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Texture Characterization of Tumors

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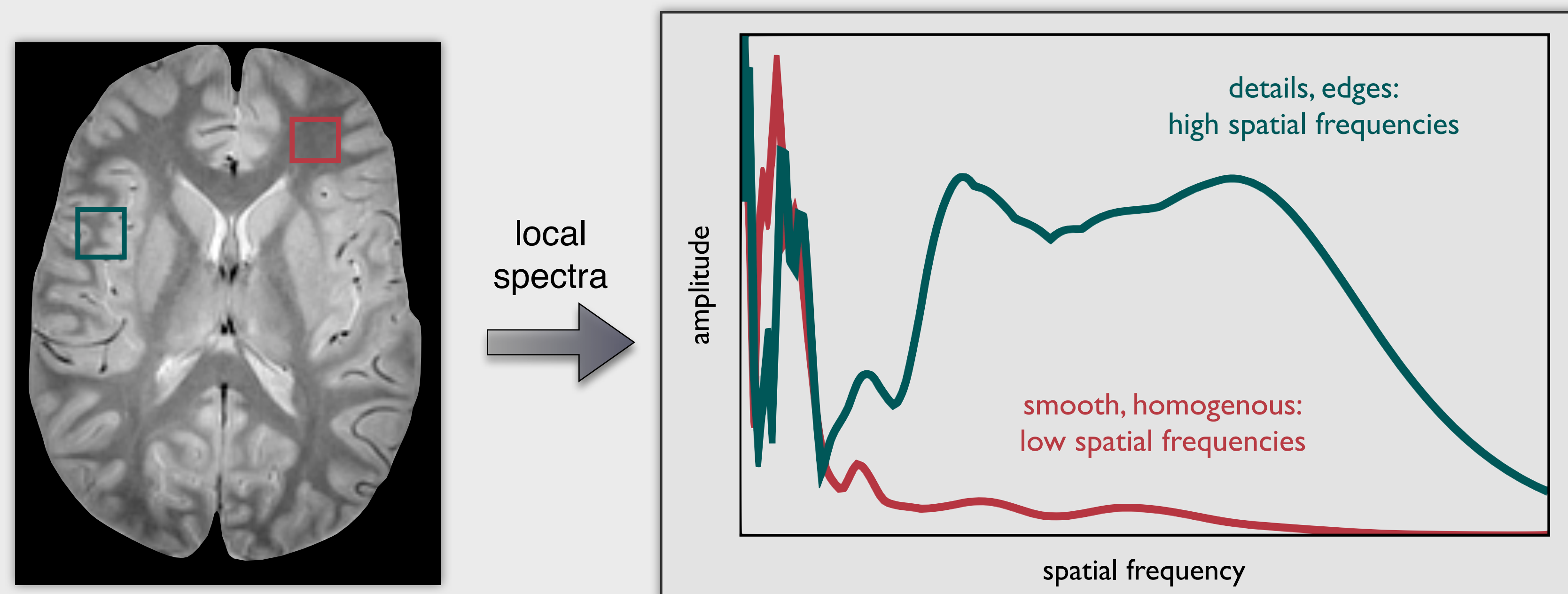
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1 Introduction

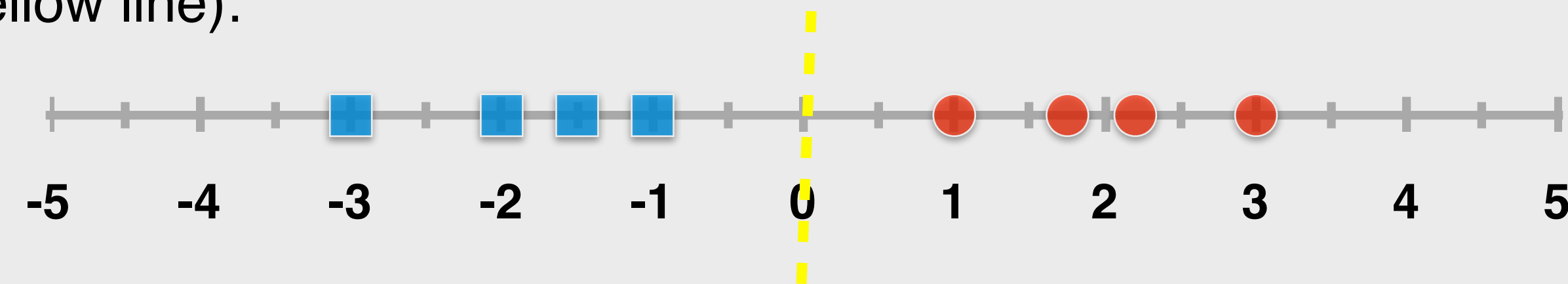
- Brain tumors often appear to be larger and inflamed in MRI after chemo and radiotherapy.
 - May be due to lack of treatment response - tumor growth
 - May be caused by a real response - an immune system reaction to tumor cell death
- The latter situation is referred to as radiographic **“pseudo-progression”**.
 - Current imaging techniques are not accurate enough to distinguish pseudo- from real tumor progression.
 - Based on biological differences (i.e. necrosis/inflammation in pseudo-progression vs. expanding viable tumor in real progression), we hypothesize that pseudo- and real progression will have different MRI **“textures”** that are detectable using machine-learning and advanced image processing algorithms.

2 Methods

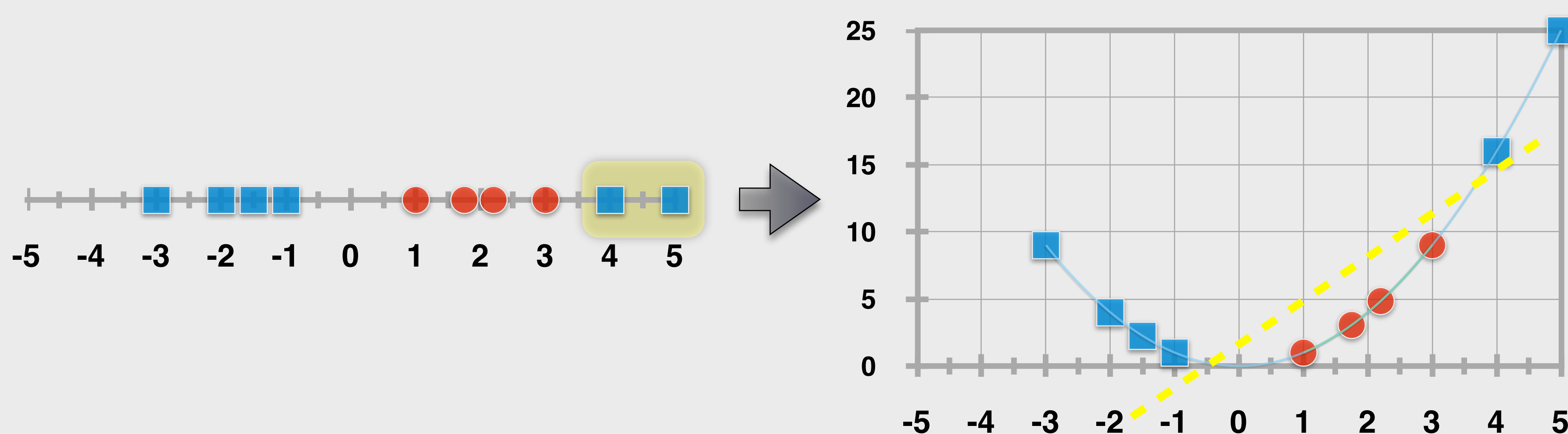
- MRI scans from 20 patients treated at the Tom Baker Cancer Center in Calgary, 10 with confirmed progression and 10 with confirmed pseudo-progression, were used to test our hypothesis.
- Each of these patients had biopsy-confirmed malignant glioma, a regimen of treatment that involved radiotherapy and temozolomide chemotherapy, and at least two post-treatment MRI scans, the first of which showed evidence of tumor change.
- Step 1:** Extract tumor texture features. Algorithms based on time-frequency analysis and variants of Stockwell Transform can be used to calculate local spectra that describe texture.



- Step 2:** Texture curves from known samples are used to train a machine learning classifier (a Support Vector Machine) to discriminate between pseudo-progression and real progression.
- Machine Learning** algorithms may be used to differentiate 2 groups, **“Group A”** and **“Group B”**.
- In the following simple example, a linear boundary that best separate two groups is identified (vertical yellow line):

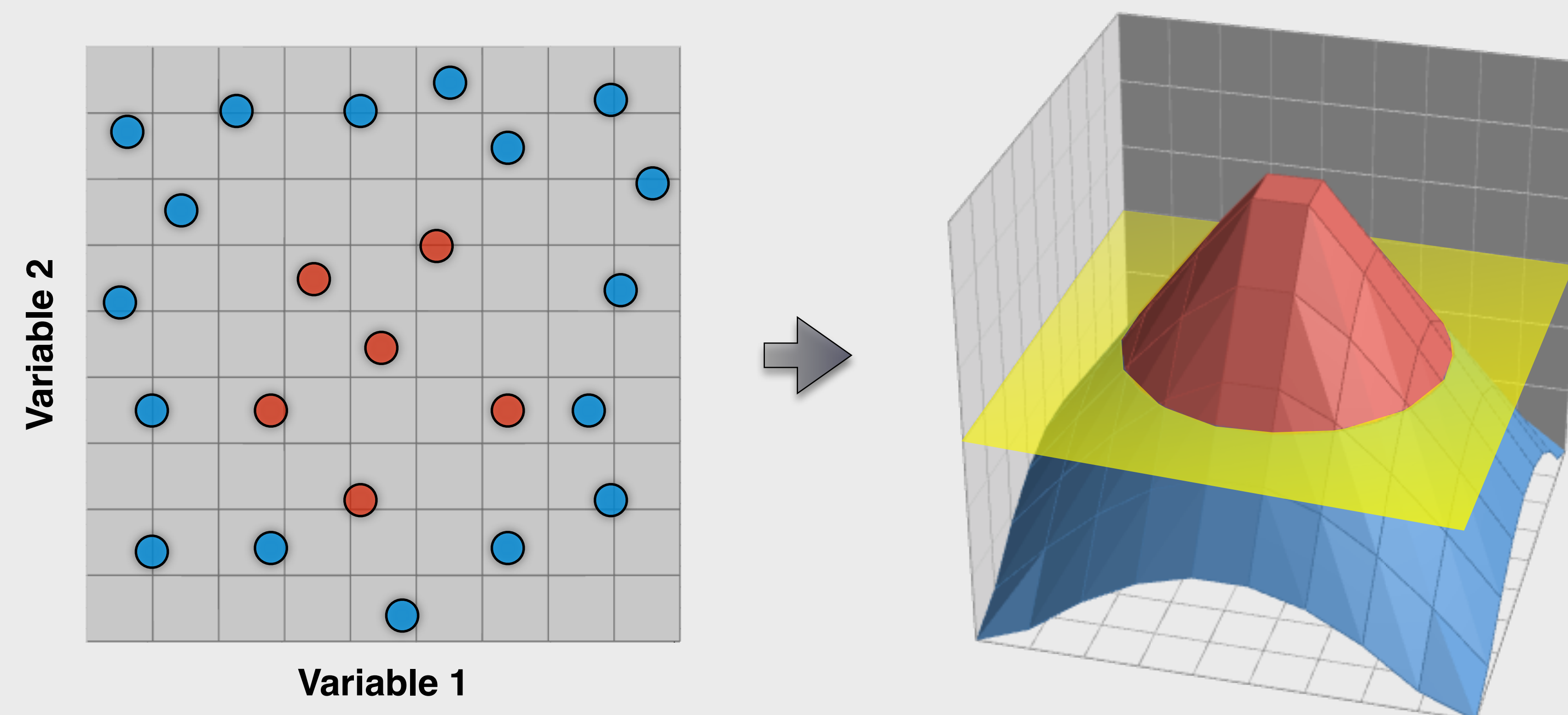


- However, if additional samples are added to **“Group A”**, finding a single linear boundary may be more difficult. The trick is to go from 1 dimension to 2 dimensions. For example, let $y=x^2$. Now a single linear boundary (yellow line) separates the 2 groups.

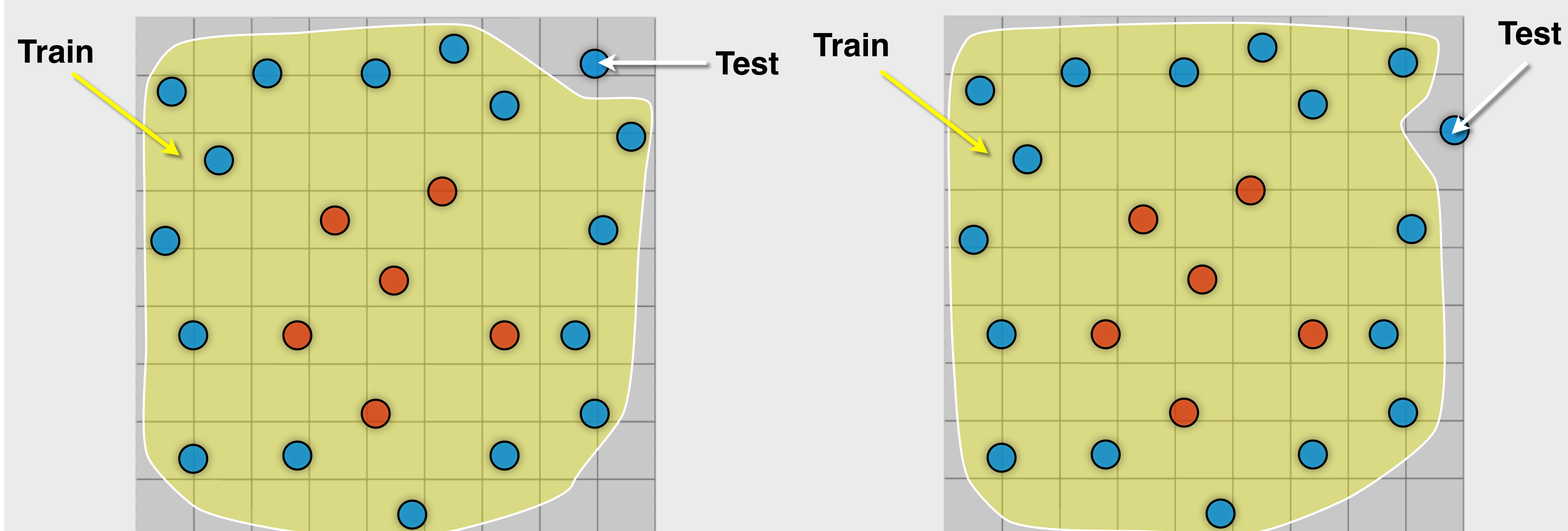


2 Methods (Continued)

- This trick can be used for data with 2 (or more) dimensions. Here, going from 2 to 3 dimensions allows a single linear boundary (yellow plane) to separate the 2 groups.



- Step 3:** The last step is to evaluate the classifier using Leave-one-out cross-validation. A single observation from original samples is used as the test data, and the classifier is trained on the remaining observations. This is a **“harsh”** test of the classifier’s performance.



3 Results

- Pseudo-progression was distinguished from real progression with 90% accuracy. The classifier was able to correctly identify the 10 real progression cases (100% sensitivity). However, it incorrectly classified 2 pseudo-progression cases as real progression (80% specificity).

