

## Machine Learning for the Cluster Reconstruction in the CALIFA Calorimeter at R<sup>3</sup>B

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nucleus of interest  
kinematically complete measurements

neutrons  
heavy fragment branch  
light fragment branch

**Physics Program:**

Experiment to study the structure of atomic nuclei and its astrophysical implications

TODO: write out more...

**CALIFA**

Endcap:  
iPhos:  
480 CsI(Tl)  
crystals  
CEPA:  
96 CsI(Tl)  
crystals

Barrel:  
1952 CsI(Tl) scintillator  
crystals

Photon absorption in CsI

BEAM

Hit observables:

- Energy deposit  $E$
- Polar angle  $\theta$
- Azimuthal angle  $\varphi$
- Hit-time  $t$

**Highly segmented detector with 2544 CsI(Tl) crystals in total**

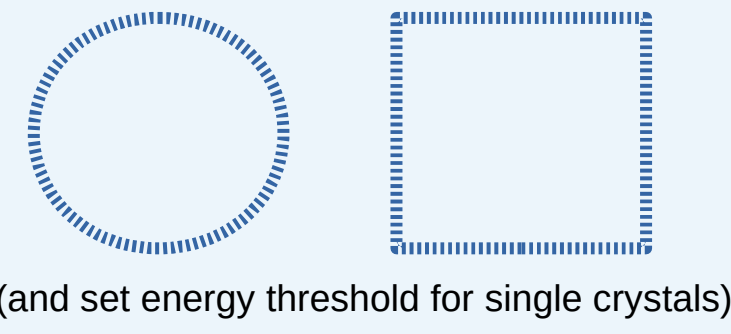
**Interaction process photons – scintillator material**

**Cluster reconstruction from 2.1 MeV simulated gammas**

### Standard R3B Clustering

#### CALIFA Standard Method for Cluster Recognition

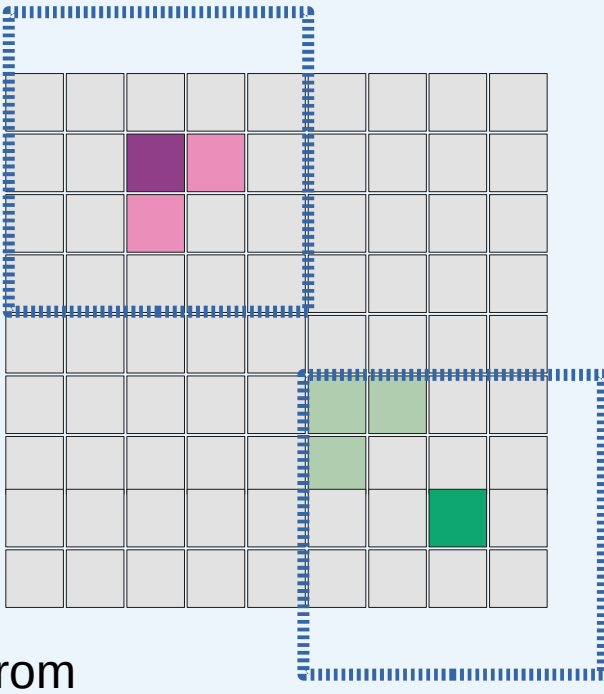
User defines shape and size of cluster:



Sort the hit list according to their energy

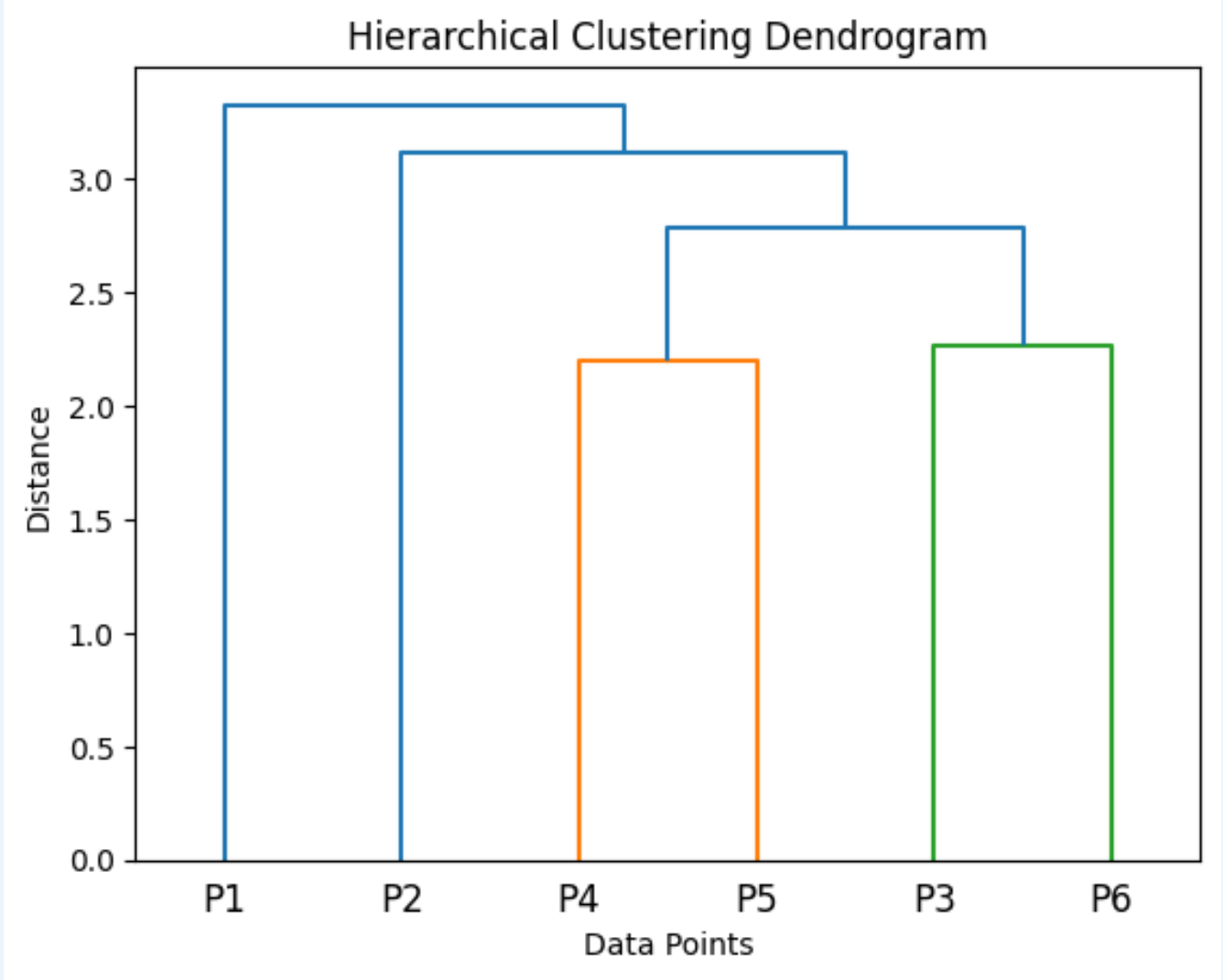
30. MeV
22. MeV
10. MeV
5. MeV
3. MeV
2.5 MeV
0.7 MeV

1. create cluster centered around first hit
2. loop over all hits in list  
– if hit inside cluster add it and remove it from the list
3. Do this procedure until list is empty

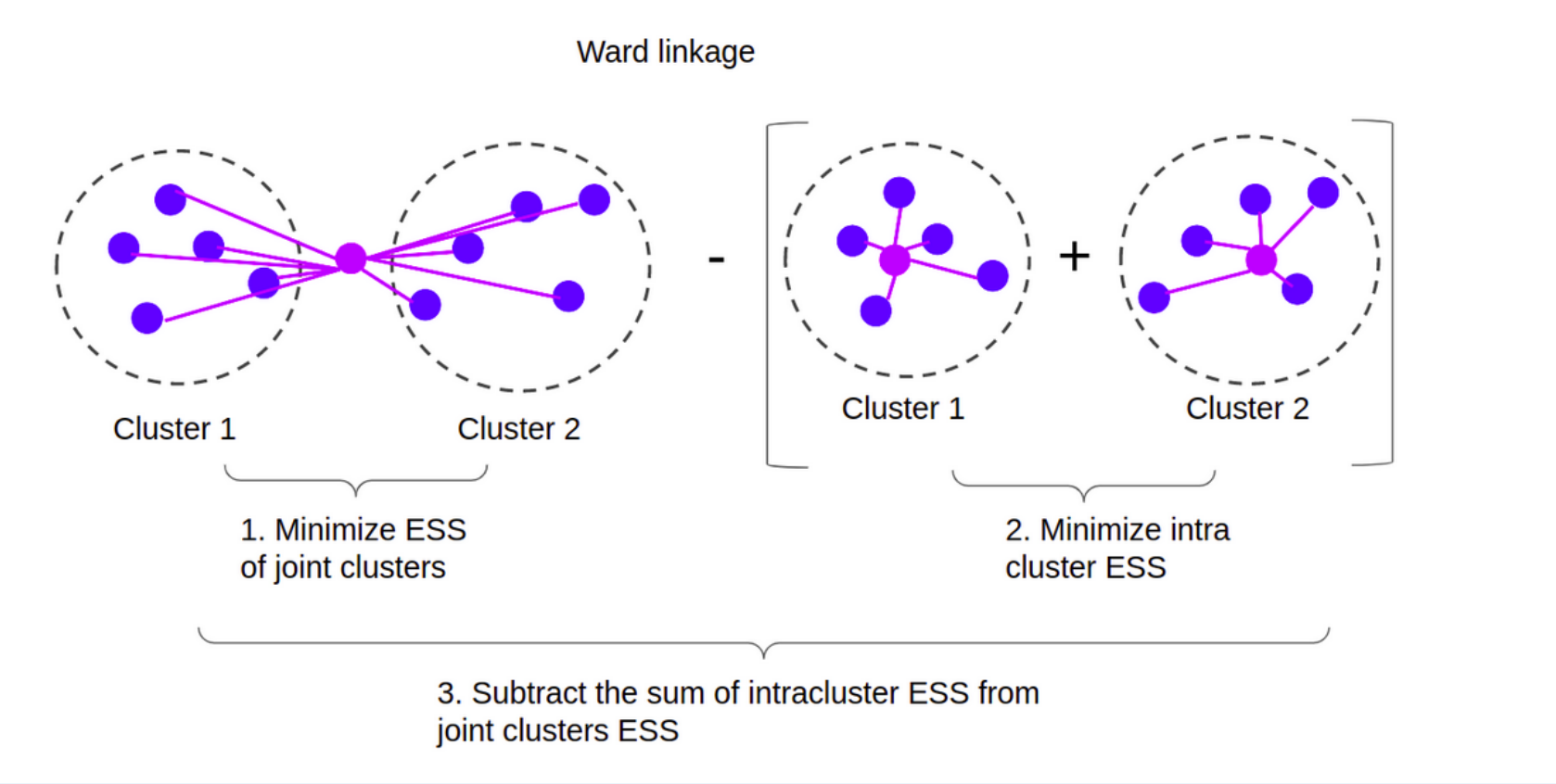


### Agglomerative Clustering

Example plot....



Example plot....



Hit – time is integrated as radius - > 3D hit:  $\theta, \varphi, r(\text{time})$

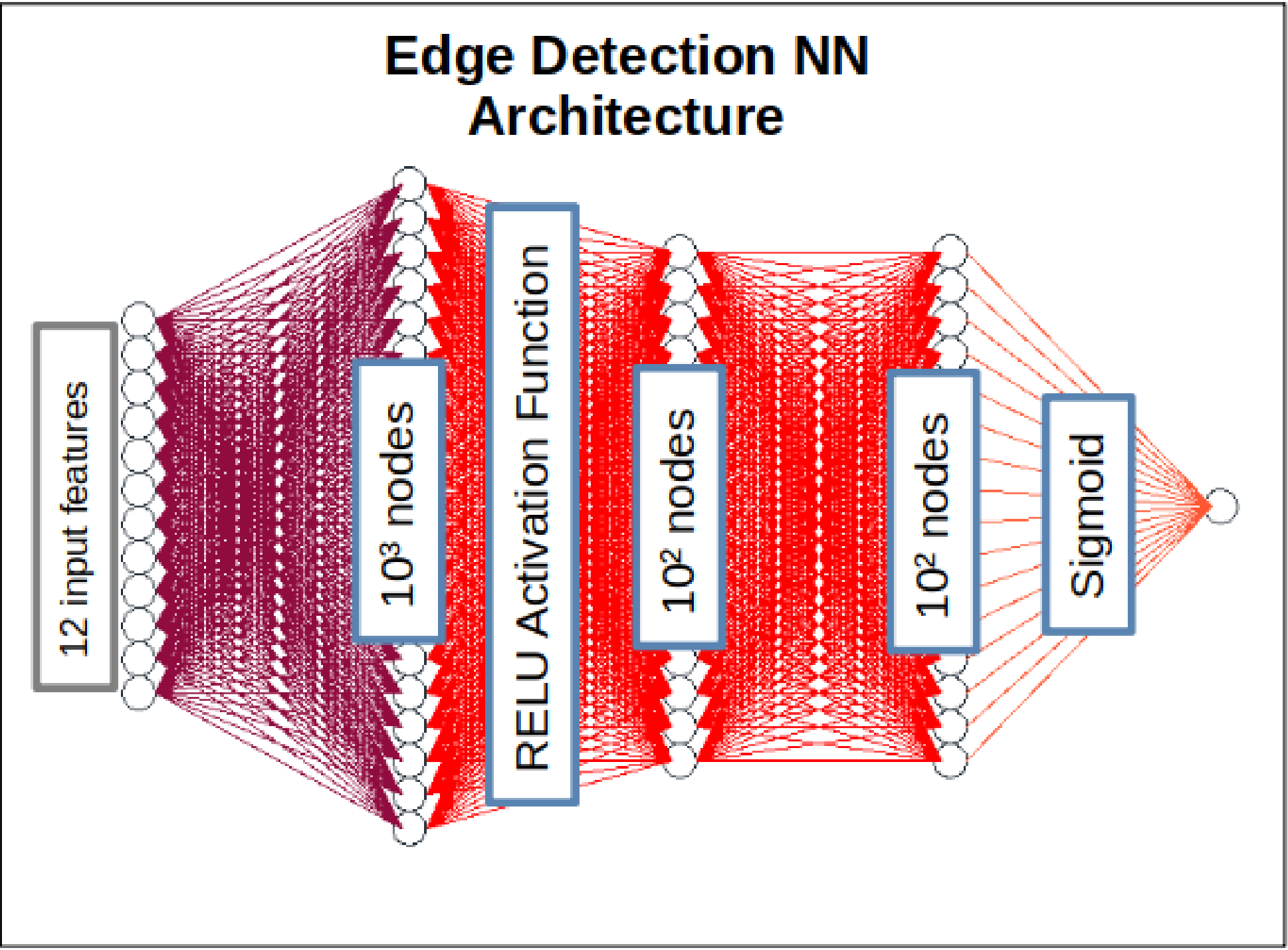
### Edge Detection Neural Network

Pairwise hit comparison ( $i, j$ )

12 input features:

$$E_{i,j}, \theta_{i,j}, \varphi_{i,j}, t_{i,j}, \Delta E_{ij}, \Delta \theta_{ij}, \Delta \varphi_{ij}, \Delta t_{ij}$$

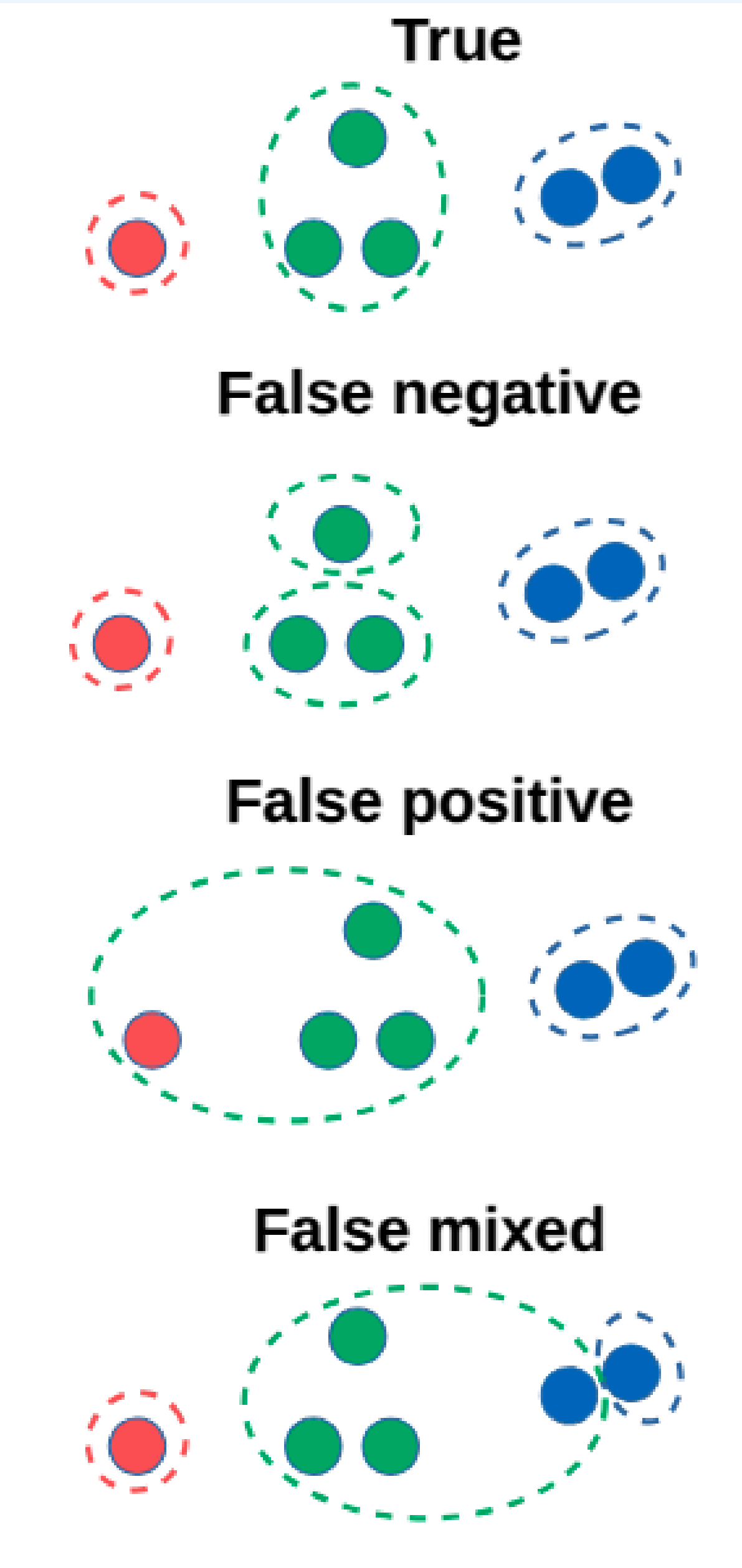
#### Edge Detection NN Architecture



Various Edge Detection NN models analyzed:

- Edge model with/without time information
  - R3B + Edge (without time)
  - Agglo + Edge (with time)
- Pre-Clustered data is fed to the Edge model

#### Metrics



#### RESULTS

