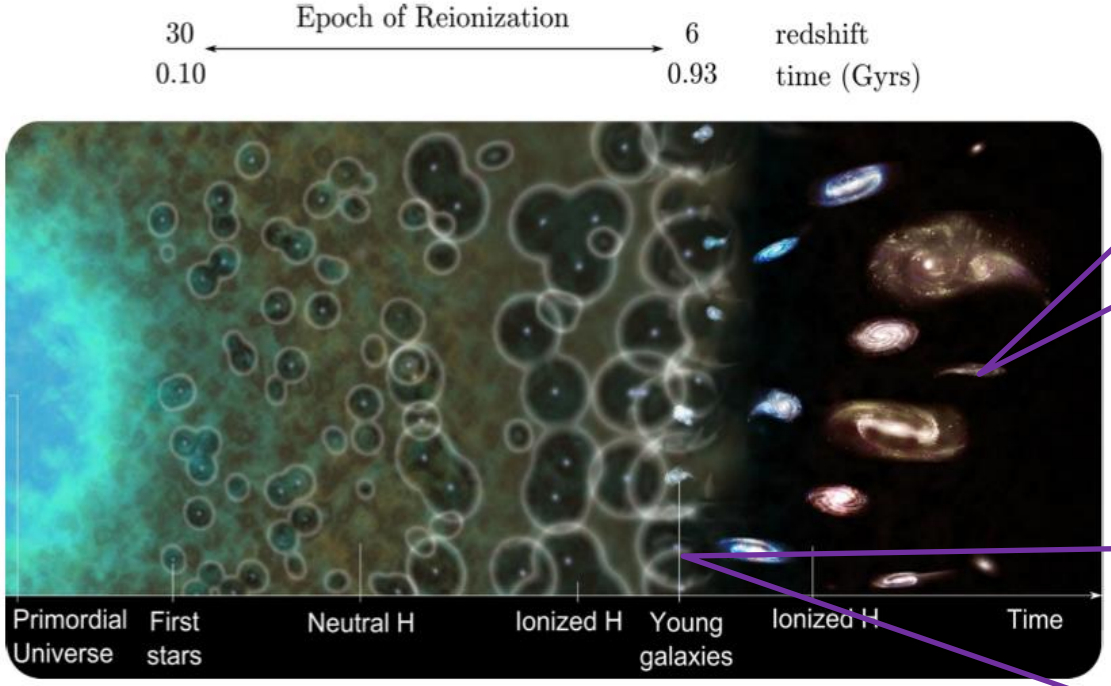
Inferring Supernova dust with Neural Networks

Zoe Ansari – May 2021

- What is cosmic dust
- Why Machine Learning?
- Mixture Density Network
- Uncertainty
- Recursive feature elimination

DARK

Why should we keep an eye on dust



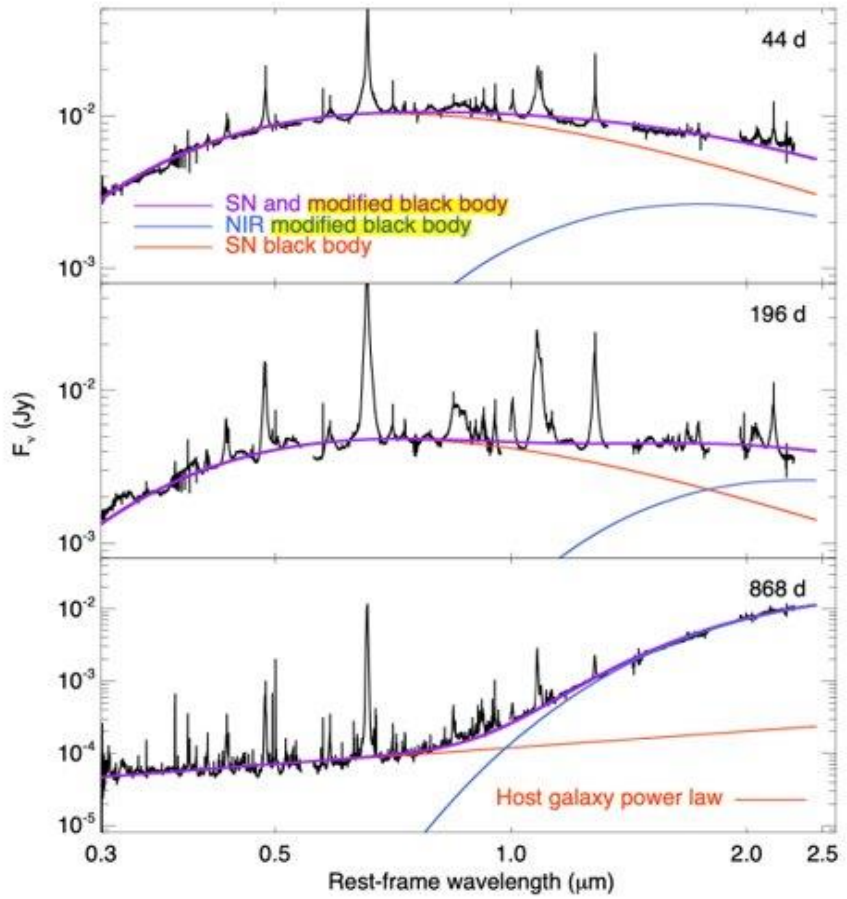
Z ~ 0.0001

Supernovae : CCSNe
Consistency in observations
(Gall & Hjorth 2018)

Z ~ 6-7

http://www.oa.uj.edu.pl/cmf2014/talks/durrive_jb.pdf

Challenges in inferring dust from observations



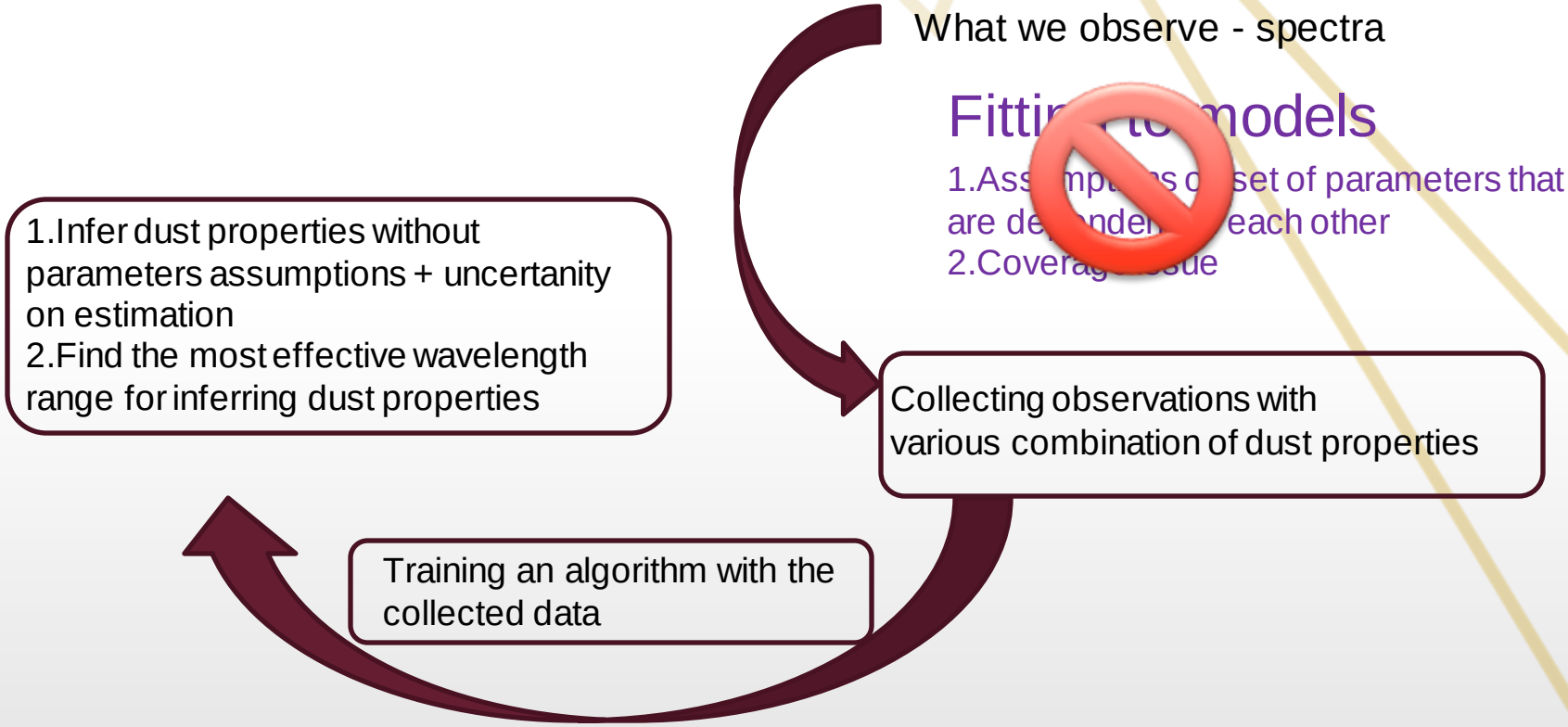
What we detect - spectra

Fitting to models

1.Assumptions on set of parameters that are dependent on each other
2.Coverage issue

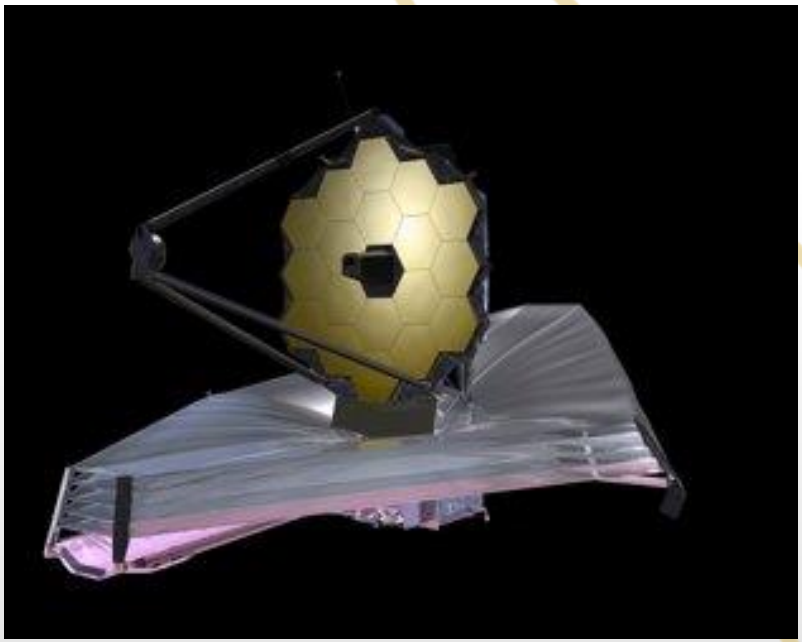
Dust mass
Dust temp.
Dust species

Inferring dust from observations with Machine



Collect the data

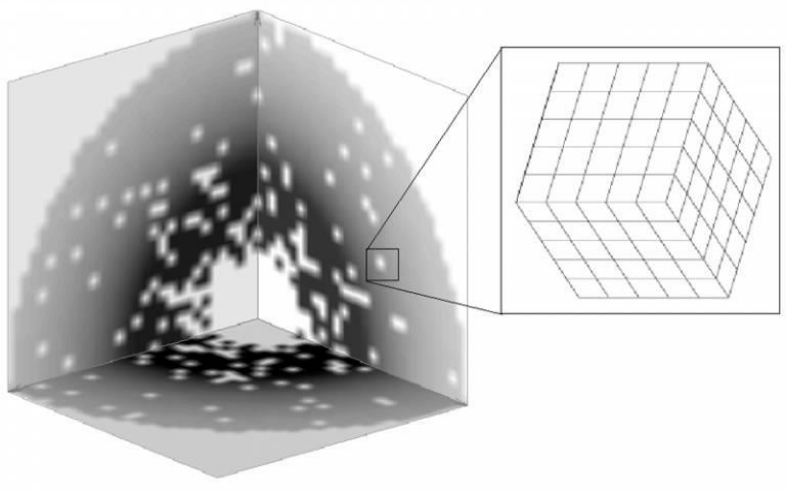
James Webb Space Telescope



Collect the data

Simulations

MOCASSIN



3D representative of supernova ejecta model

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Collect the data

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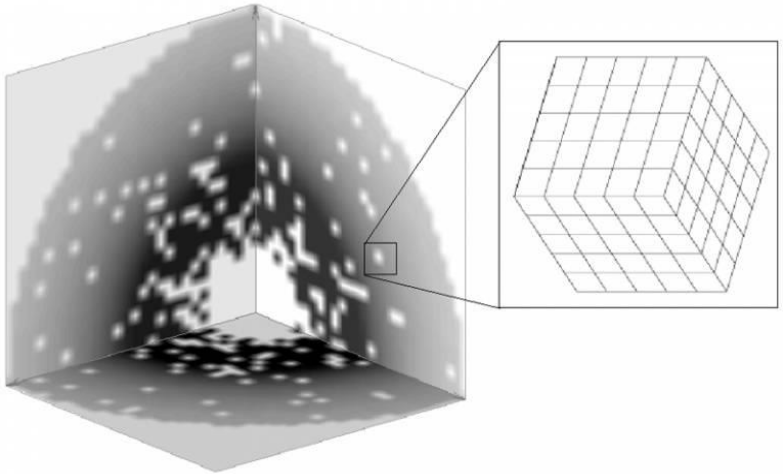
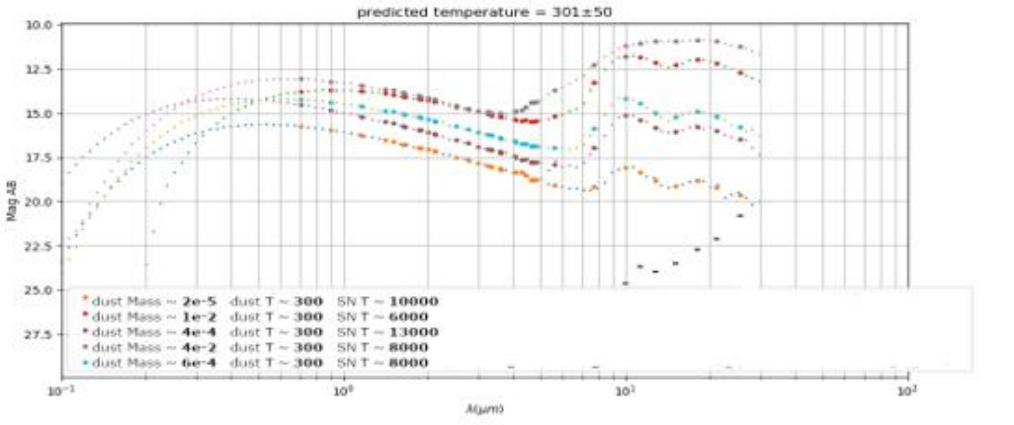
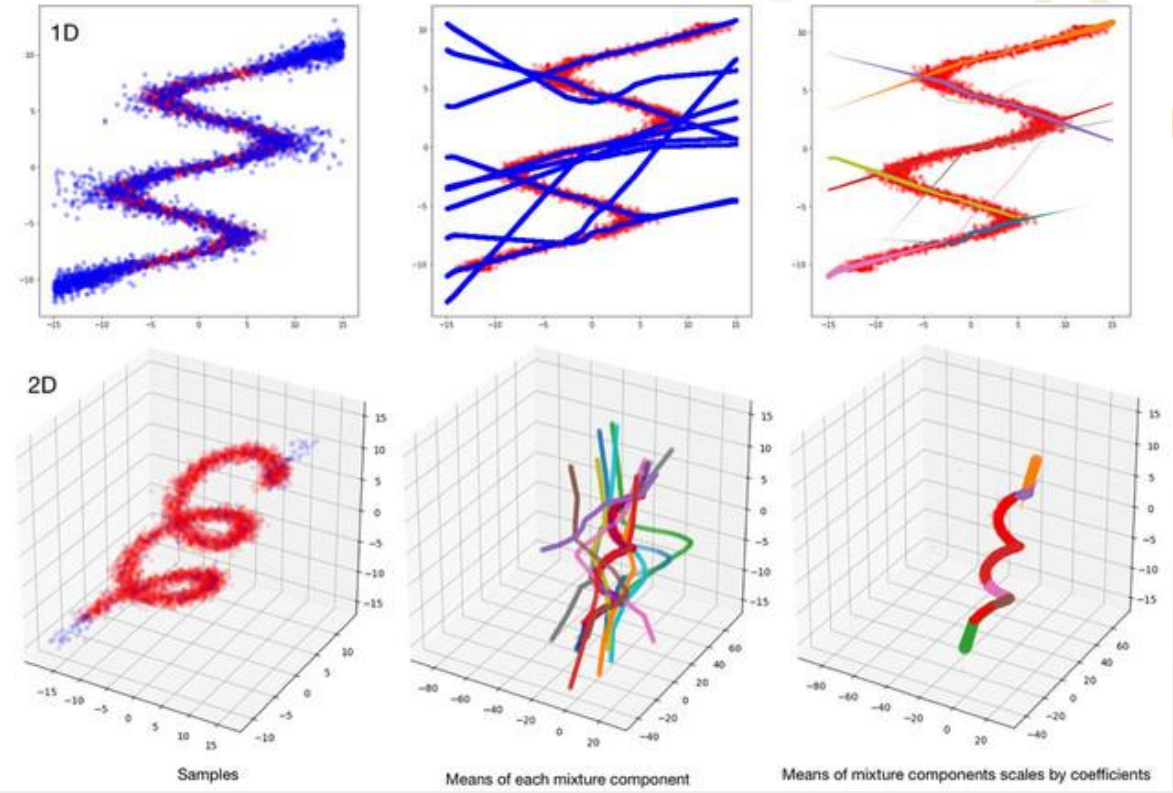


3D representative of supernova ejecta model



Mixture Density Network



$$E(\boldsymbol{w}) = -\sum_{n=1}^{N} \ln \left\{ \sum_{k=1}^{K} \pi_k(\boldsymbol{x}_n, \boldsymbol{w}) \mathrm{N}(\mathrm{t} \mid \mu_k(\boldsymbol{x}_n, \boldsymbol{w}), \sigma_k^2(\boldsymbol{x}_n, \boldsymbol{w})) \right\}$$

https://github.com/cpmpercussion/keras-mdn-layer

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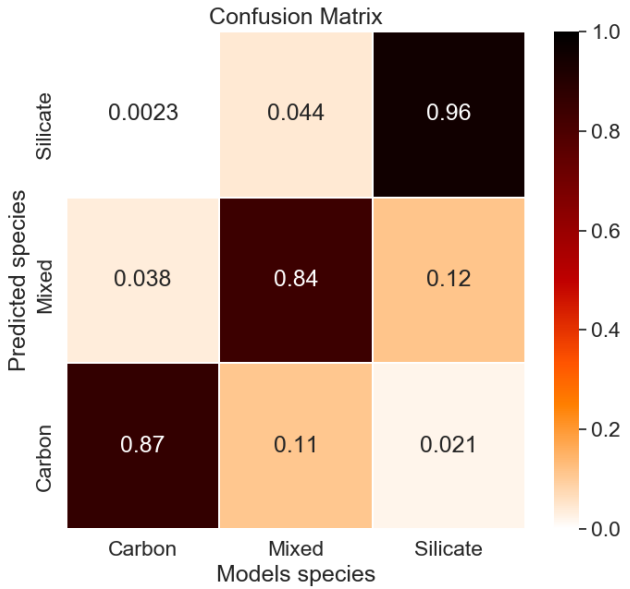
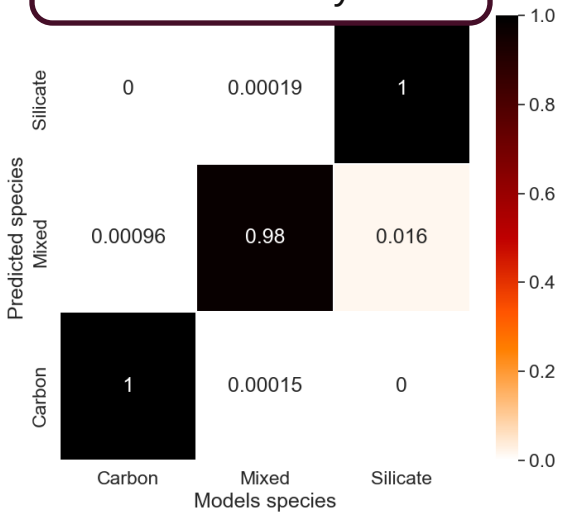
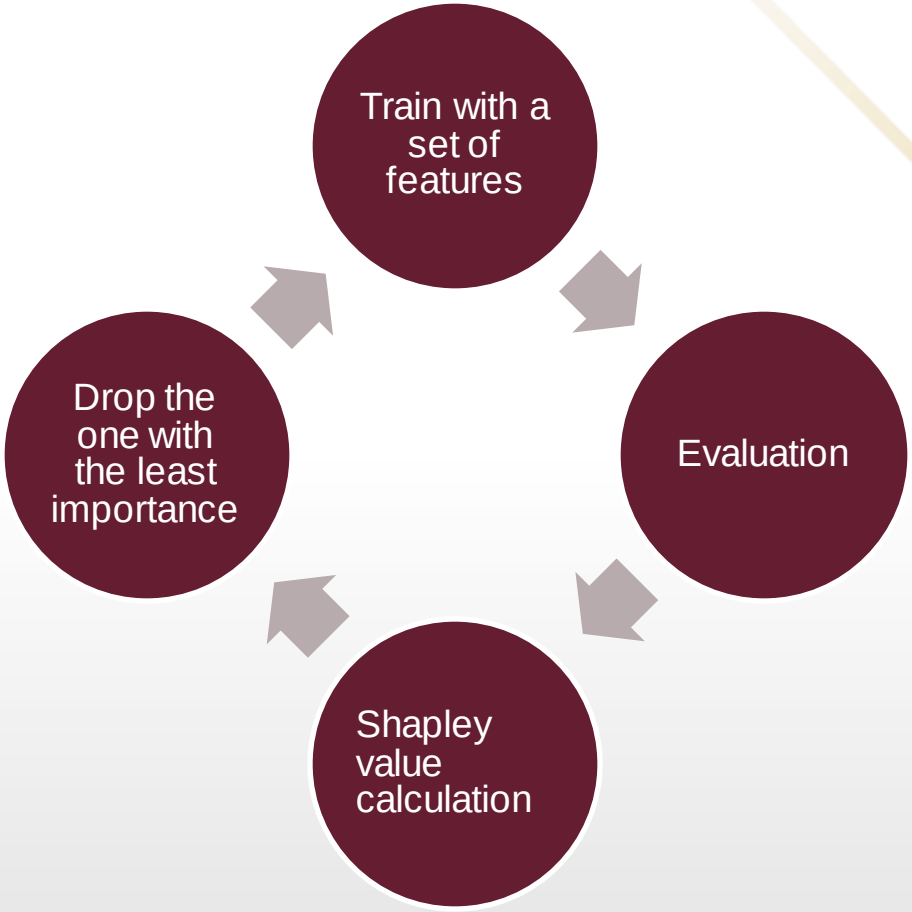
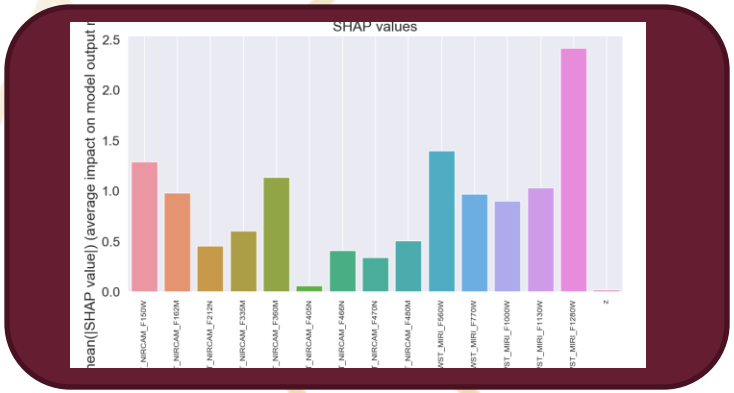


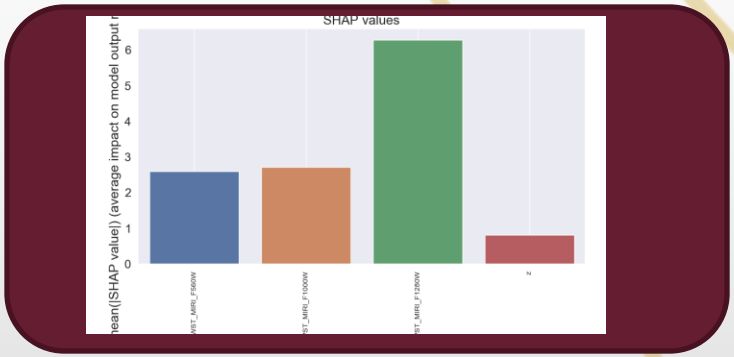
Estimates with low uncertainty



Recursive feature elimination







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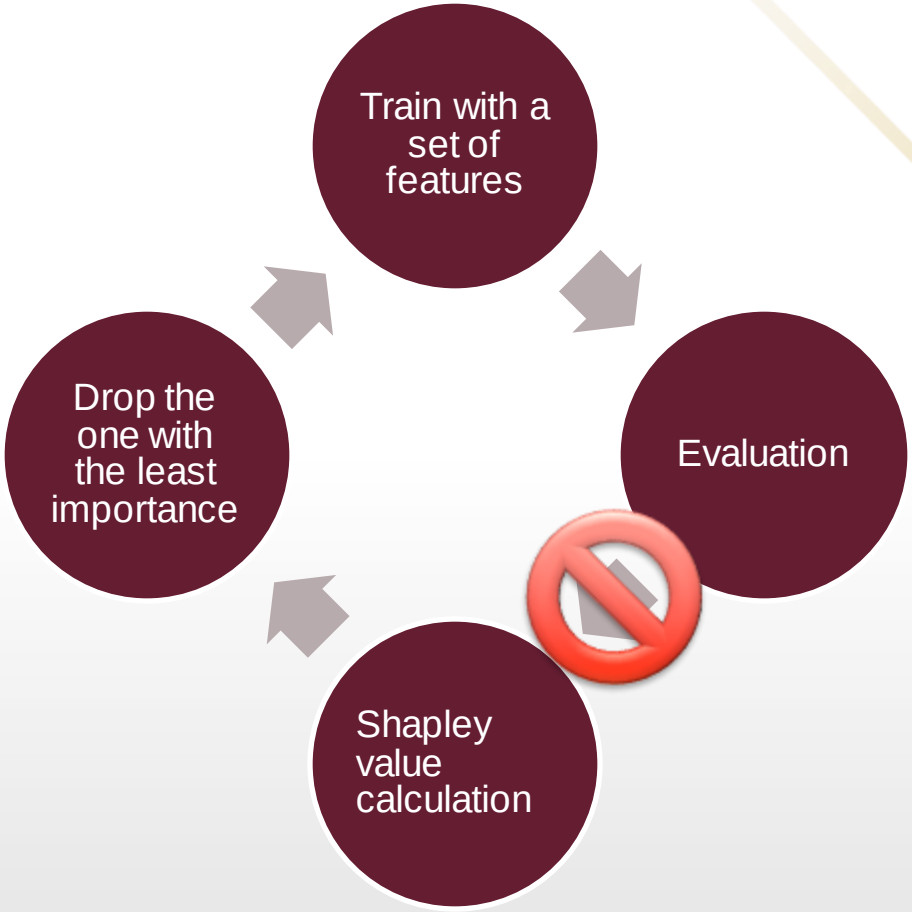
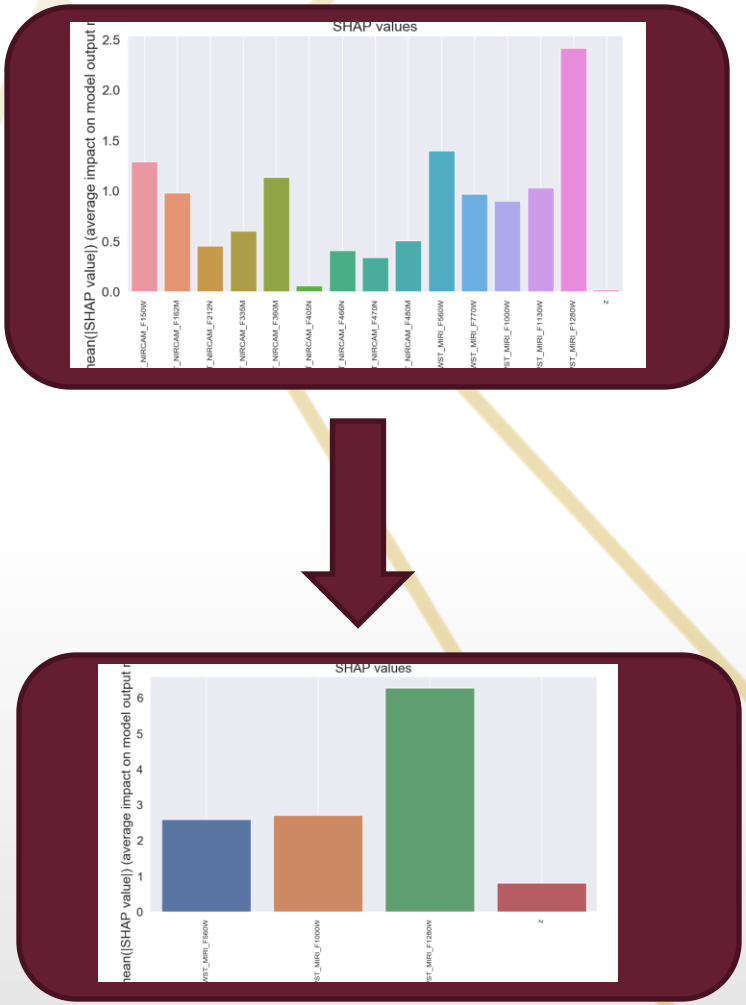
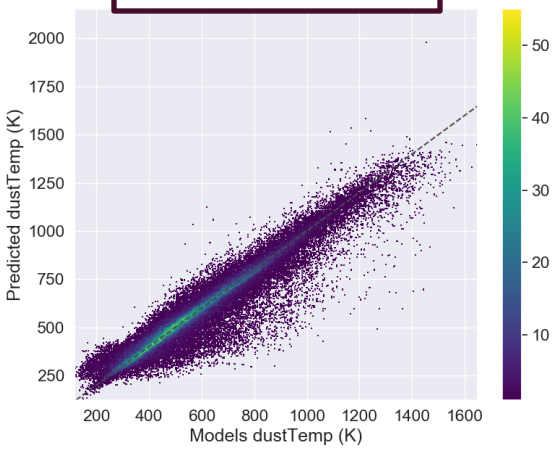


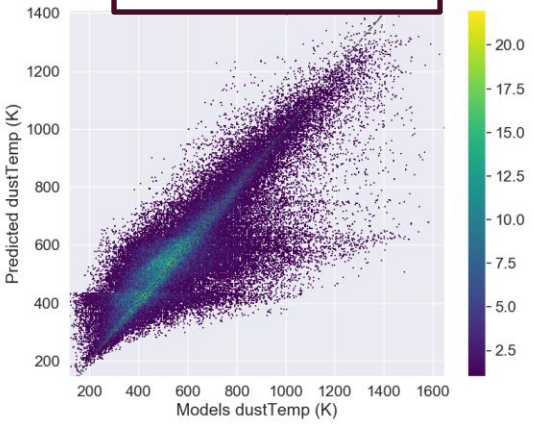


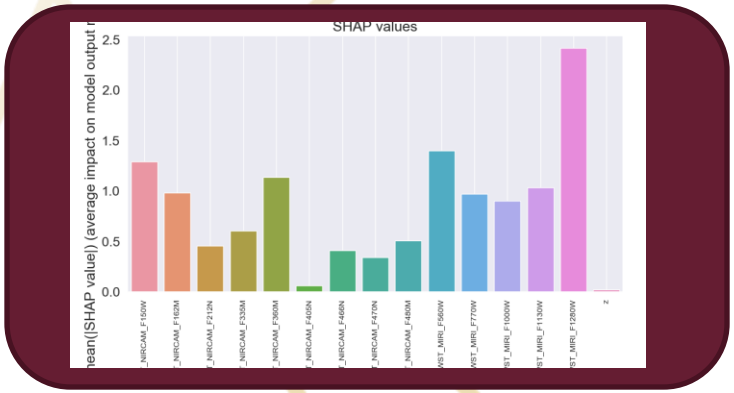
Recursive feature elimination

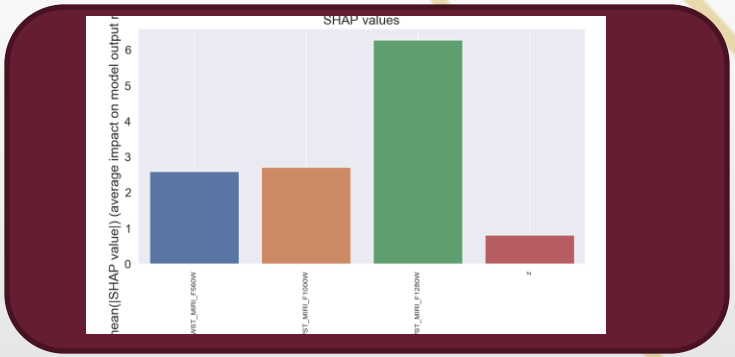
15 features



4 features





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