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PLATAFORMA TECNOLÓGICA DE ENERGÍA NUCLEAR DE FISIÓN

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# Cross-checking of Experimental and Evaluated Nuclear Databases

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“Outlier detection techniques to EXFOR and Evaluated Nuclear Databases”

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## ❖ EXFOR – Identifying outliers

### □ Data Mining – EXFOR and ENDF

- MF3/MT1, MT2 ... MT207 (gas production)
- Angular distribution: MF4/MT2
- Isotopes and natural elements

### □ Assessing Outlier Detection Techniques

- DBSCAN
- Multivariate normal distribution
- Distance-based technique

See JEF/DOC-1778 (*G. Berton, "Verification of the databases EXFOR & ENDF", 2016*)

```
./EXFOR.ALL/
  001_H_000.c4
  001_H_001.c4
  ...
  100_Fm_257.c4
```

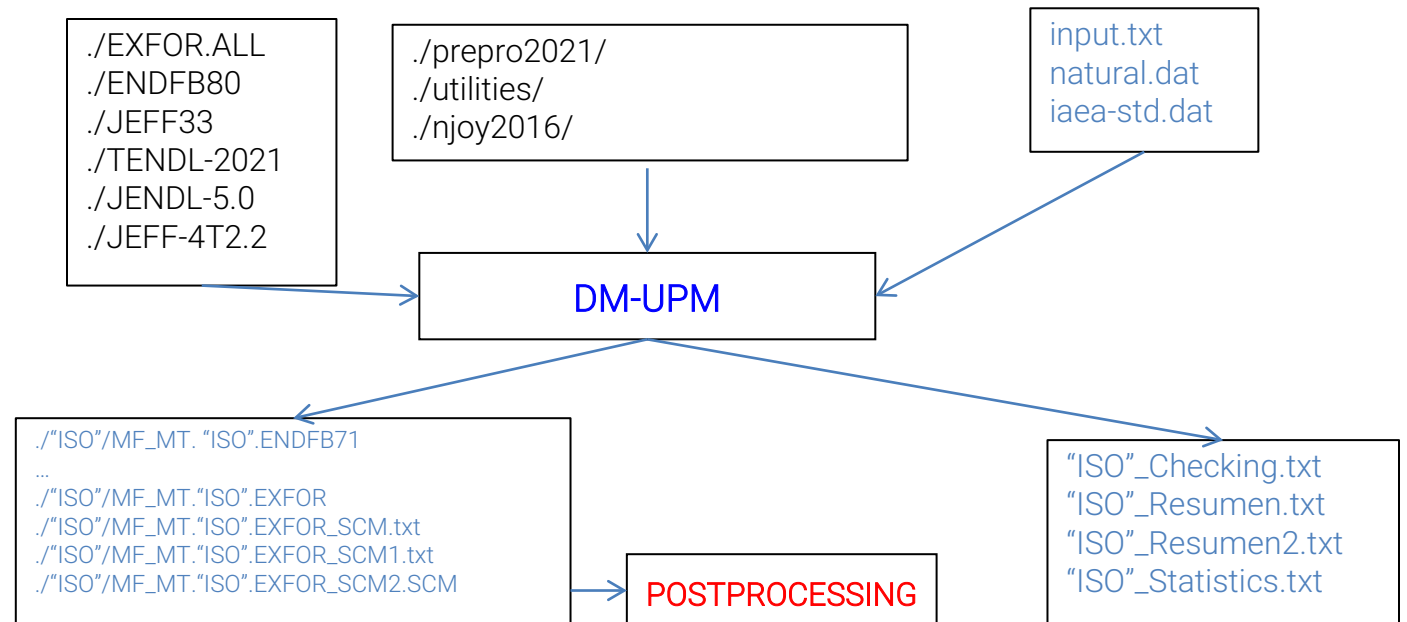
(601 Files)

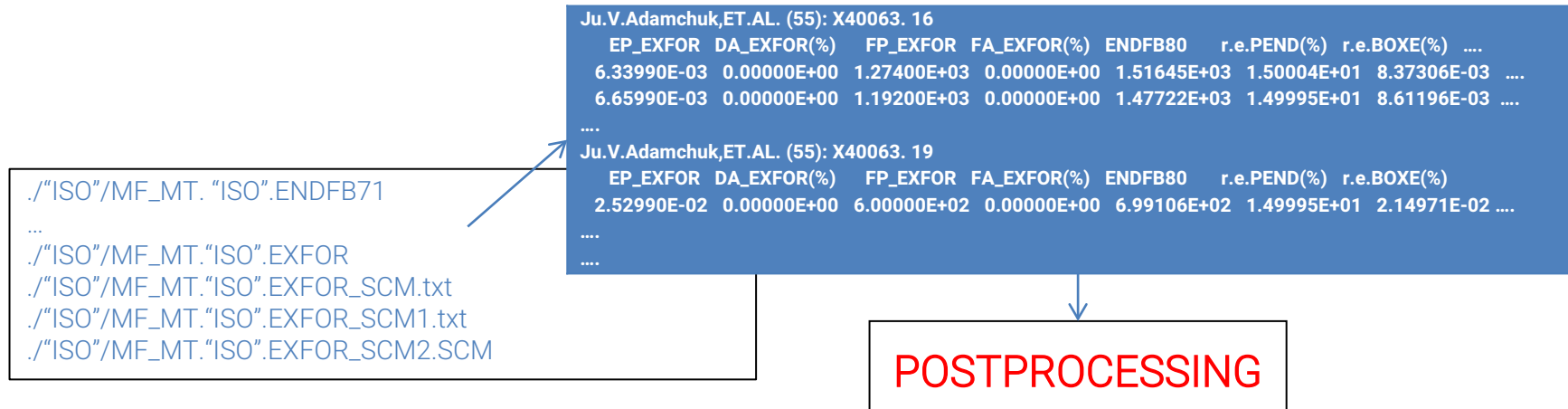
**ENDF Files**

```
./ENDFB80/
  (557 Files)
./JEFF33/
  (562 Files)
./TENDL-2021/
  (2813 Files)
./JENDL-5.0/
  (795 Files)
./JEFF-4T2.2/
  (564 Files)
```

RUN: `.\python.exe parseC4.py C4-2023-02-28.xc4`  
 start with .xc4 file containing full EXFOR library in one file  
 (obtain latest from <http://www-nds.iaea.org/x4toc4-master/?C=M;O=D>)  
 (Thanks to Viktor Zerkin)

## Data Mining - UPM: Flowchart





The set of **reactions** analyzed:

- MF3 (cross-sections) for all isotopes and natural elements, (except MT51 for natural elements)
- MF3/MT251 ( $\mu$ -bar = average cosine from angular distributions)
- MF3/MT203-207 (gas production cross-sections)
- MF4/MT2 (angular distribution - (n,elastic) ) for isotopes (except for natural elements)
- MF10 for branching ratio reactions for isotopes

## EXPERIMENTAL DATA

EXFOR

## EVALUATED DATA

ENDF, JEFF...

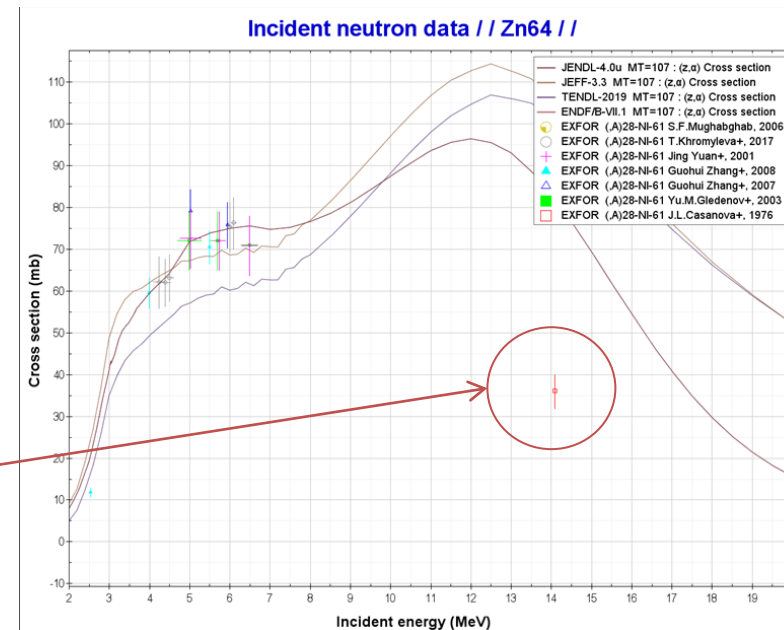
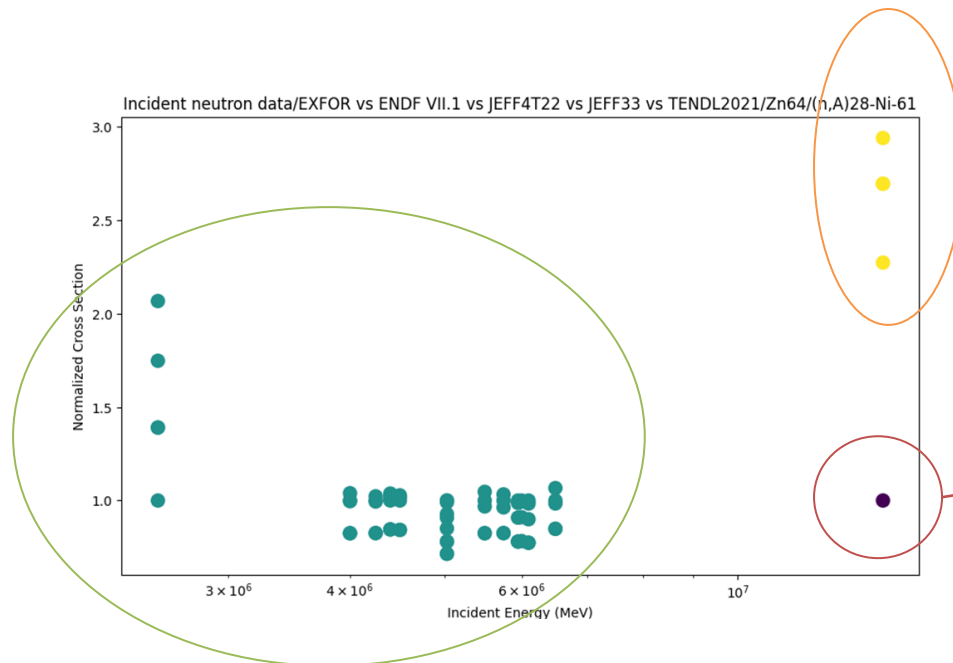
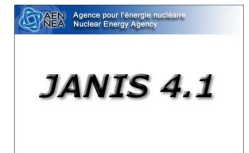
Data Mining  
 Comparison of data for a set of entries

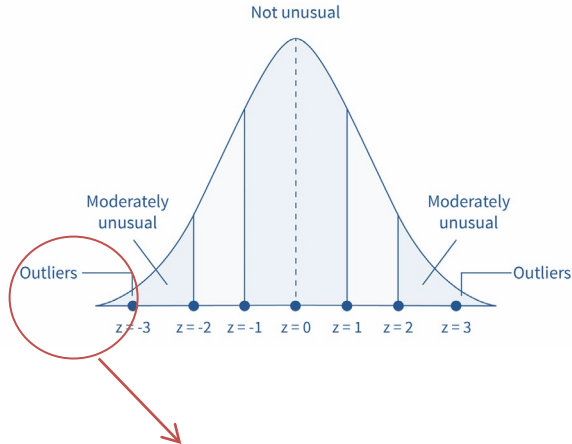
## MACHINE LEARNING

DBSCAN

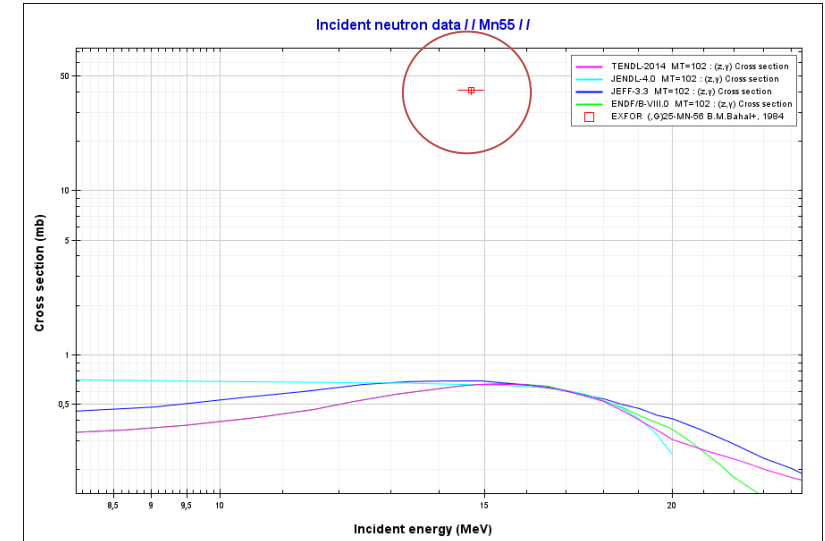
*Density Based Spatial Clustering of Applications with Noise*

## POTENTIAL OUTLIERS



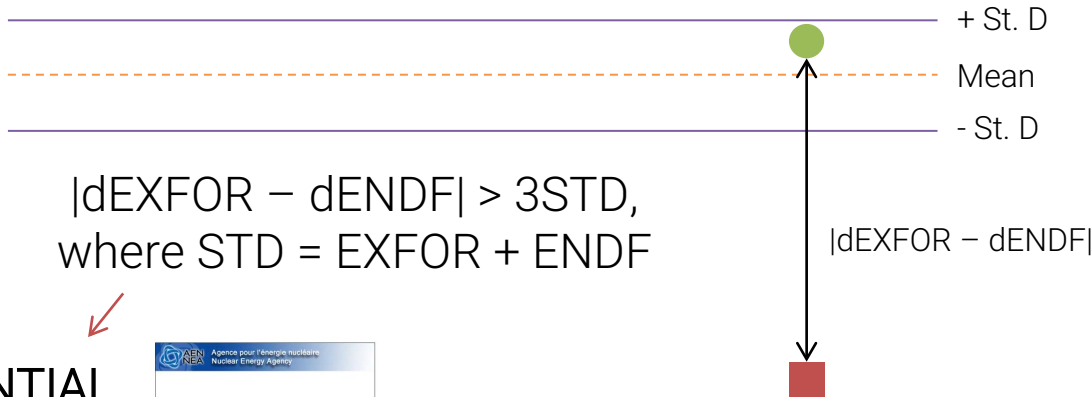


POTENTIAL  
OUTLIERS

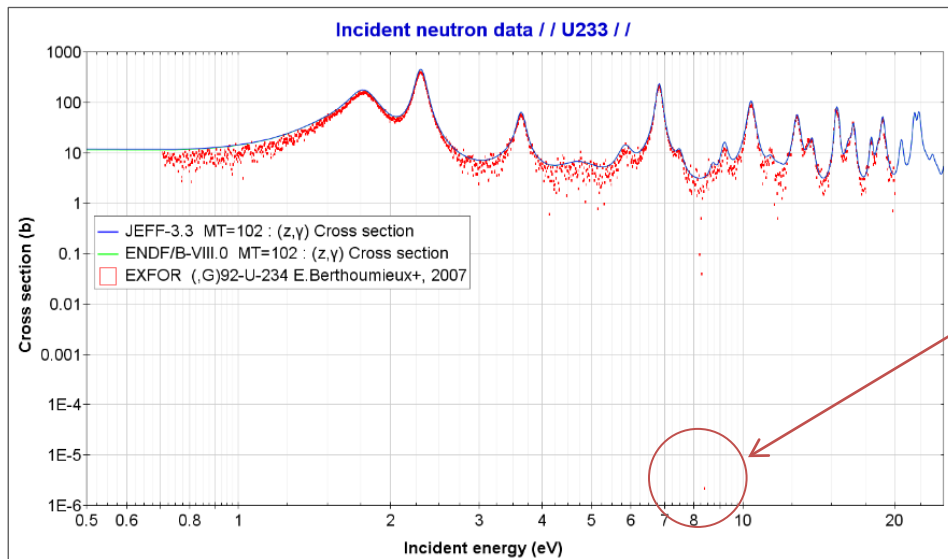
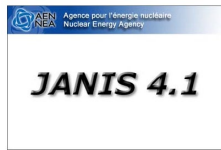


- ❑ Procedure: fit a multivariate normal distribution to the dataset, compute the probability of each point, and flag the points whose probability is low.
- ❑ An outlier is a value whose probability is unexpectedly small, this is a point far from the mean, in either direction.

# Distance-Based Technique



POTENTIAL  
OUTLIERS



**Table 1.** List of EXFOR (MT102 – (n,gamma)) entries identified as potential outliers using distance EXFOR-ENDF technique

Element	MF	MT	Pts	EXFOR	dEXFOR	dLIBS
029_Cu_065	3	102	264	X14571.002	2347.41	8.94
042_Mo_095	3	102	47	X41233.002	721.56	2.86
053_I_127	3	102	22968	X22869.004	206143.22	5.48
053_I_127	3	102	18830	X22869.002	46902.61	7.29
053_I_127	3	102	23888	X22869.003	49663	5.68
053_I_129	3	102	21919	X22868.002.1	56399.12	11.84
053_I_129	3	102	22489	X22868.002.2	51797.55	11.85
069_Tm_171	3	102	136	X14128.003	669.97	7.74
071_Lu_173	3	102	9871	X14410.004	2892.91	80.44
<b>092_U_233</b>	<b>3</b>	<b>102</b>	<b>1451</b>	<b>X23071.004</b>	<b>91879.99</b>	<b>4.53</b>
092_U_235	3	102	32	X40070.039.2	510.35	2.48
092_U_235	3	102	6	X14230.002	2088.82	28.68
093_Np_237	3	102	20040	X23745.002	838.98	14.46
095_Am_241	10	102	8	X30021.002	4404512	28.83
095_Am_241	10	102	8	X30021.002	938364.62	57.17
095_Am_243	10	102	13	X30034.002	16701840	56.86

- ❑ As a result of the application of the above-mentioned techniques:

## Isotopes

- 526 EXFOR-C4s files successful processed
  - DM-UPM failed in sixtab code - Hg200/Hg204
- 207 599 subentries
- 4 398 164 EXFOR energy-points
- 122 Subentries TO BE CHECKED

## Natural Elements

- 72 EXFOR-C4s successful processed
  - DM-UPM failed in sixtab code - Hg000
- 4 288 Subentries
- 1 125 858 EXFOR energy-points
- 17 Subentries TO BE CHECKED

- ❑ Our work to be continuing ... *J. Antonio Monleón, Master Thesis Project, 2023*



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Thank you for your attention