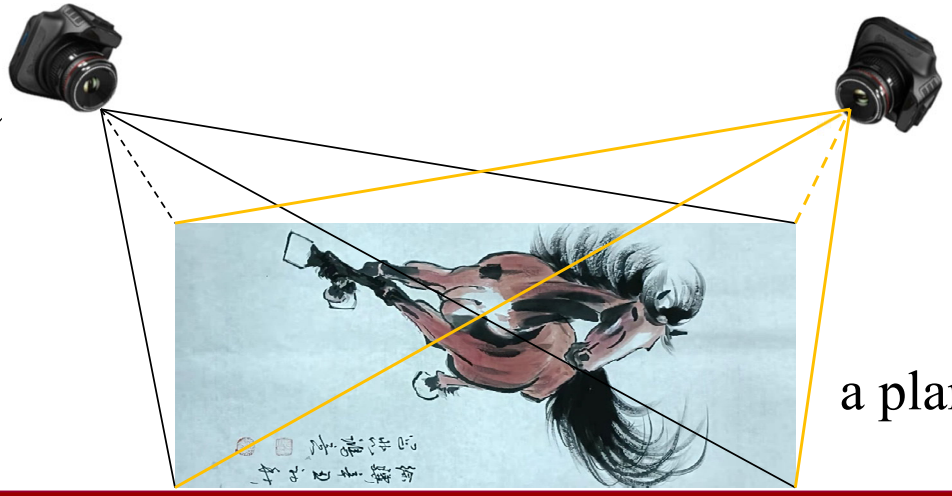
Problem definition of panorama stitching

Corresponding points can be linked via a unique linear geometric transformation $\boldsymbol{H}$

$\boldsymbol{H}$

$\boldsymbol{H}^{-1}$

pinhole camera

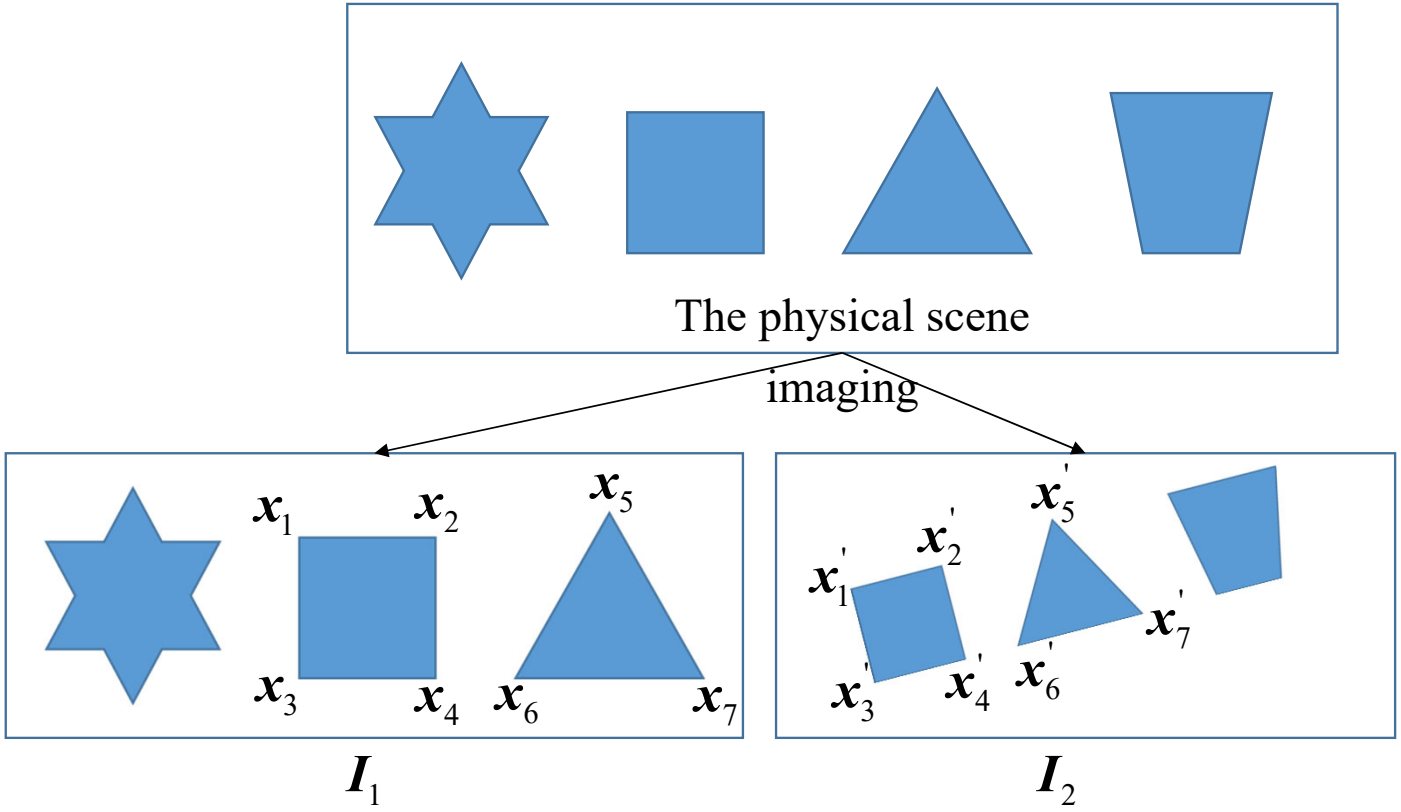


pinhole camera

a plane

How to achieve panorama stitching?

A toy example



Can you imagine how to stitch I_1 and I_2 together manually?

By computerizing the manual process, we can get the algorithms to fulfill this task

How to achieve panorama stitching?

- ✓ Identify the key points on $\boldsymbol{I}_1$ and $\boldsymbol{I}_2$
- ✓ Build descriptors for all the key points
- ✓ Matching key points to get the correspondence pairs $\mathcal{S} = \left\{ \boldsymbol{x}_i \leftrightarrow \boldsymbol{x}_i^{'} \right\}_{i=1}^{p}$

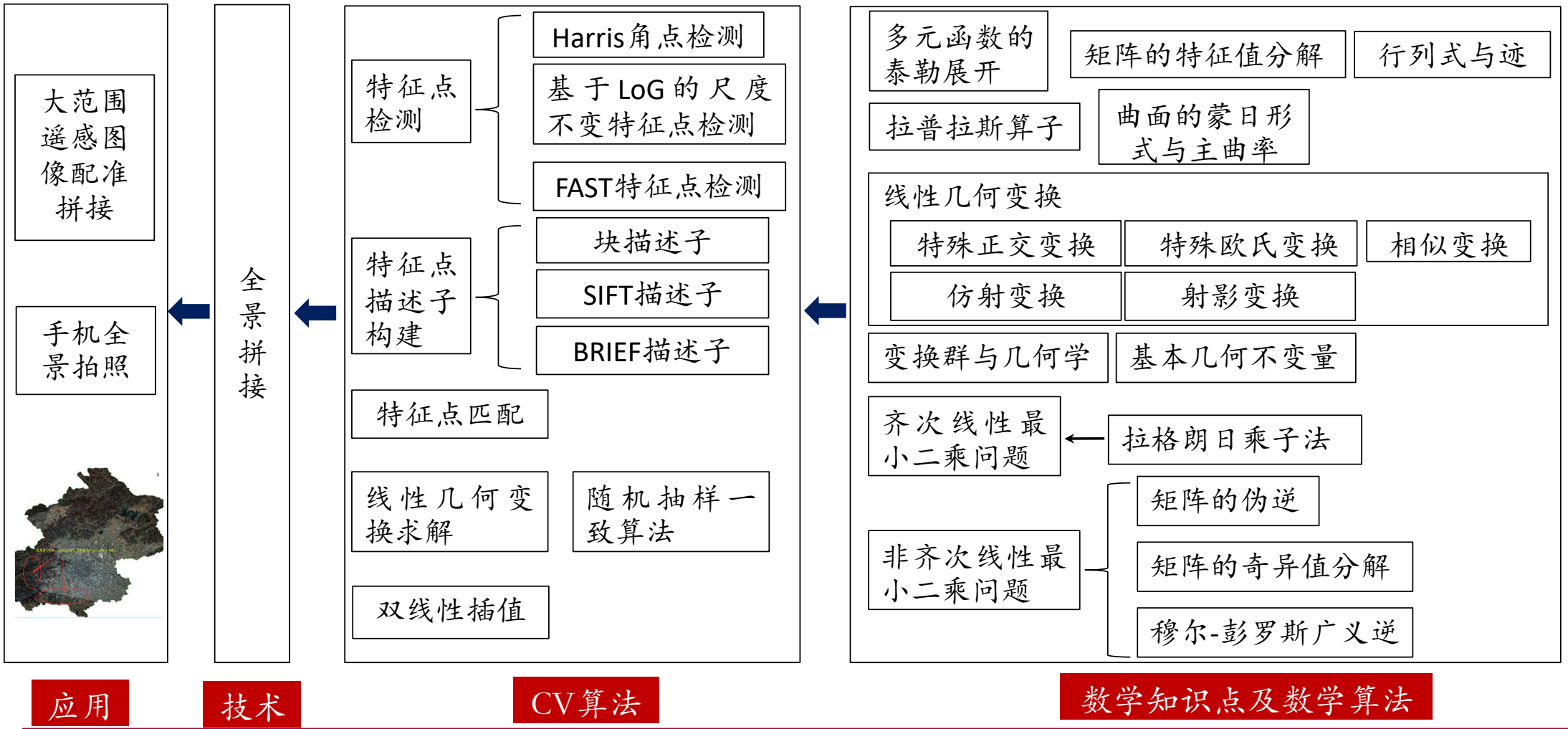
  where $\boldsymbol{x}_i \leftrightarrow \boldsymbol{x}_i^{'}$ means that the point $\boldsymbol{x}_i$ from $\boldsymbol{I}_1$ and the point $\boldsymbol{x}_i^{'}$ from $\boldsymbol{I}_2$ matches, and p is the number of correspondence pairs

- ✓ Based on $\mathcal{S}$, solve $\boldsymbol{H}$ that can (roughly) map each $\boldsymbol{x}_i$ to $\boldsymbol{x}_i^{'}$. At this step, we need to consider the imperfectness of $\mathcal{S}$, i.e., some correspondence pairs in $\mathcal{S}$ may be **outliers**
- ✓ Apply $\boldsymbol{H}$ to $\boldsymbol{I}_1$ to align it with $\boldsymbol{I}_2$; this step needs to use **image interpolation** techniques

Contents of this theme

- ✓ Chapter 3 will introduce details about linear geometric transformation
- ✓ Chapter 4 will discuss key point detection and matching
- ✓ To solve $\boldsymbol{H}$ from the correspondence pairs is a linear least-squares problem, which will be discussed in Chapter 5
- ✓ RANSAC is a universal framework to estimate model from observations with outliers, which will be introduced in Chapter 6; also, the bilinear interpolation technique will be introduced there

Contents of this theme



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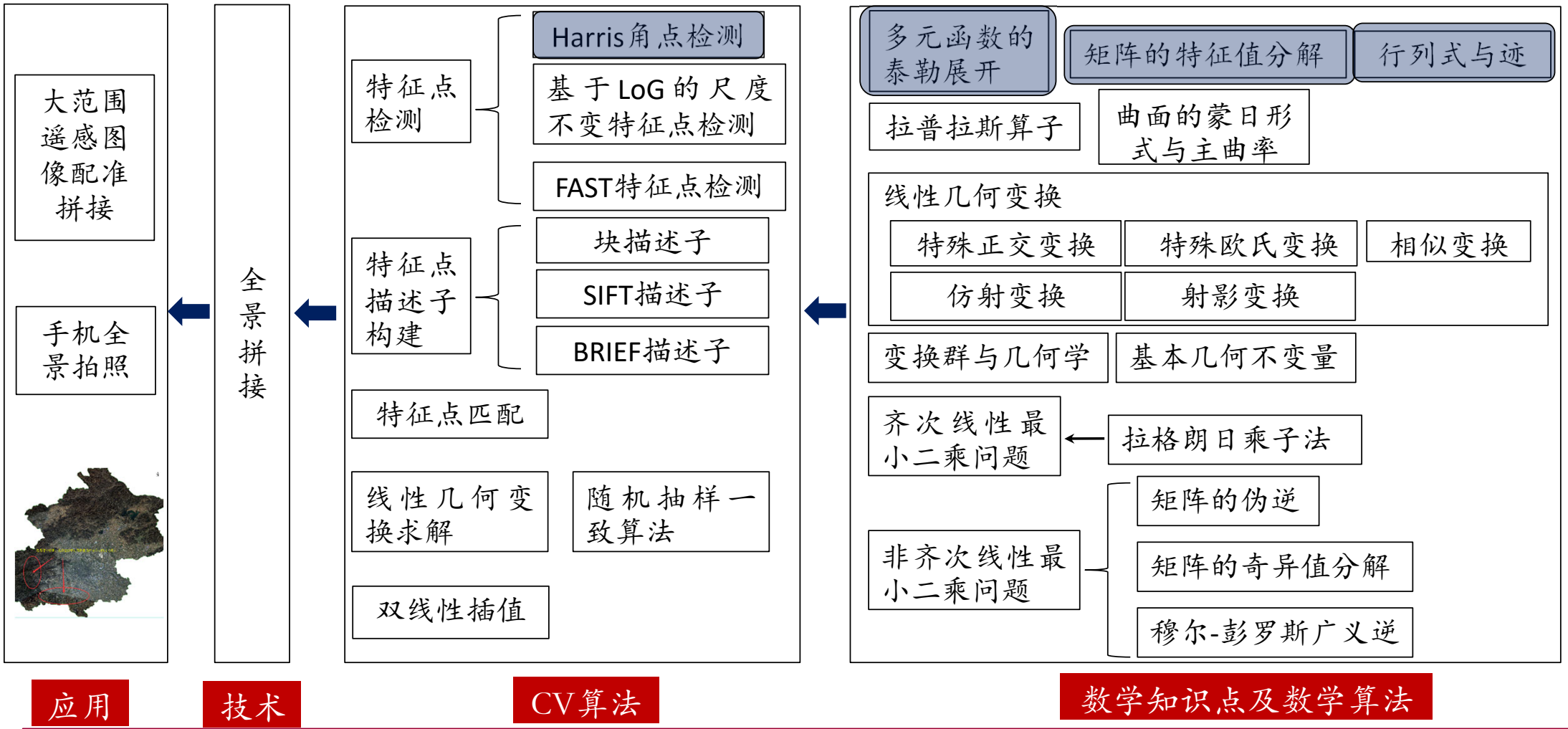

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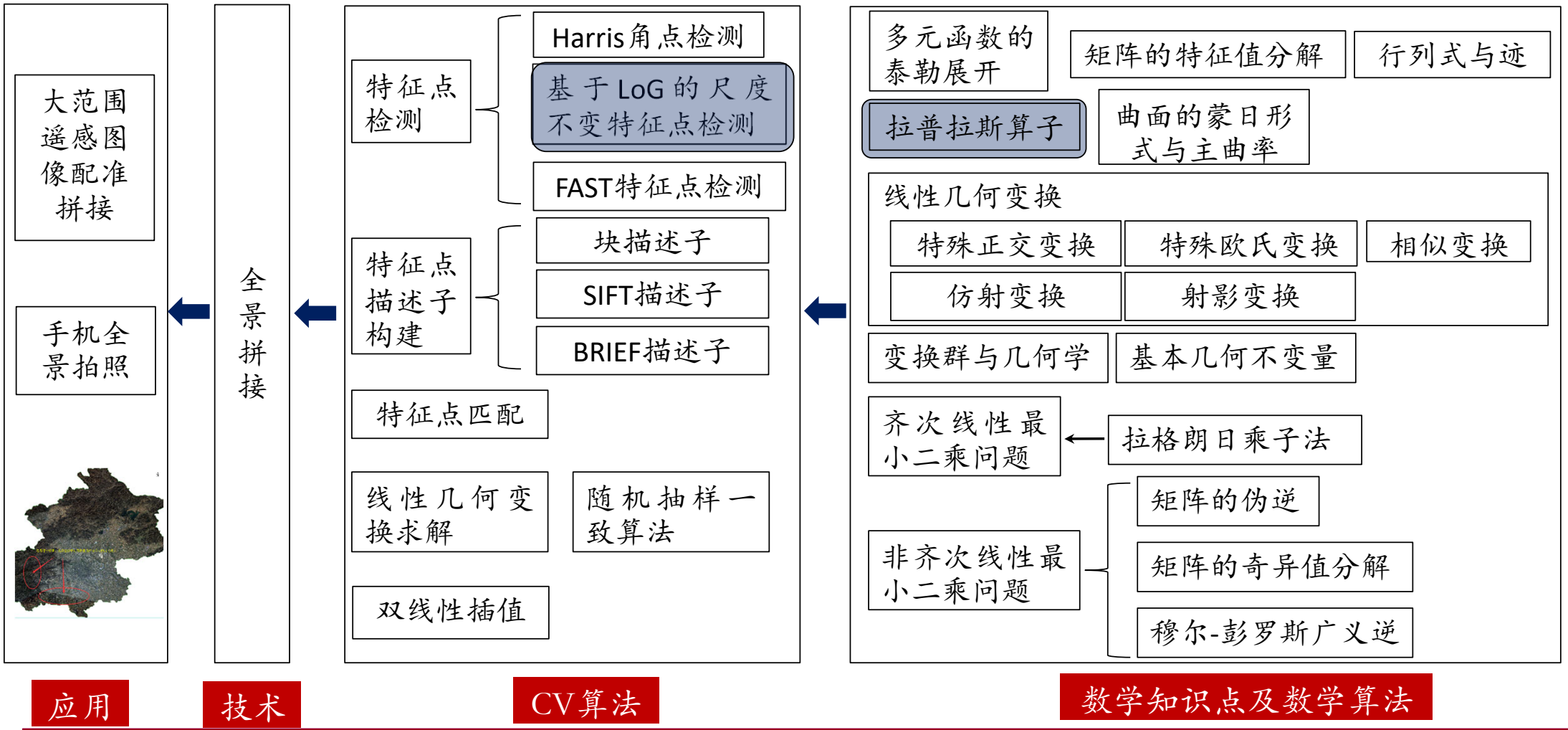

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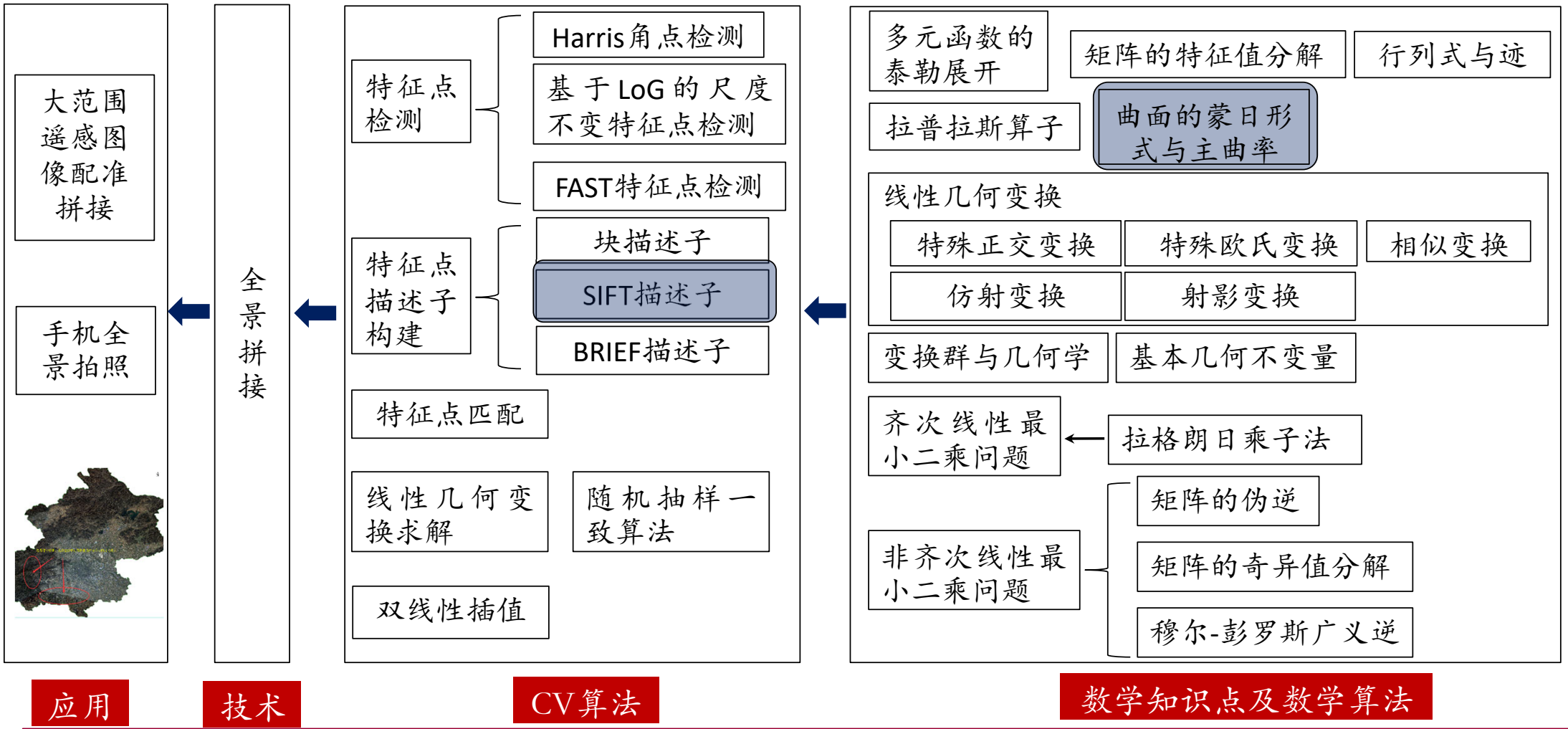

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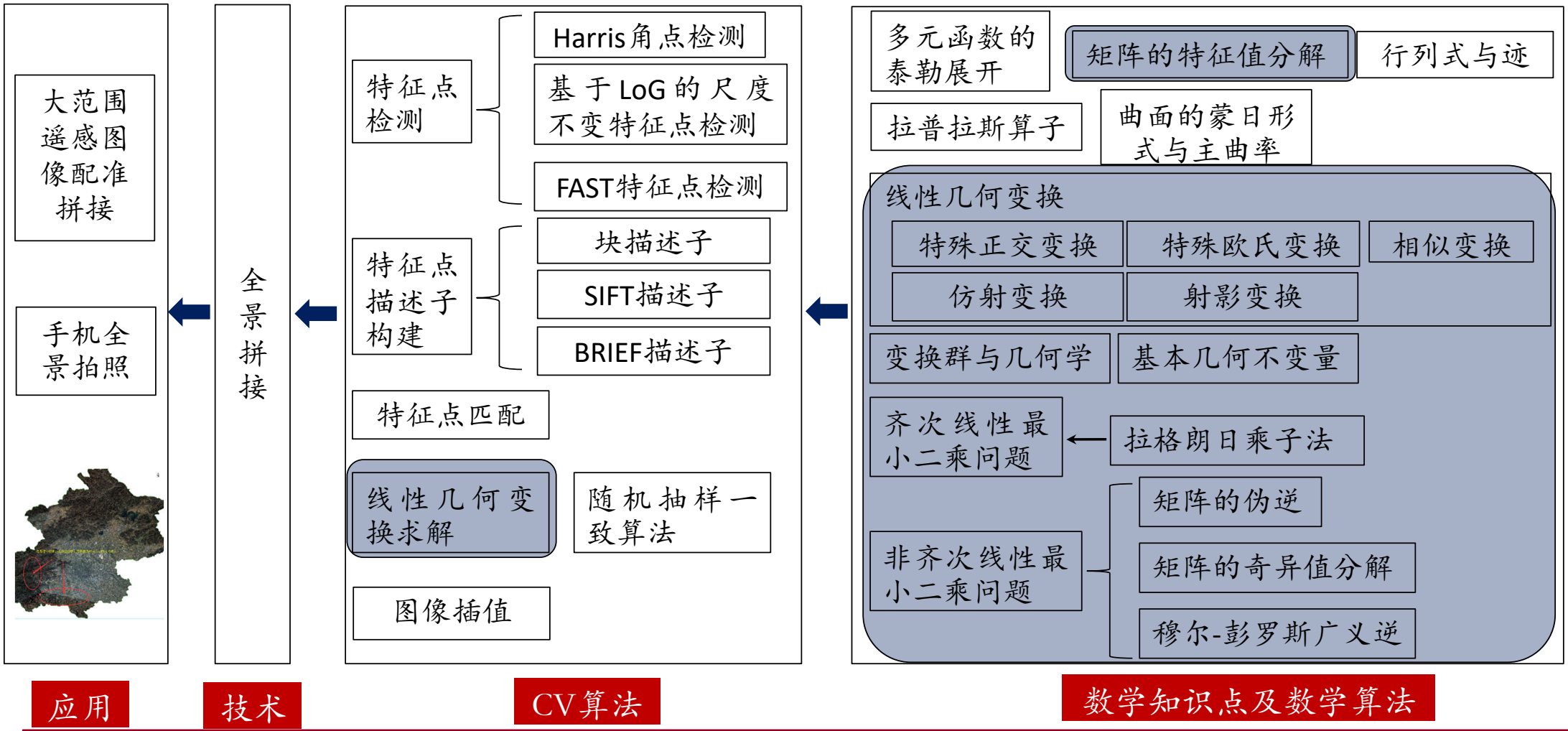


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