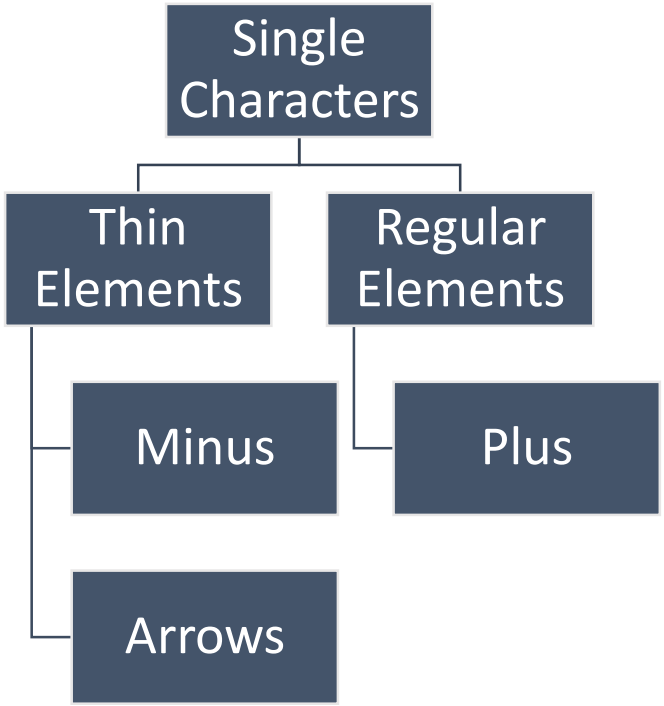
Detection and Identification of Operators

Operators we are interested in :

- + and –
- All possible side arrows $\rightarrow, \leftarrow, \leftrightarrow, \rightharpoonup, \leftharpoondown$
- Up/Down arrow $\uparrow$ and $\downarrow$;

Proposed Method

Rule Based Tree Classification



Why rule based ???

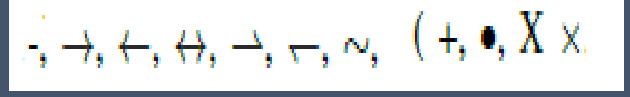
Less error rate for both

- Detection of operators
- Identification of operators

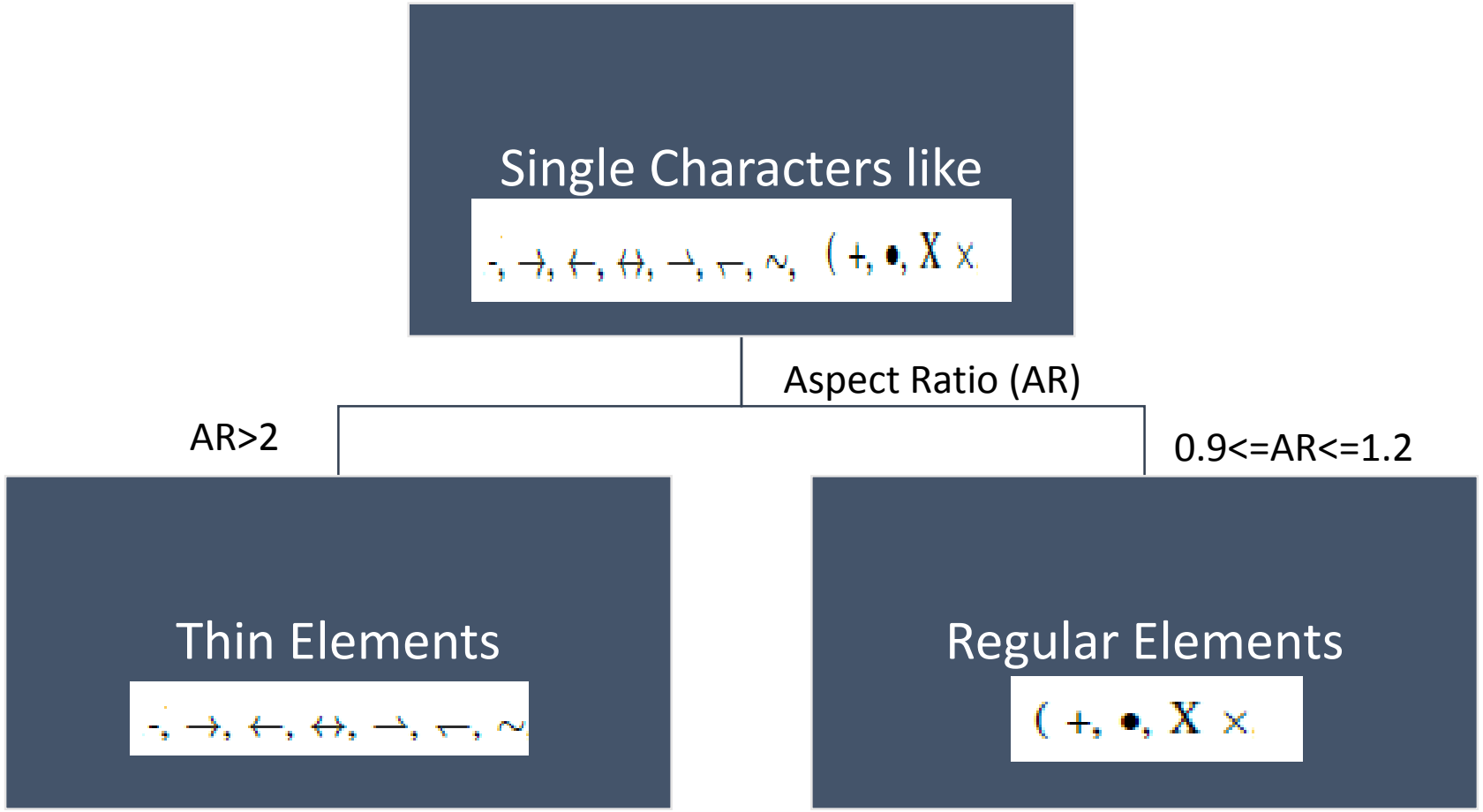
from one class SVM method with various feature vectors.

Sample single characters

Single Characters like



Detection and Identification of Operators



About the Thin Elements…

- Both minus and arrows have thin elongated portion > ½ * width

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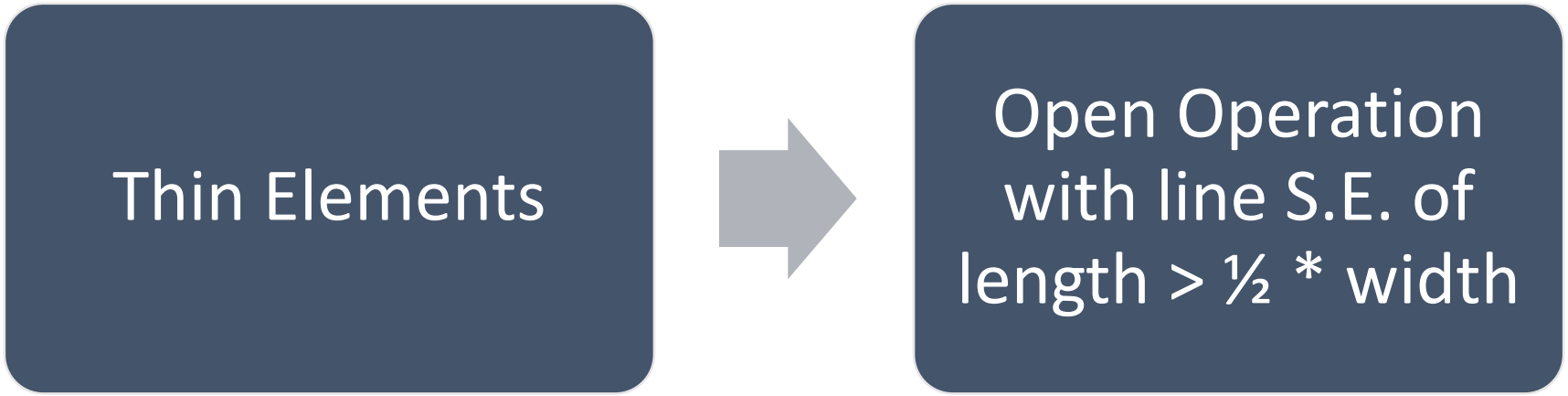

About the Thin Elements…

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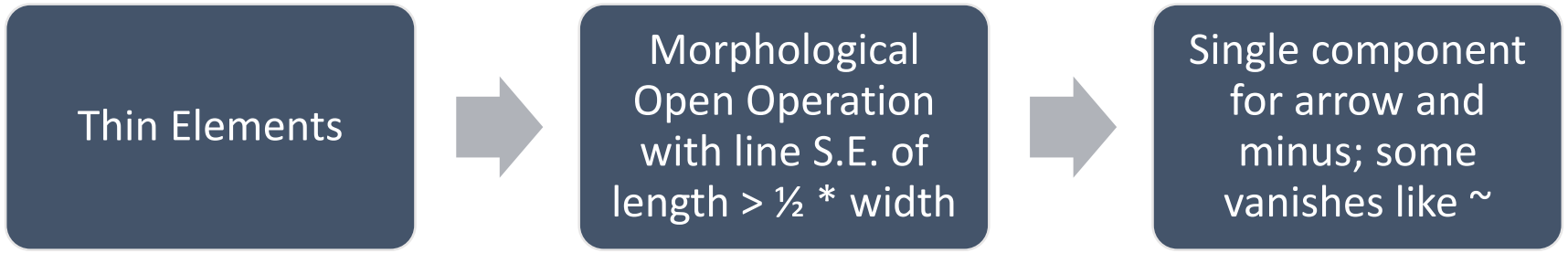

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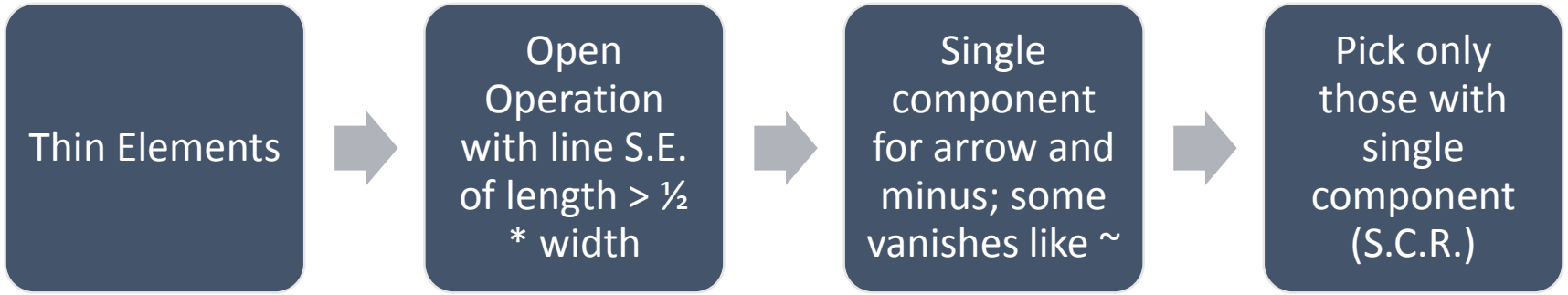
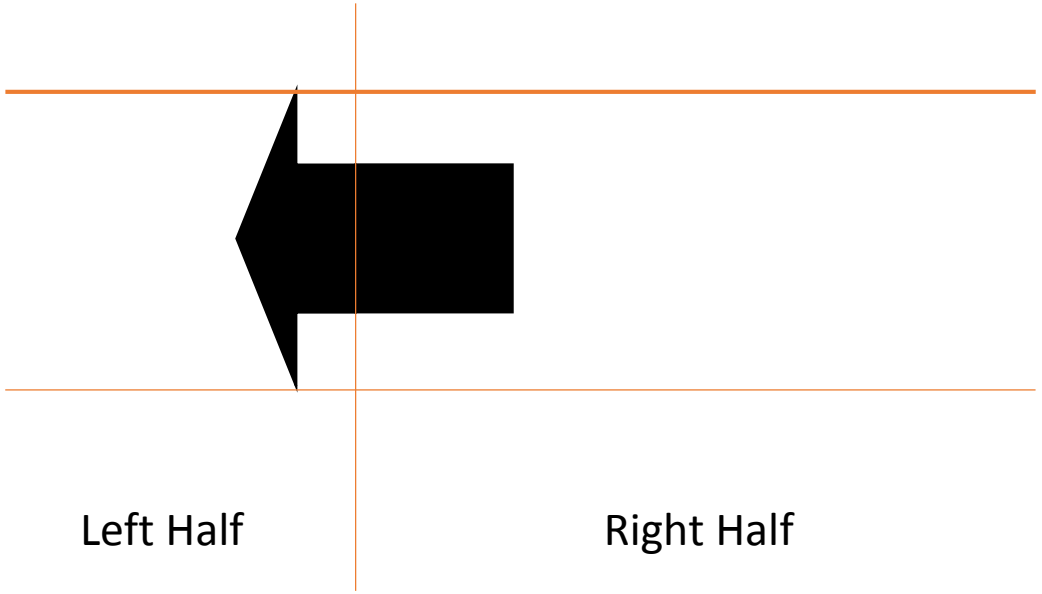


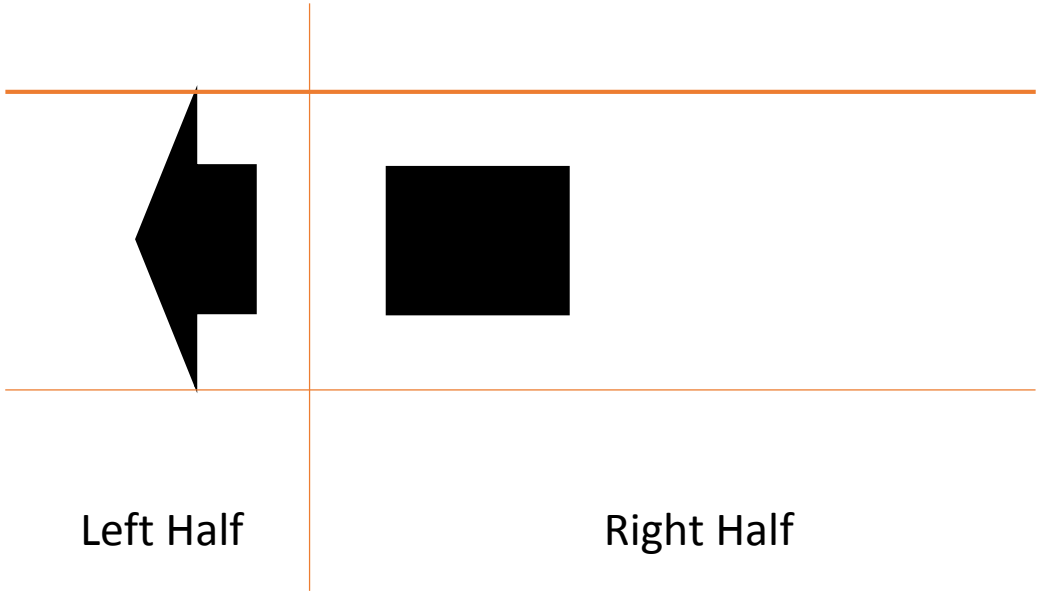
Additional properties

- For minus
  - # end points = 2
  - Very dense elements
- For arrows
  - # end points >= 3

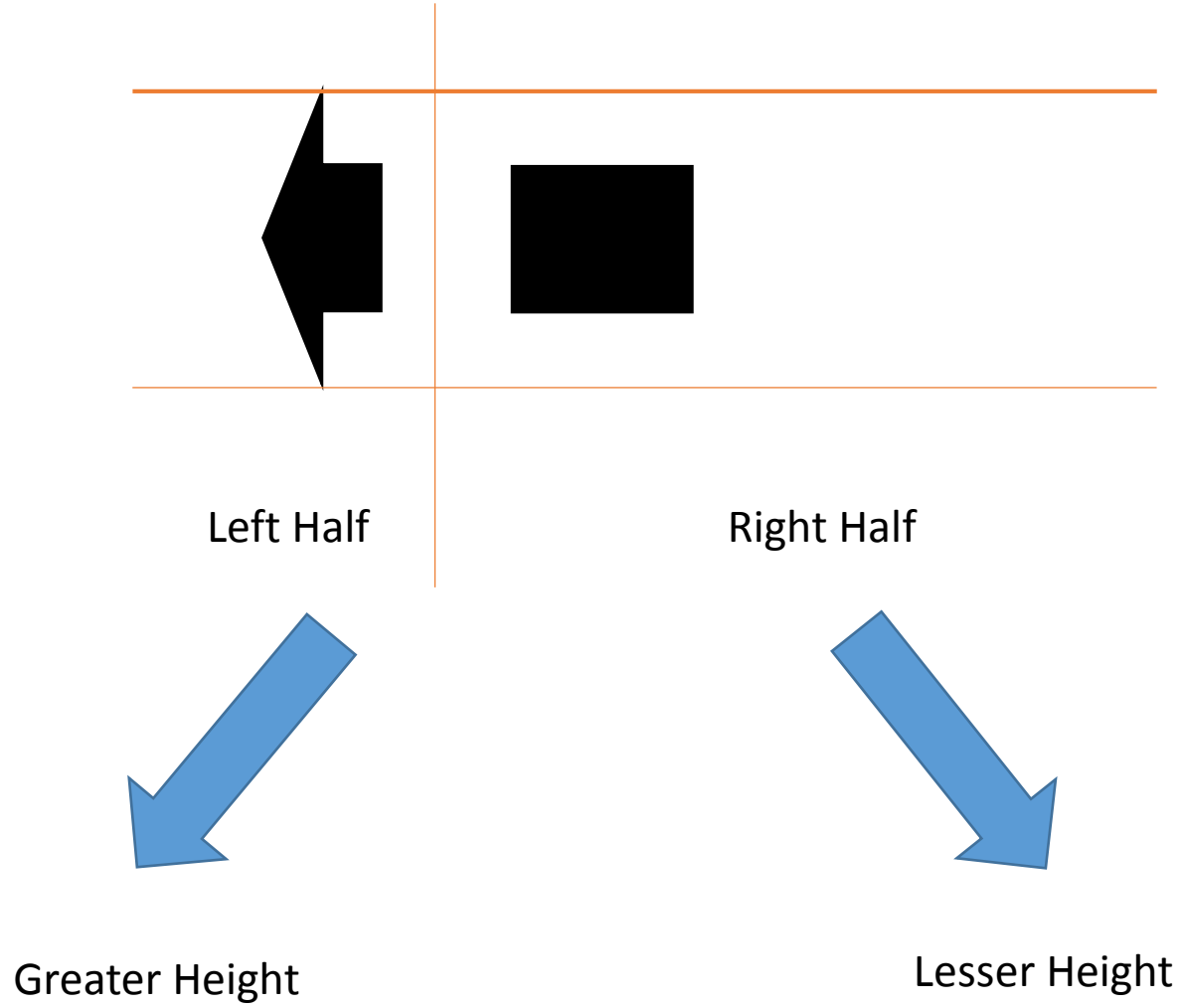
Classify Arrows



Split Arrow



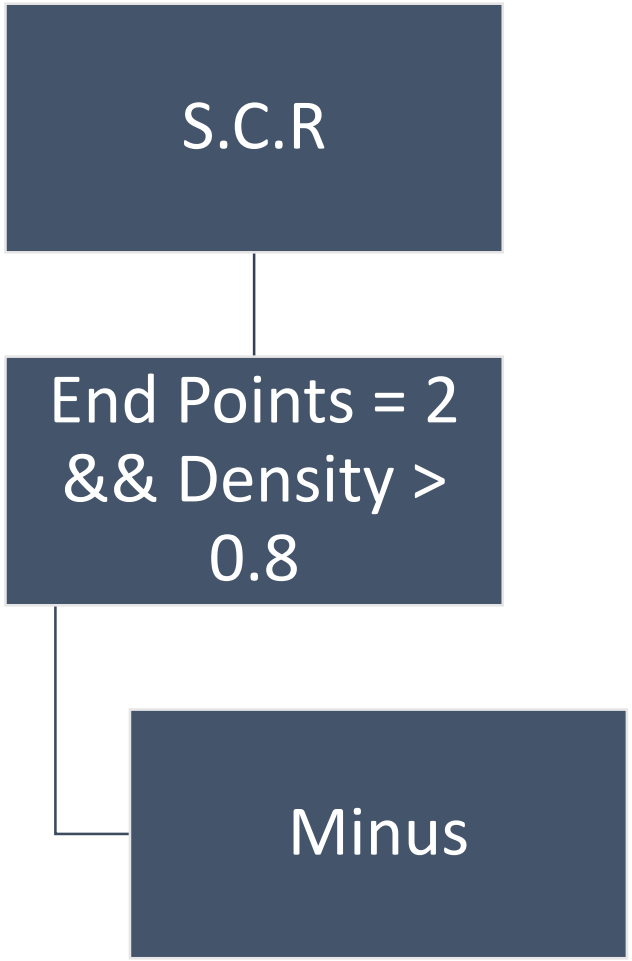
Measure height



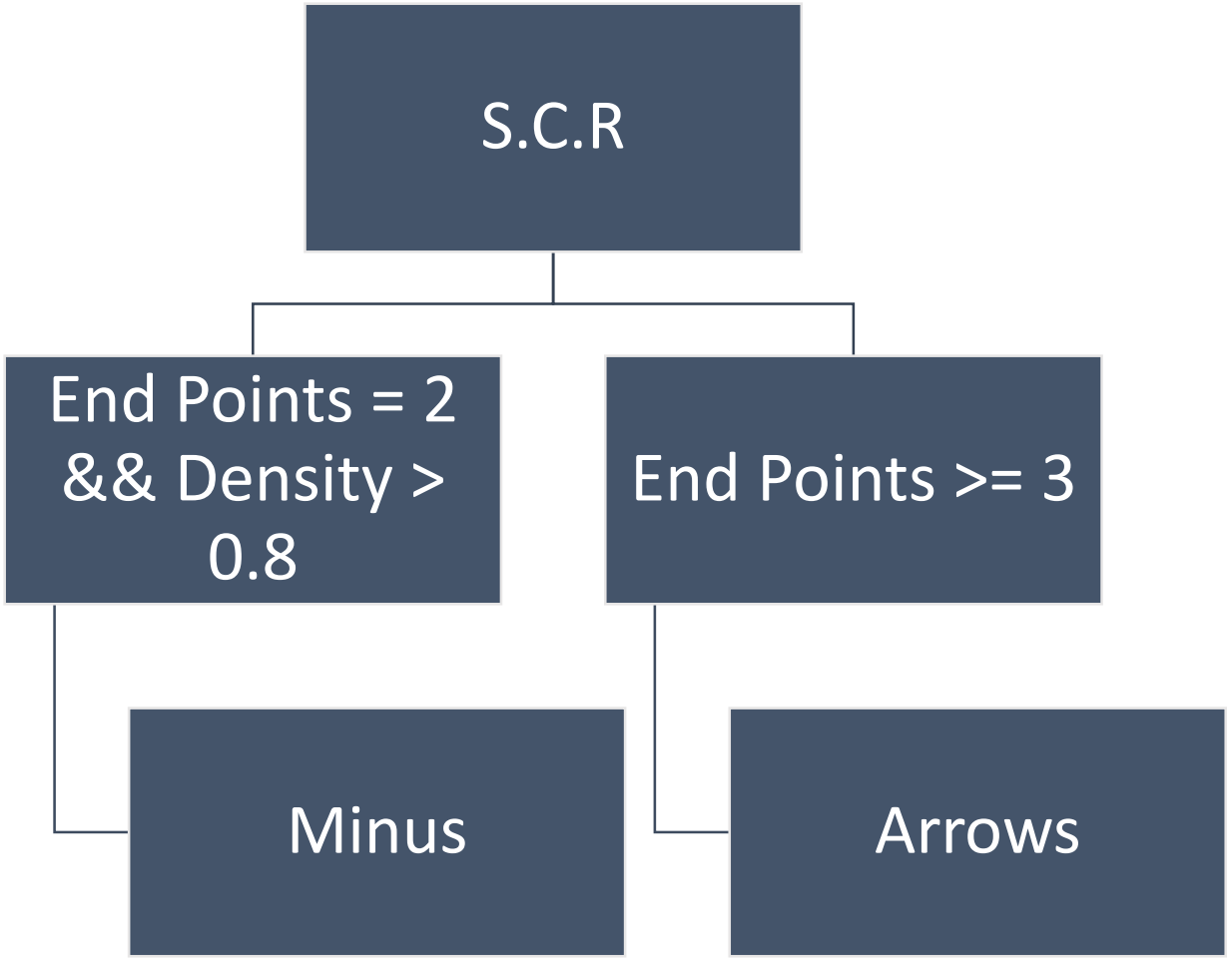
Adding up…

S.C.R

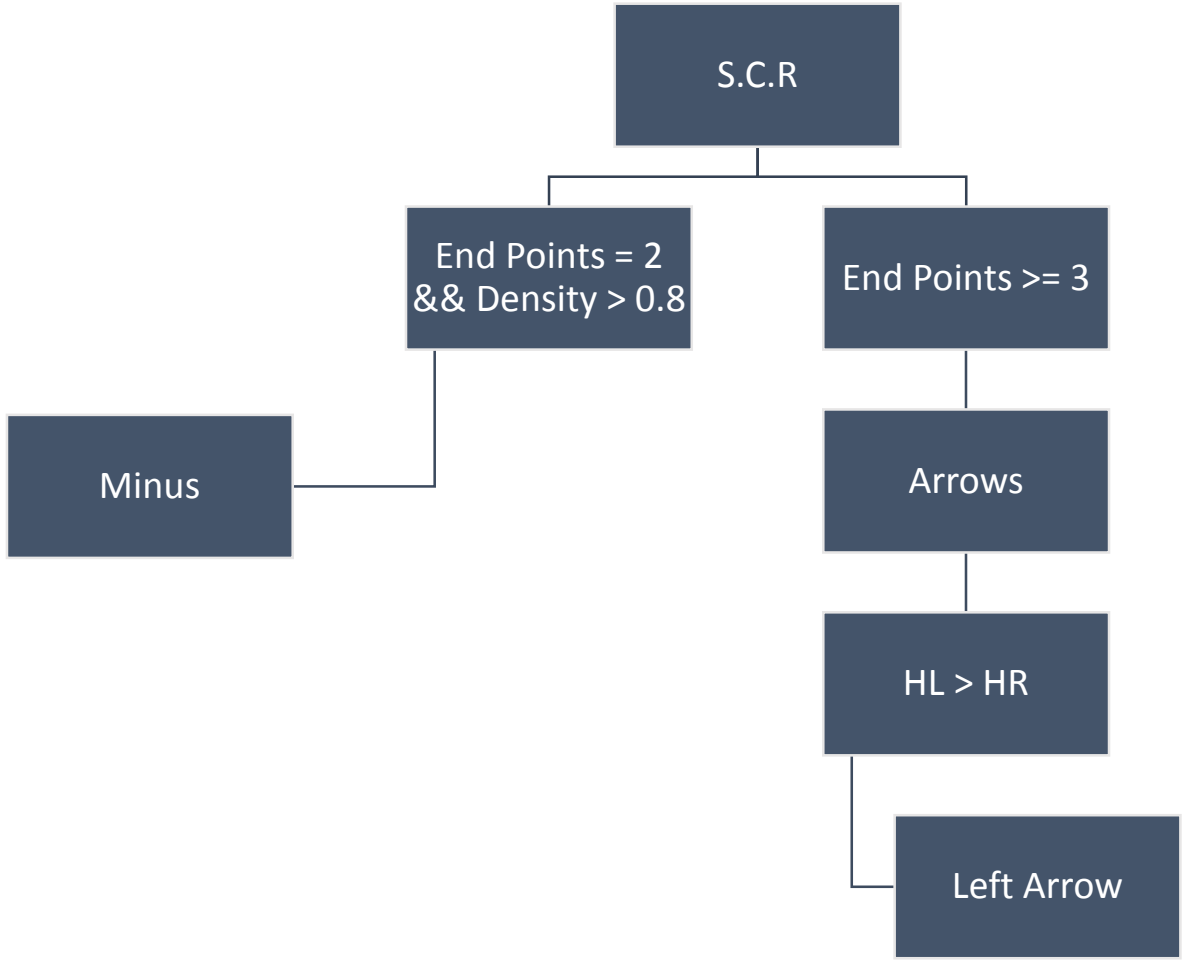
Adding up…



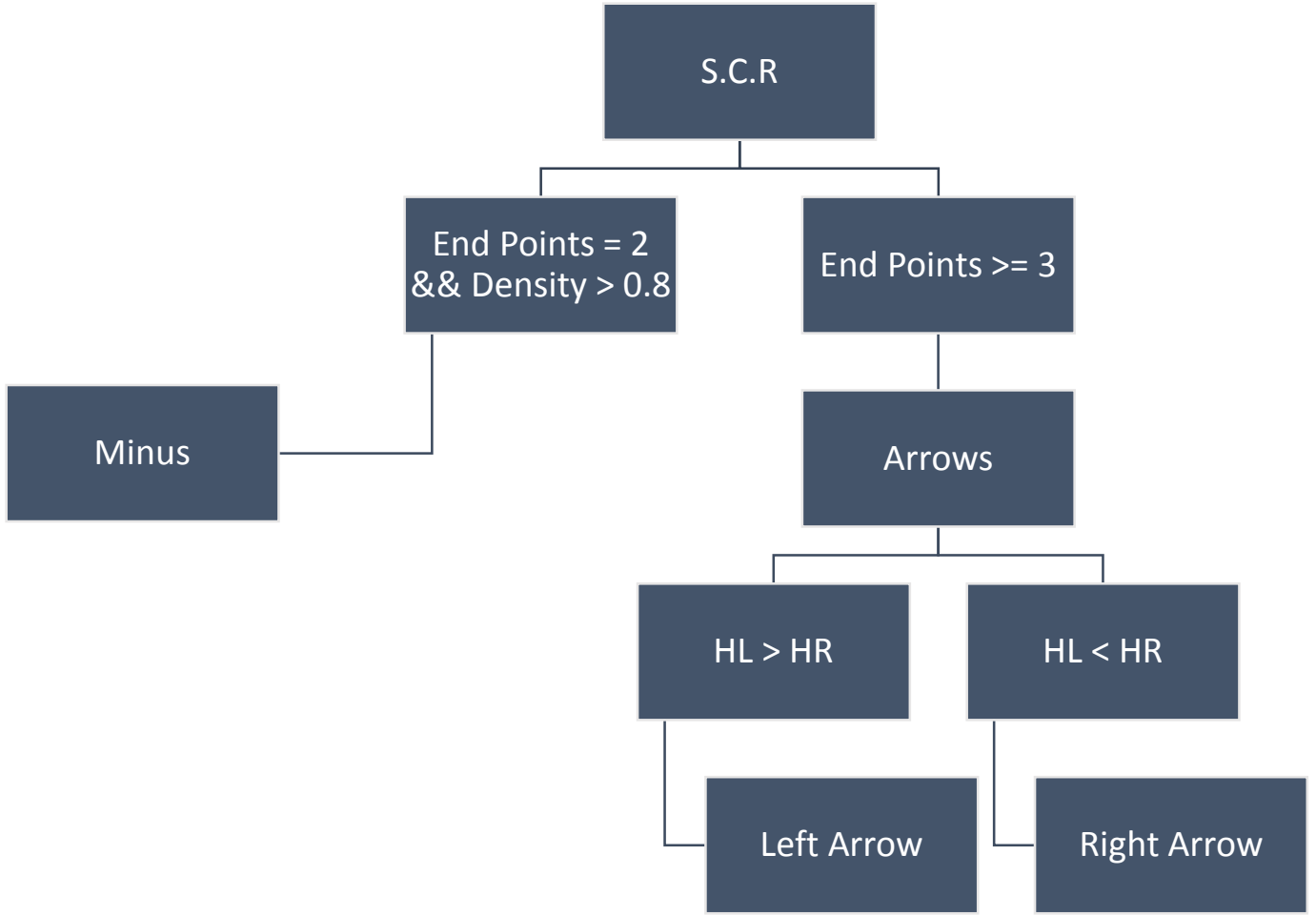
Adding up…



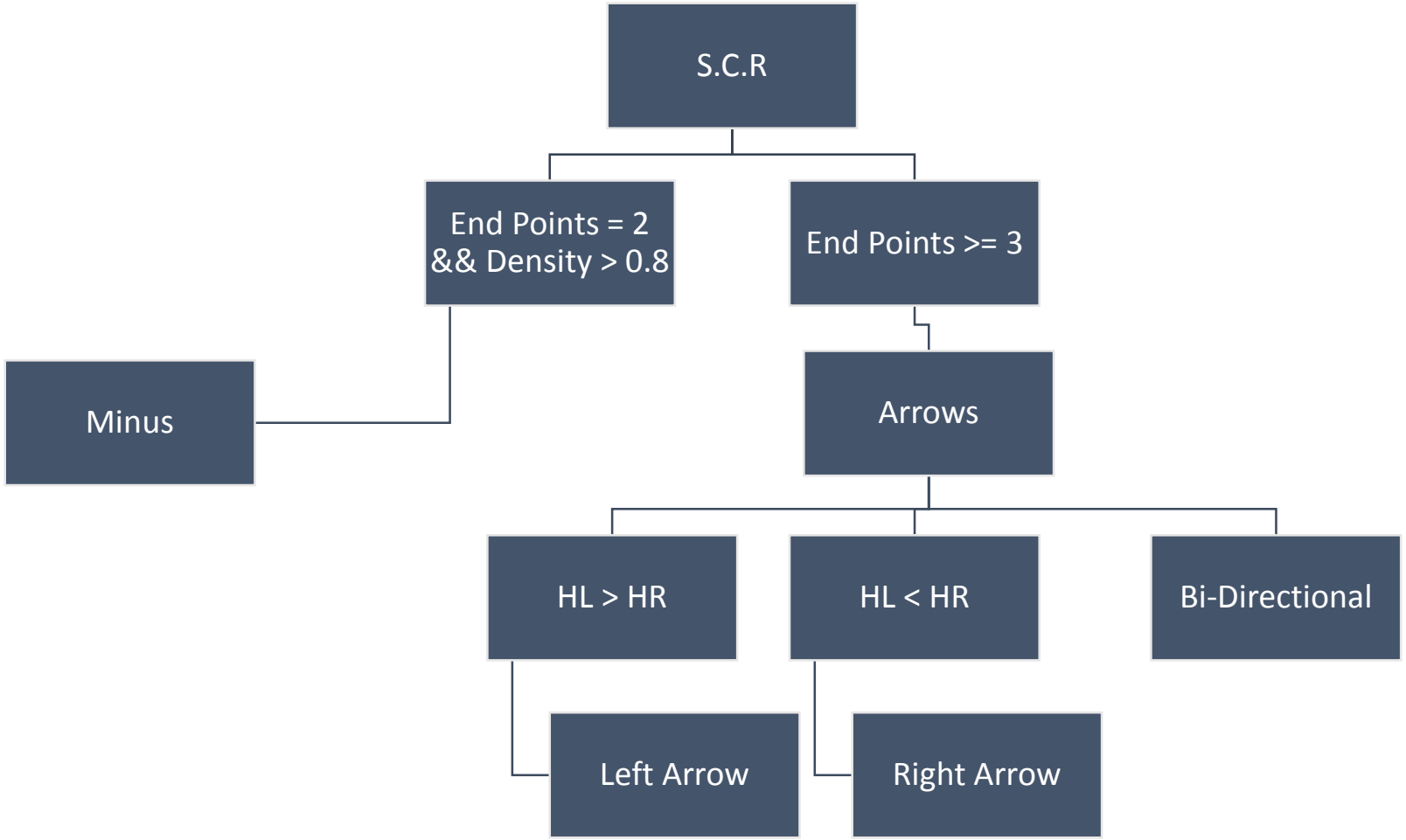
Adding up…


S.C.R
End Points = 2
&& Density > 0.8
End Points >= 3
Minus
Arrows
HL > HR
Left Arrow

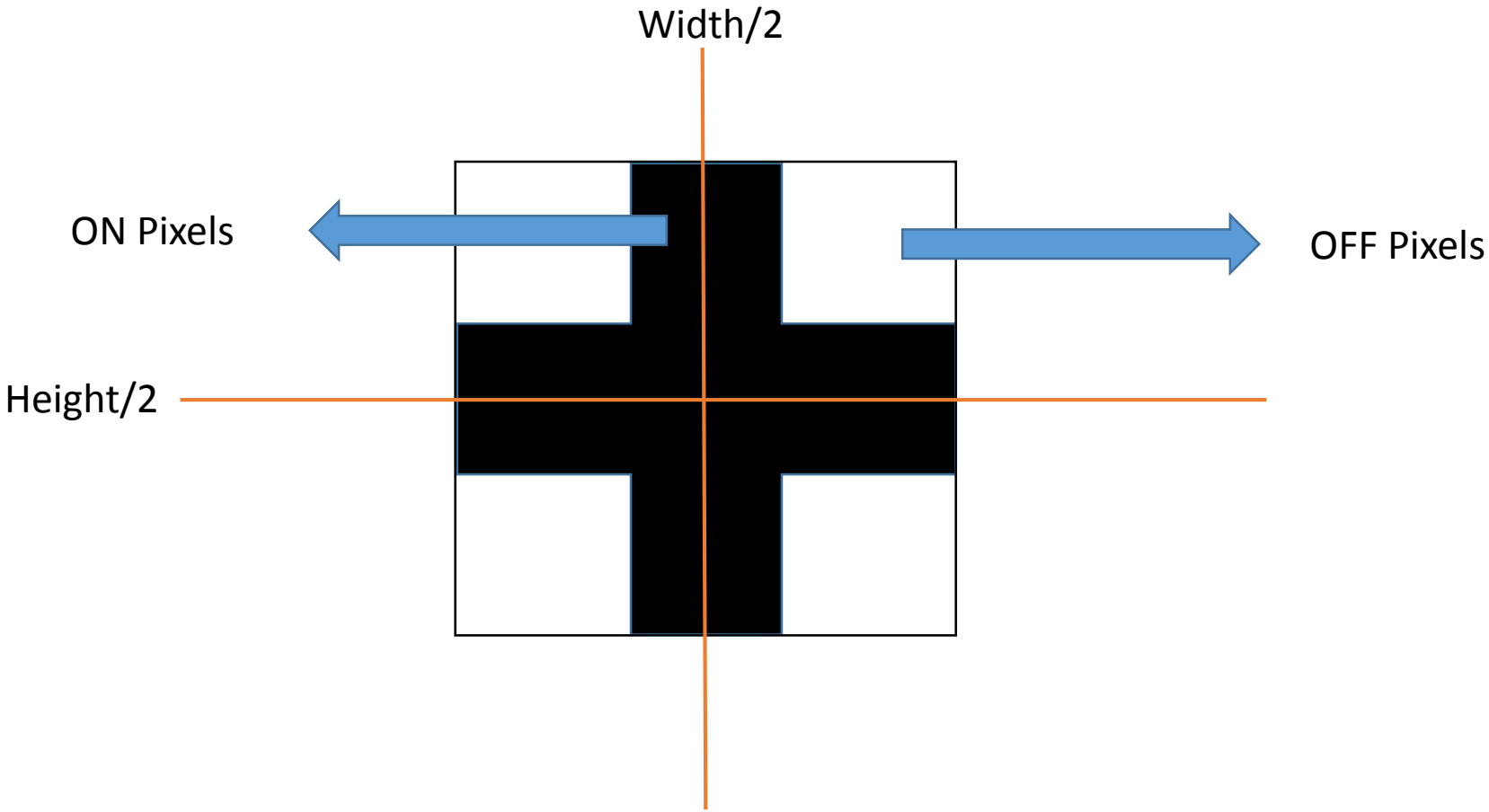
Adding up…


S.C.R
End Points = 2
&& Density > 0.8
End Points >= 3
Minus
Arrows
HL > HR
HL < HR
Left Arrow
Right Arrow

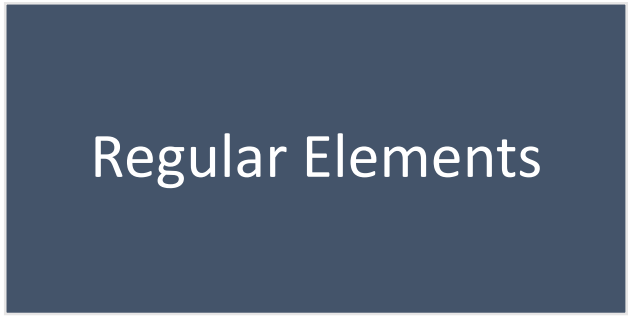
Adding up…


S.C.R
End Points = 2
&& Density > 0.8
End Points >= 3
Minus
Arrows
HL > HR
HL < HR
Bi-Directional
Left Arrow
Right Arrow

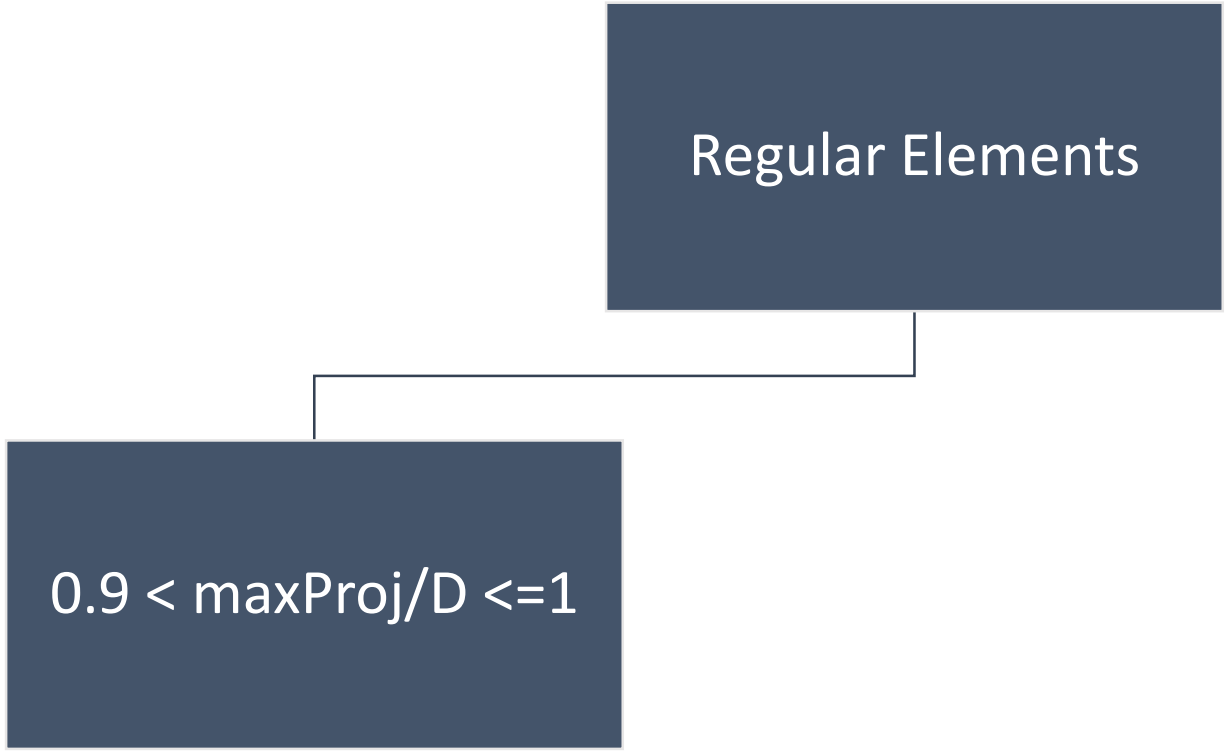
What about + ???



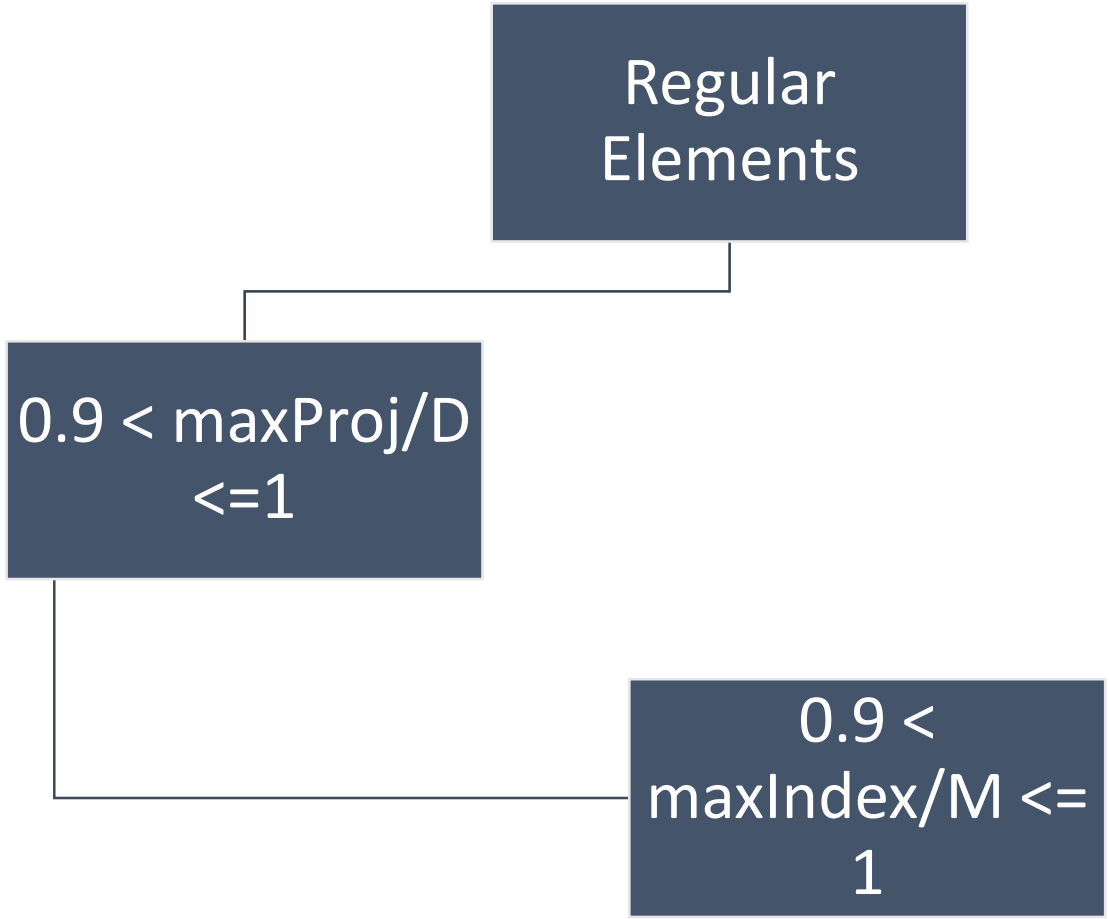
Putting it in action…



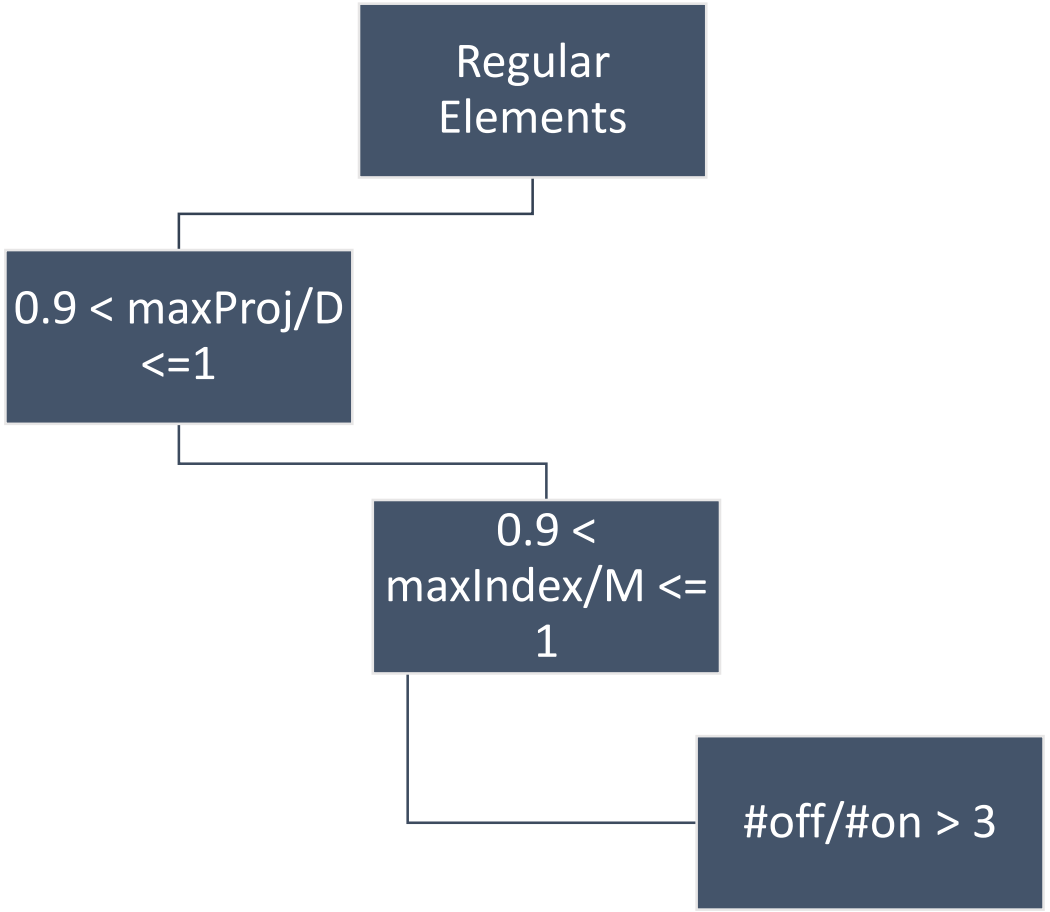
Putting it in action…



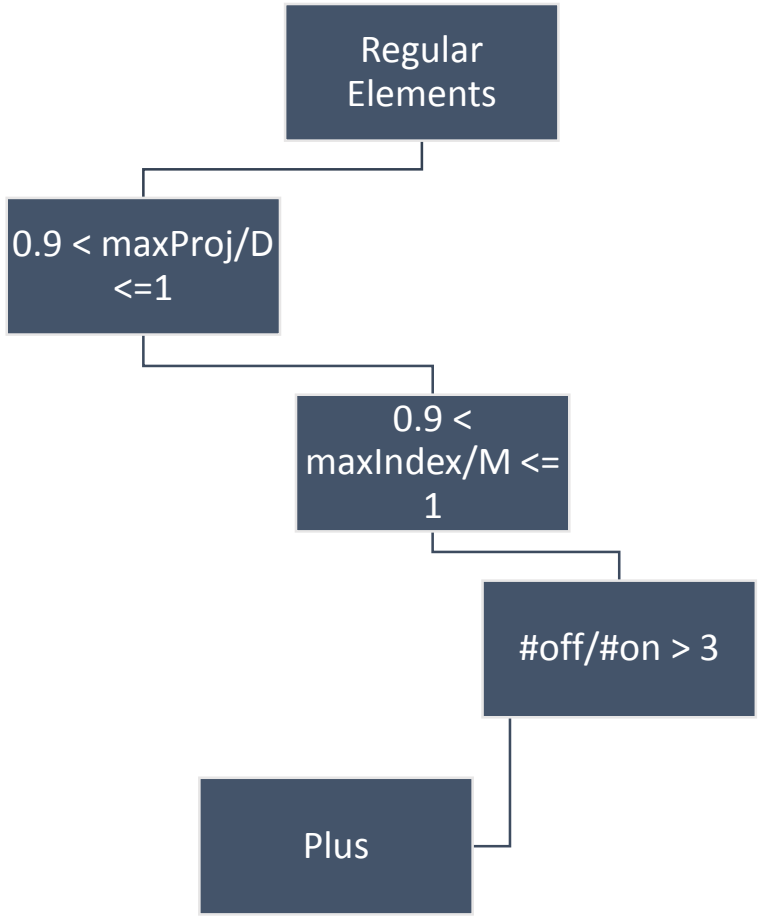
Putting it in action…



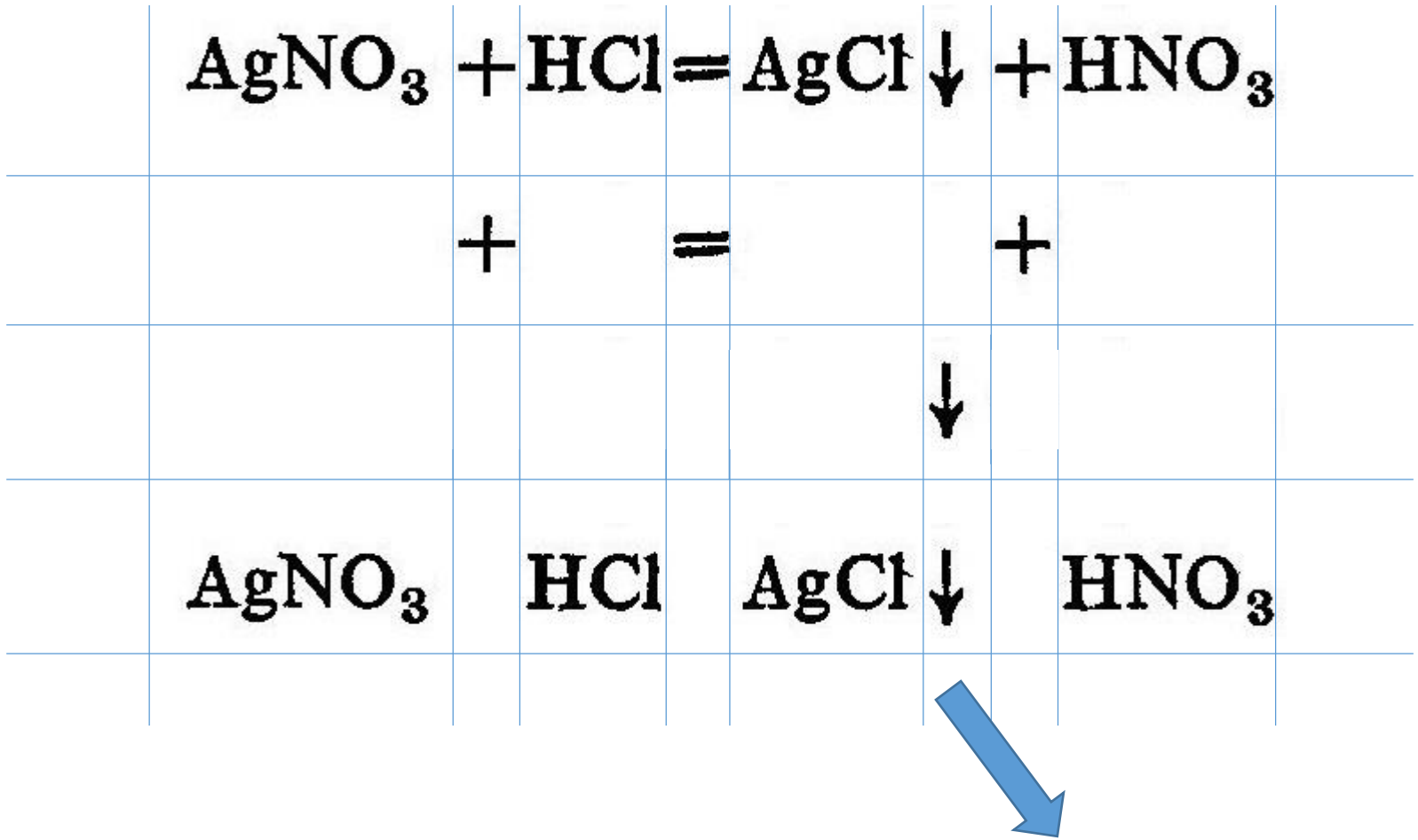
Putting it in action…



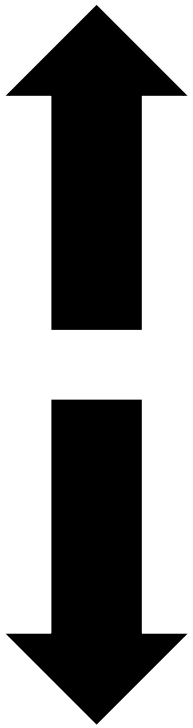
Putting it in action…



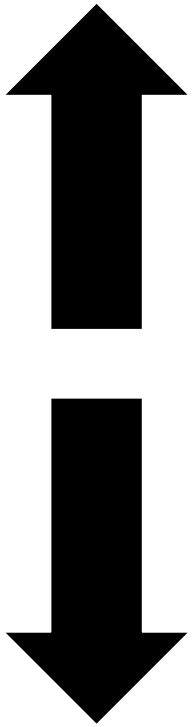
Up/Down arrow (Use this after equation segmentation)



Up or Down ???

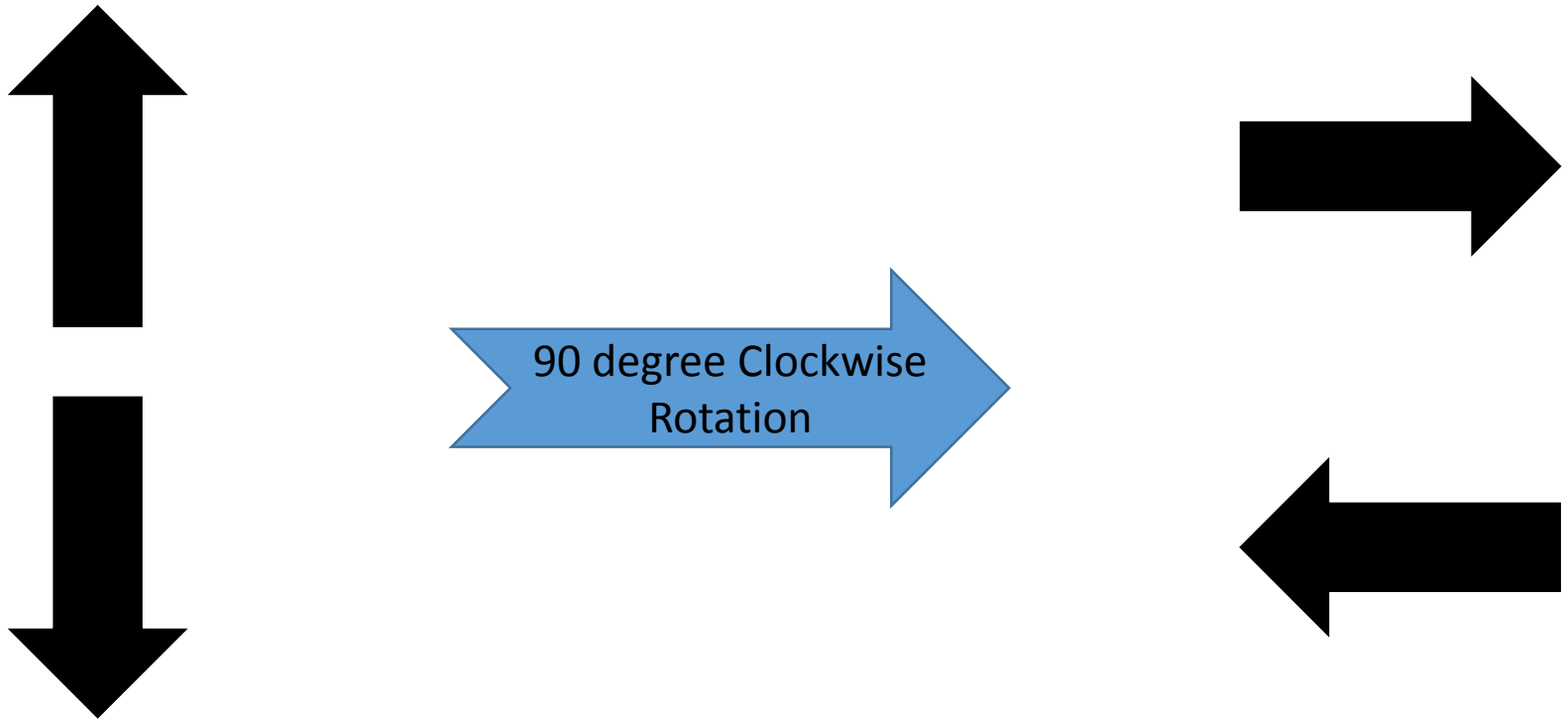


Up or Down ???



90 degree Clockwise Rotation

Up or Down ???



Up or Down ???