

# SciGRID\_gas: Attribute value generation

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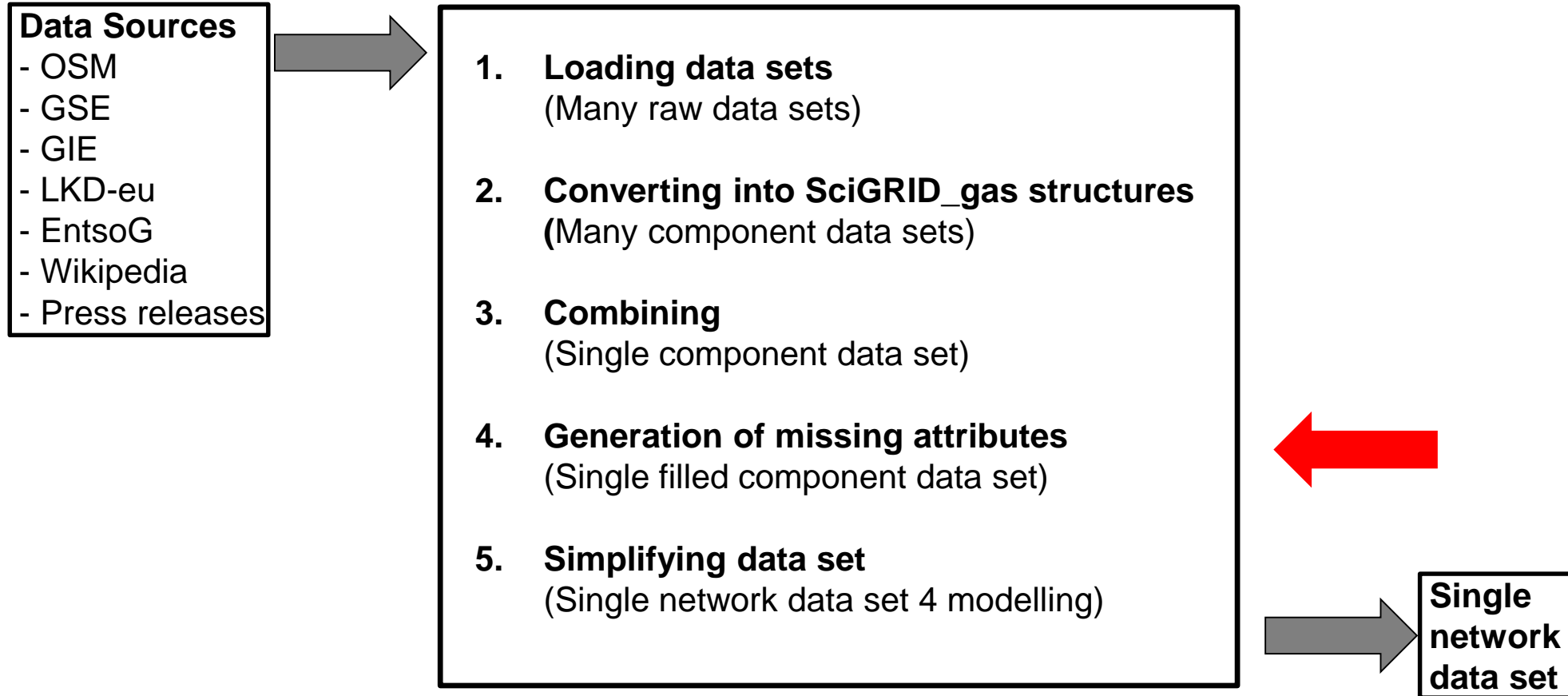
DLR Institute of Networked Energy Systems



Knowledge for Tomorrow



# Pathway



# Methods of attribute generation

## Physical based methods

- Pipe capacity  $\sim$  diameter<sup>2</sup> \* max pressure
- Directionality of gas flow

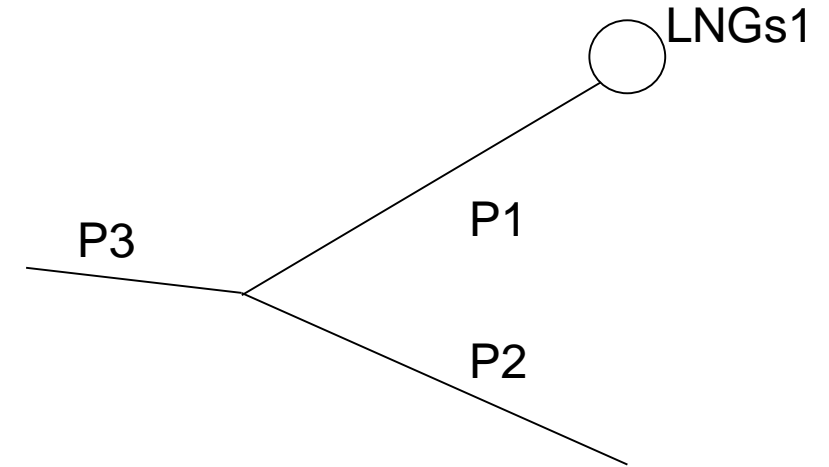
## Statistical based method

- Any parameter can be related to any other parameter (in each element)



# Pre-processing of components

- Copying attributes between elements
  - **Pipe**(pipe\_class\_Emap) → **compressor**(pipe\_class\_EMap)
    - Pipe\_pipe\_class\_EMAP
  - **Pipe**(max\_cap) → **compressor**(max\_cap)
    - Pipe\_max\_cap
  - **LNG**(max\_cap\_store2pipe) → **pipe**(max\_cap)
    - LNG\_max\_cap
  - **Compressor**(max\_pressure) → **pipe**(max\_pressure)
    - Comp\_max\_pressure

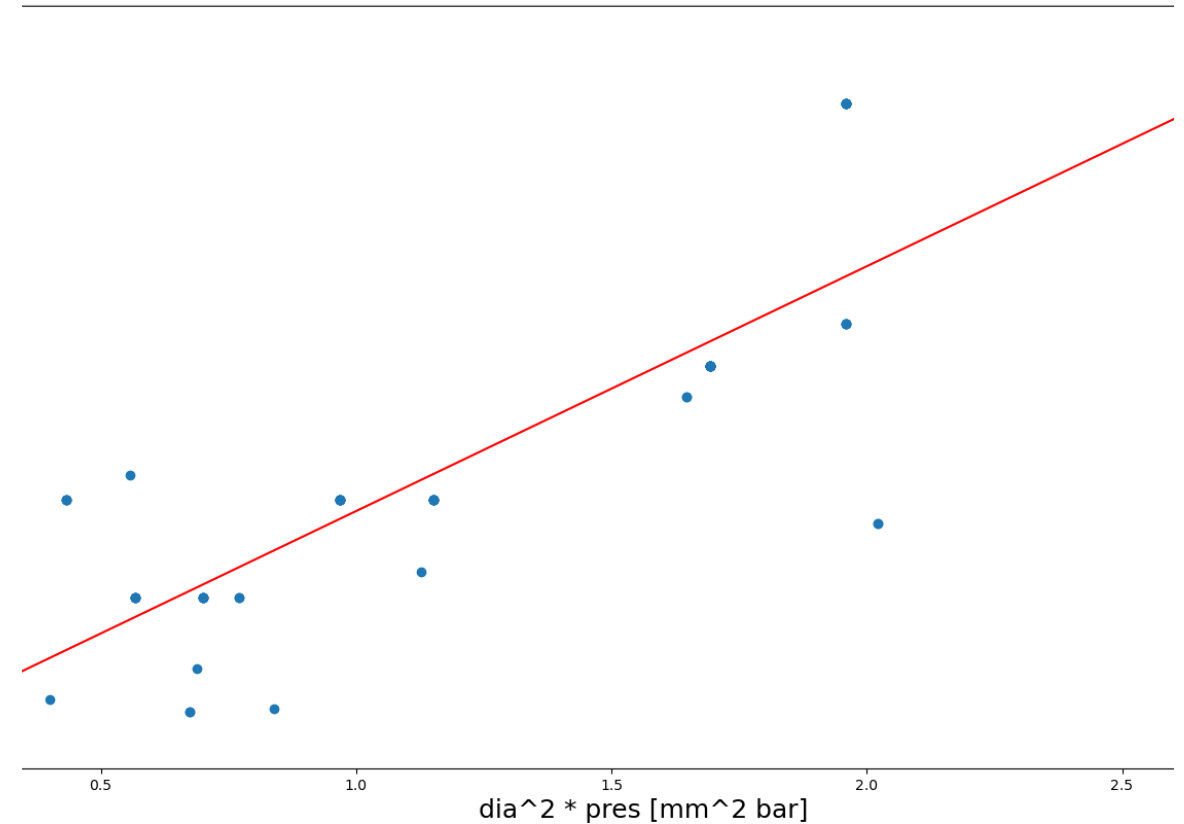


	A	B	C	D	E
1	<b>Comp_Source</b>	<b>Attrib_Source</b>	<b>Comp_Destination</b>	<b>Attrib_Destination</b>	<b>FillMethod</b>
2	PipeSegments	pipe_class_EMap	Compressors	Pipe_pipe_class_EMap	fill
3	PipeSegments	pipe_class_EMap	Storages	Pipe_pipe_class_EMap	fill
4	PipeSegments	diameter_mm	Consumers	Pipe_diameter_mm	fill
5	PipeSegments	max_pressure_bar	Consumers	Pipe_max_pressure_bar	fill
6	PipeSegments	max_cap_M_m3_per_d	Consumers	Pipe_max_cap_M_m3_per_d	fill
7	PipeSegments	pipe_class_EMap	LNGs	Pipe_pipe_class_EMap	fill
8	Consumers	est_generation_GWh	PipeSegments	Consumers_est_generation_GWh	fill
9	Consumers	capacity_E_MW	PipeSegments	Consumers_capacity_E_MW	fill
10	Consumers	capacity_TH_MW	PipeSegments	Consumers_capacity_TH_MW	fill



# Physical based heuristics (N = 74)

- Pipe capacity  $\sim$  diameter<sup>2</sup> \* max pressure
  - $r^2$  = 0.77
  - Ave (%-diff) = 37%
- Pipe Diameter<sup>2</sup>  $\sim$  pipe capacity / max pressure
  - $r^2$  = 0.63
  - Ave (%-diff) = 29%
- Max pressure  $\sim$  pipe capacity / pipe diameter<sup>2</sup>
  - $r^2$  = 0.32
  - Ave (%-diff) = 14%

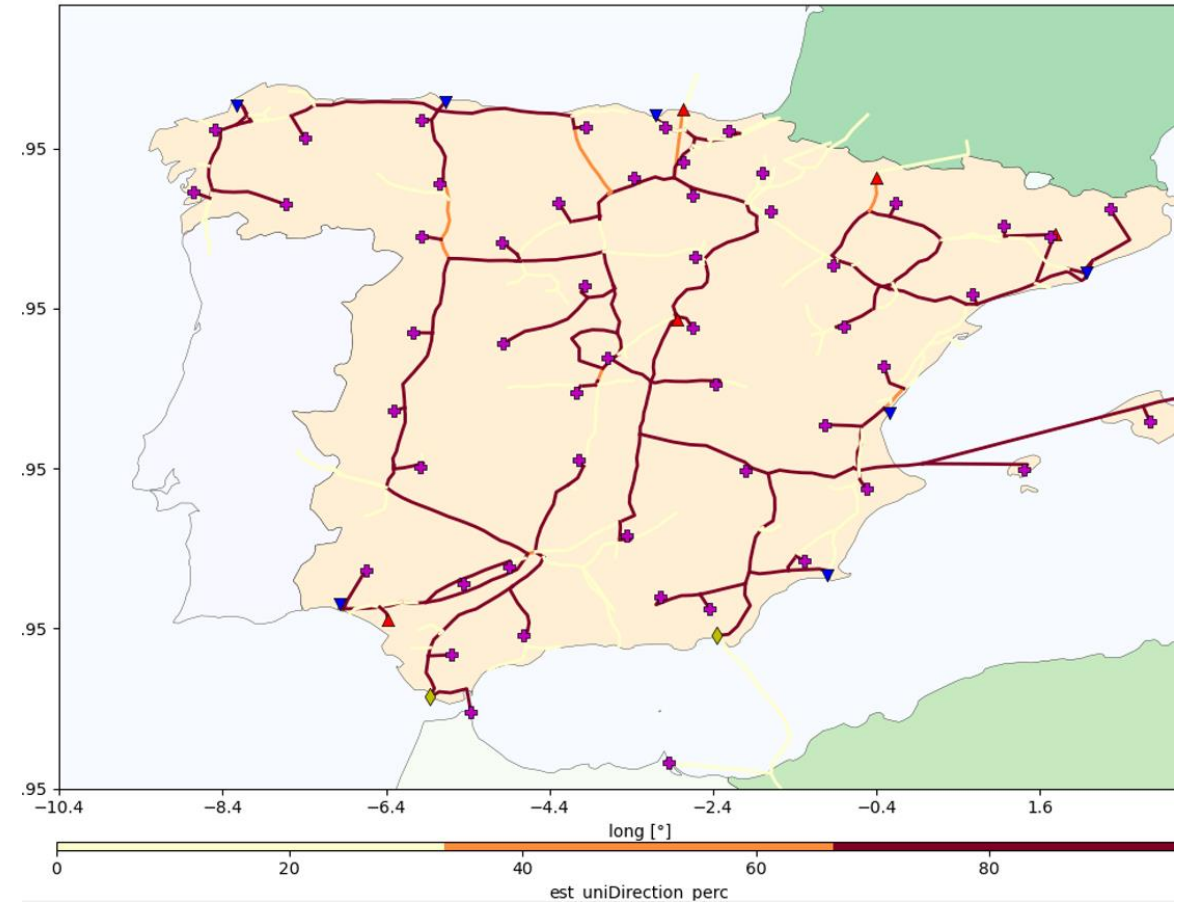




# Physical based heuristics

- Pipeline flow direction

- Sinks
  - Consumers
- Source
  - LNGs
  - Productions
- Sink & Source
  - Storages
- Pipeline capacity
- LNG/storages/border point capacities
- Summer/winter simulation
- Shortest path



# Statistical based heuristics

## Approach

- Selection which attribute to be independent
- Selection which attribute to be estimated
- Within component relate attributes
- 1, 2, 3,... independent attributes

## Regression methods

- Linear
- Logistic
- Min
- Max
- Median
- Mean



# Possible statistical methods

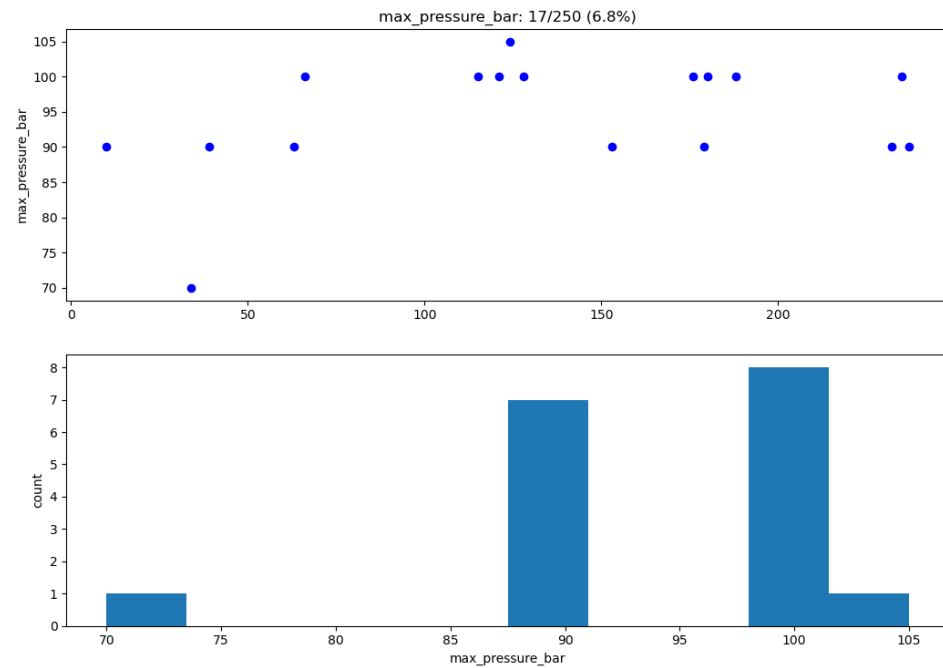
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	CompName	AttribName	NumElemen	ModelName	NumFeatures	FeatureNames	Plots	NumSample	NumFill	BIC	MeanAbsErr	R_2	R_2_adj
2	Compressors	max_cap_M_m3_per_d	250	Lasso	2	["turbine_power_3_MW", "Pipe_diameter_mm"]	../StatsData/	6	28	33.5257237	9.07719747	0.65558074	0.4259679
3	Compressors	max_cap_M_m3_per_d	250	Lasso	2	["max_power_MW", "turbine_power_1_MW"]	../StatsData/	12	50	63.7278772	9.50118089	0.68939559	0.62037239
4	Compressors	max_cap_M_m3_per_d	250	Lasso	2	["max_power_MW", "turbine_power_2_MW"]	../StatsData/	12	48	63.7278772	9.50118089	0.68939559	0.62037239
5	Compressors	max_cap_M_m3_per_d	250	Lasso	2	["max_power_MW", "num_turb"]	../StatsData/	12	50	63.6390845	9.60292992	0.69168539	0.62317104
6	Compressors	max_cap_M_m3_per_d	250	Median	1	["max_cap_M_m3_per_d"]	../StatsData/	18	232	152.793614	39.5306667	-0.12793029	-0.19842593
7													
8	Compressors	max_power_MW	250	Lasso	2	["num_turb", "turbine_power_2_MW"]	../StatsData/	36	0	122.217754	3.06604583	0.95798504	0.95543868
9	Compressors	max_power_MW	250	Lasso	2	["num_turb", "turbine_power_1_MW"]	../StatsData/	37	0	134.882645	3.64405705	0.94783577	0.94476729
10	Compressors	max_power_MW	250	Lasso	2	["num_turb", "turbine_power_3_MW"]	../StatsData/	24	0	92.6994375	3.99098757	0.93391806	0.92762454
11	Compressors	max_power_MW	250	Lasso	2	["num_turb", "turbine_power_4_MW"]	../StatsData/	9	0	38.0651123	4.65099348	0.85722233	0.80962978
12	Compressors	max_power_MW	250	Median	1	["max_power_MW"]	../StatsData/	41	209	322.968678	26.5286734	-0.05904622	-0.08620125
13													
14	Compressors	max_pressure_bar	250	Lasso	2	["max_cap_M_m3_per_d", "Pipe_max_pressure_bar"]	../StatsData/	8	8	25.2375843	3.37826197	0.40518191	0.16725467
15	Compressors	max_pressure_bar	250	Lasso	2	["max_cap_M_m3_per_d", "Pipe_max_cap_M_m3_per_d"]	../StatsData/	8	8	29.0496275	4.57210937	0.04208311	-0.34108365
16	Compressors	max_pressure_bar	250	Lasso	2	["max_cap_M_m3_per_d", "Pipe_diameter_mm"]	../StatsData/	8	8	29.0496275	4.57210937	0.04208311	-0.34108365
17	Compressors	max_ressure_bar	250	Lasso	2	["max_cap_M_m3_per_d", "turbine power 3 MW"]	../StatsData/	8	0	29.2816686	4.65265084	0.01389173	-0.38055158



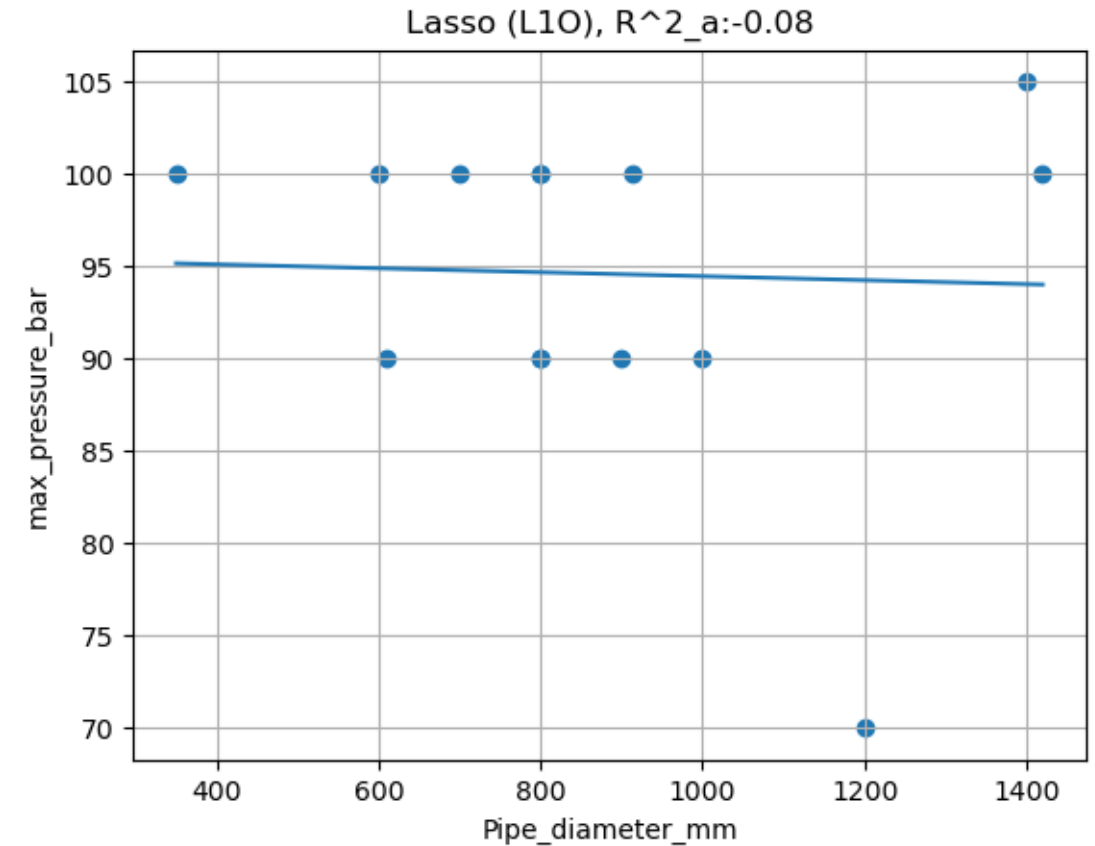


# Inspection of heuristic process

## Histogram plots

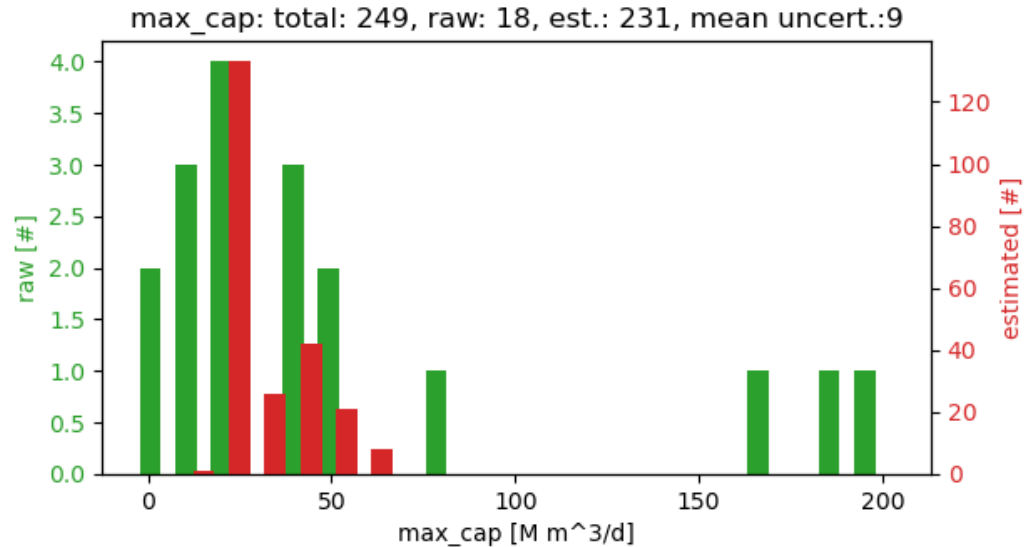


## Attribute relation plots



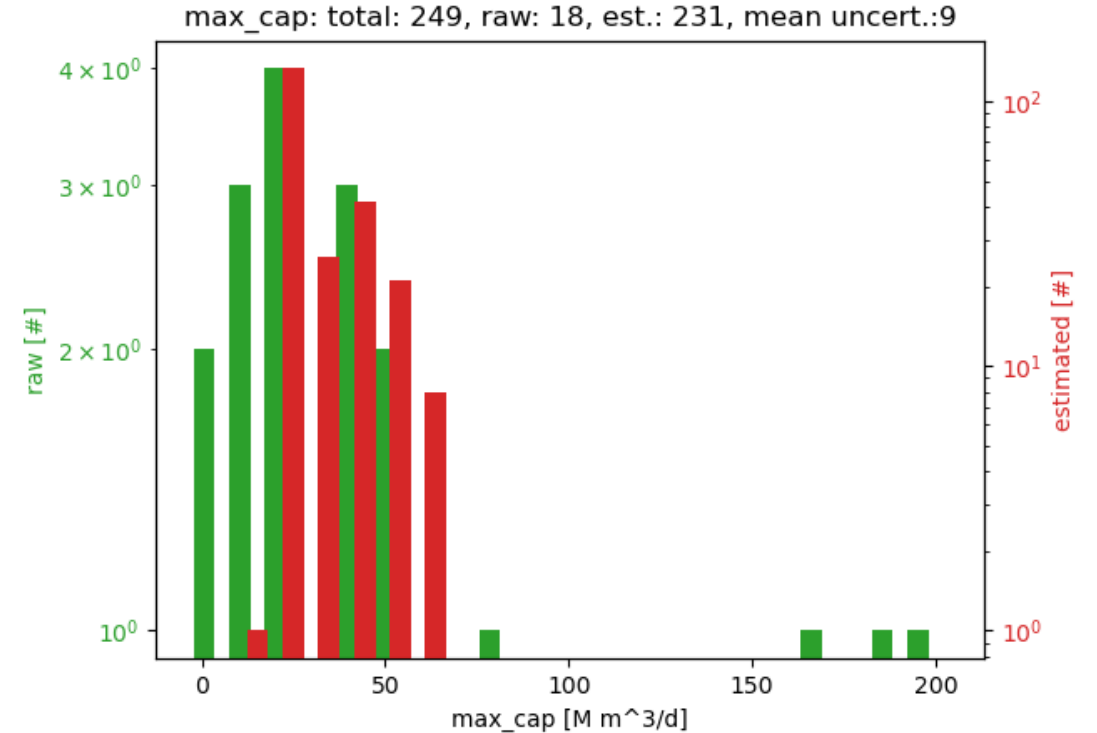
# Inspection of heuristic process

## Distribution of Raw and estimated values



Lasso(turbine\_power\_3\_MW, Pipe\_diameter\_mm): 99 (mean uncert.: 9)  
 Lasso(max\_power\_MW, turbine\_power\_1\_MW): 132 (mean uncert.: 10)  
 min(raw):5.52, max(raw):199.99, min(est):11.0, max(est):64.25

## Log representation



# Checking generated attribute values

- Compressor:

- $70 < \text{max\_press\_bar} < 200$ 
  - Replacing value with min or max
  - Setting new uncertainty value

- LNGs

- $1 < \text{max\_workingGas\_M\_m3} < 1000$ 
  - Replacing value with min or max
  - Setting new uncertainty value

	CompName	AttribName	MinVal	MaxVal	UncVal
1	Compressors	max_pressure_bar	70	200	50
2	Compressors	turbine_power_1_MW	0	50	25
3	Compressors	turbine_power_2_MW	0	50	25
4	Compressors	turbine_power_3_MW	0	50	25
5	Compressors	turbine_power_4_MW	0	50	25
6	Compressors	max_cap_M_m3_per_d	5	200	50
7	Compressors	max_power_MW	2	300	100
8	Consumers	capacity_E_MW	2	5000	1000
9	Consumers	capacity_TH_MW	12	2600	1000
10	Consumers	est_generation_GWh	5	26000	10000
11	LNGs	max_cap_store2pipe_M_m3	1	100	50
12	LNGs	max_workingGas_M_m3	2	1000	400
13	LNGs	median_cap_store2pipe_M_m3	2	100	50
14	PipeSegments	diameter_mm	60	1600	500
15	PipeSegments	max_cap_M_m3_per_d	2	200	50
16	PipeSegments	max_pressure_bar	10	220	100
17	Productions	max_supply_M_m3_per_d	1	4000	1000
18	Storages	max_cushionGas_M_m3	1	60000	20000
19	Storages	max_power_MW	1	500	100
20	Storages	max_storage_pressure_bar	12	600	200
21	Storages	min_storage_pressure_bar	1	600	200
22	Storages	num_storage_wells	1	1800	500
23	Storages	max_cap_pipe2store_M_m3	1	270	100
24	Storages	max_cap_store2pipe_M_m3	1	270	100
25	Storages	max_workingGas_M_m3	10	50000	10000
26					



# Results of heuristic processes

## PipeSegments

Attrib Name	N(R)	N(E)	Mean	Med	P(10)	P(90)	MAE(E)	Z
diameter_mm	768	1291	980.92	964.55	800	1219	132	0.84
max_cap_M_m3_per_d	310	1749	48	42	15	79	22	3.62
max_pressure_bar	557	1502	77	75	70	83	6.15	0.95
is_bothDirection	194	1865	0.0563	0	0	0	0.5	17



# Questions?

