Prediction of Avalanche Danger Levels with Meteorological Data

Overview and Concept

DATA SET 1
13'918 Recorded Snow Avalanches 1999-2019

DATA SET 2
Weissfluhjoch Meteorological and snowpack measurements

Data Combination and Analysis

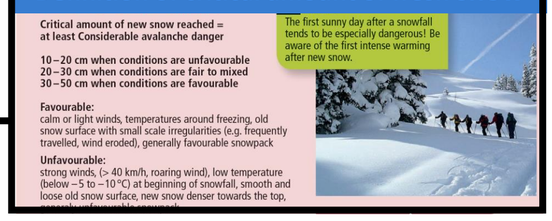
Module 3 – Project

Prediction of Avalanche Danger Levels with Meteorological Parameters

Module 2 – Project

Investigate the Influence of Meteorological Parameters on the Number of Avalanches

Recommendation for ski touring
Definition of critical amount of fresh snow



Criteria used to split data into 2 classes

Critical Fresh Snow = 1

10 to 25 cm *Snow fall* with "Unfavorable conditions"
Wind max > 40km/h **OR** *Temp min* < -7.5 degree C

OR

More than 25cm *Snow fall*

Critical Fresh Snow = 0

10 to 25 cm *Snow fall* with "favorable conditions"
Wind max < 40km/h **AND** *Temp min* > -7.5 degree C

OR

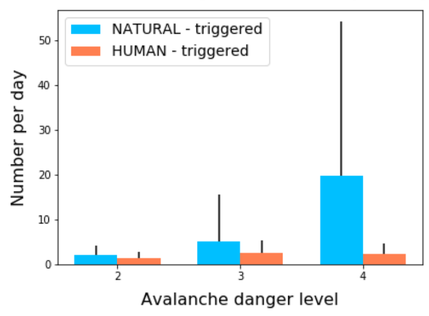
Less than 10 cm of *Snow fall*

Data Available in the Avalanche Dataset

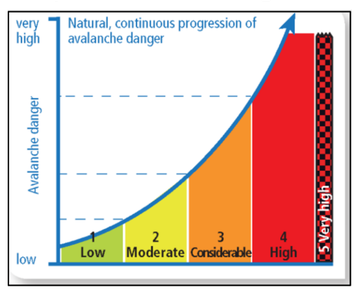
	Date	Snow_type	Trigger_type	Avalanche_size_m2	Avalanche_danger_level
11394	2017-03-10	wet	EXPLOSIVE	7,022.0	4
11395	2017-03-10	dry	EXPLOSIVE	9,953.0	4
11396	2017-03-10	dry	NATURAL	3,306.0	4
11397	2017-03-10	dry	EXPLOSIVE	10,339.0	4
11398	2017-03-10	dry	HUMAN	3,925.0	4
11399	2017-03-10	dry	NATURAL	1,411.0	4

3 avalanches triggered artificialy, for security reasons
2 avalanches triggered by natural causes
1 avalanche triggered by human causes
1 "wet" snow avalanche
5 "dry" snow avalanches

Number of "dry" avalanches per day



European Avalanche Danger Levels

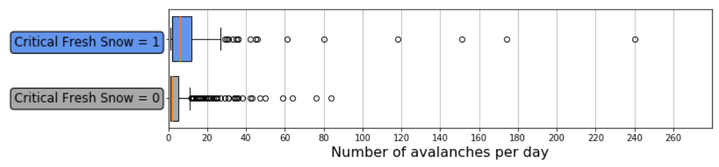


➔Number of NATURAL triggered avalanches per day increases with the danger level
➔Number of HUMAN triggered avalanches per day slightly decrease with danger level 4

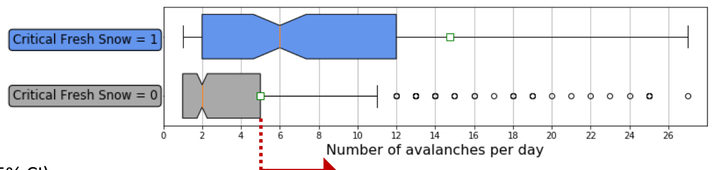
Influence of Fresh Snow/Meteorological Parameters on Avalanches

Box plot to compare the distributions

- **High number of avalanches per day**
  - Max number per day = 240



- **Median = 6 for *Critical Fresh Snow* = 1**
- **Median = 2 for *Critical Fresh Snow* = 0**
- **No overlap of the notches**
  - The 2 medians are not the same (with 95% CI)



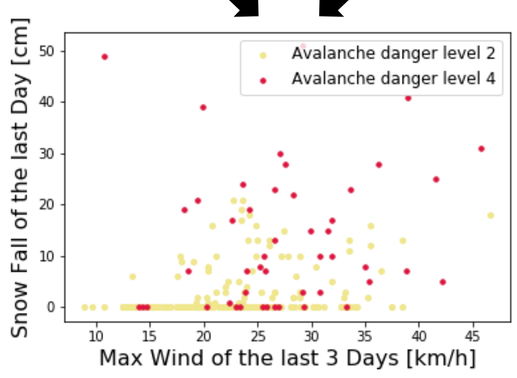
- **Critical Fresh Snow = 0**
  - 25% of the time: more than 5 avalanches per day
  - up to max 85 avalanches per day
  - **➔Still high risk of avalanches with Critical Fresh Snow = 0**
  - **➔Other parameters play a role?**
  - Unfavorable snow surface before the snow fall has an influence on the number of avalanches

Filtering of avalanche danger levels with meteorological parameters

- **Filtering possibilities….**

- **Statistical tests performed on those distribution**
  Max Wind tested for normality with D Agostino-Pearson
  Max Wind is normal for Avalanche Danger Level 4
  The 2 other ***Max Wind*** distributions reject H0 with p<=0.01

- **Scatter plot, possible filtering of the 2 avalanche danger level classes**
  Avalanche danger level 2 | Avalanche danger level 4
  Some visible separation



Conclusion and Outlook for Project Module 3

Conclusion Project Module 2

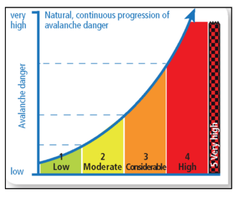
- **Number of avalanche occurring per day:**
  ➔Consistent with definition of European avalanche danger level
- ***Binary Variable - Critical Fresh Snow*** **(Snow/wind/temperature)**
  ➔Influence on the number of avalanches occurring per day
- **LOCAL parameters play an important role**
  ➔Meteorological parameter
  ➔Snow surface condition before a snow fall
  ➔Snowpack composition
  ➔Topological parameters where the avalanche occurs (Slope steepness, orientation, altitude,…)

Prediction of Avalanches Danger Levels

- **Total 699 rows available**
  ➔Only 48 rows Avalanche Danger Level 4
  ➔Not only snow/wind/temp data, but also relative humidity, incoming radiation, outgoing radiation, …

Avalanche_risk_level	Snow_fall_1	Wind_max_3	Temp	RH	ISWR	OSWR	ILWR	OLWR	TSS
2	0	28.48	-1.71	0.21	98.77	79.66	188.43	249.86	-18.09
2	0	30.46	-14.40	0.37	85.10	72.14	156.11	219.34	-24.55
2	0	20.41	-1.42	0.15	85.68	72.02	183.49	249.73	-17.50
...	...	...	...	...	...	...	...	...	...
3	31	32.58	-13.25	0.77	45.01	41.62	255.33	262.31	-12.48
3	0	32.58	-15.36	0.63	54.63	47.79	197.96	231.47	-19.58
3	0	32.58	-11.44	0.66	56.64	49.40	229.80	249.78	-15.14
...	...	...	...	...	...	...	...	...	...
4	51	29.23	-9.27	0.80	43.49	39.96	267.36	275.75	-9.25
4	10	25.63	-1.62	0.69	129.74	110.47	212.85	285.13	-8.05
4	3	23.90	-2.77	0.90	207.48	184.62	295.99	309.26	-1.91
...	...	...	...	...	...	...	...	...	...

Level 2 207 rows
Level 3 444 rows
Level 4 48 rows



- **Module 3 Project:**
  ➔Data quantity is enough to apply machine learning algorithms on it?