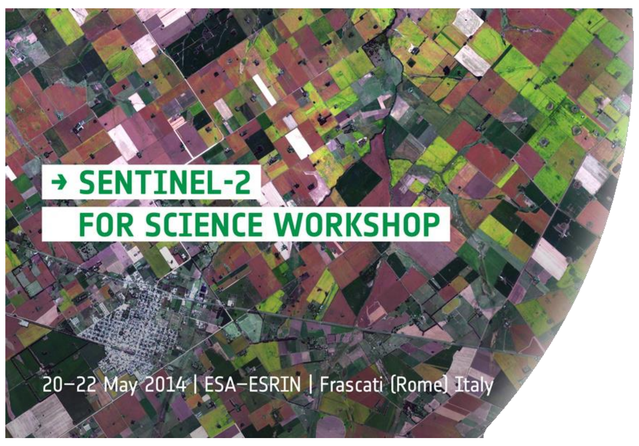

FUSION OF REMOTE SENSING DATASET WITH HETEROGENEOUS SPATIO-TEMPORAL RESOLUTION: SIMULATION OF SENTINEL-2 TIME SERIES OF VEGETATION INDEXES FOR AGRICULTURAL MONITORING

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1. Goal of the Work

Agricultural monitoring needs updated information on both type and dynamic of cultivated varieties. Thus, a suitable monitoring system, exploiting remote sensing capabilities, requires data featuring both high spatial resolution and high revisiting time. Currently, only heterogeneous data – in terms of spatial and temporal resolutions – are available for operational monitoring purposes. Typically, high spatial resolution (HR) data (< 30 m) feature low revisiting time (16 to 26 days) while, daily data are available at low or very low spatial resolution (LR) (250-1000 m).

In this study, **we propose an approach to perform the fusion of NDVI images** derived from the available heterogeneous satellite dataset, **in order to generate new NDVI time series at desired timestamps, characterized by better spatio-temporal resolution**.

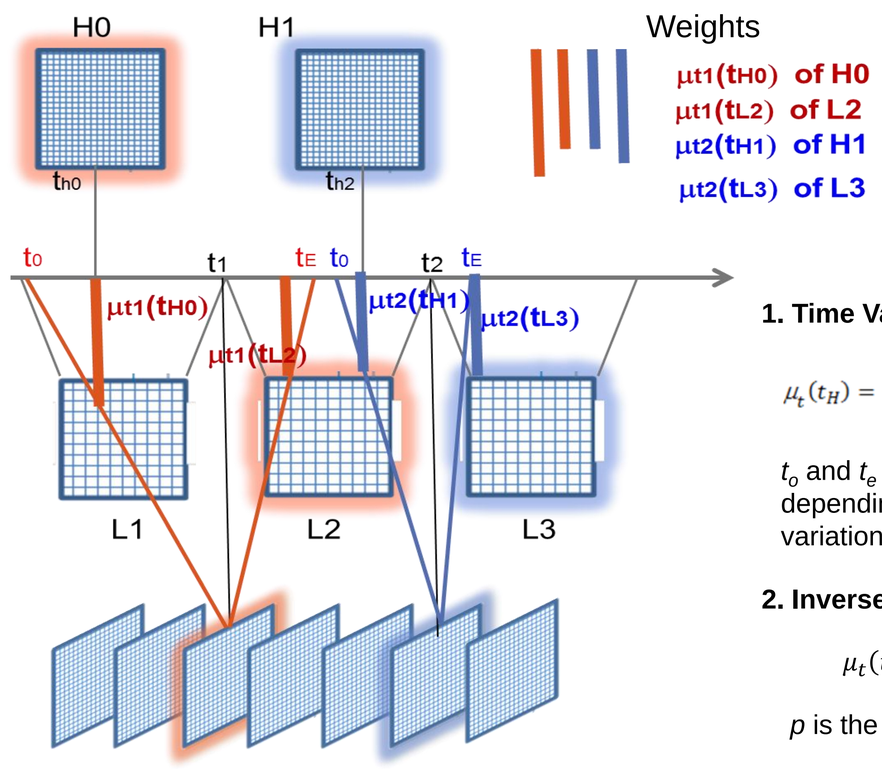
2. Dataset

The heterogeneous satellite dataset used in this study is represented by **20 SPOT4(Take5)** scenes and **21 MODIS** (MOD09A1) images, acquired over the **Provence region** from February, 3rd 2013 to June, 18th 2013.

NDVI values have been calculated for both **S4(T5)** and **MODIS** dataset. **NDVI** dataset retrieved **from S4(T5)** has then been **divided into training and testing** dataset sampling each scenes with a frequency of 10 days.

SERIES	SENSOR	# IMAGES	SPAT. RES.	FREQUENCY
H_{input}	S4(T5)	12	20 *m*	10 days
H_{target}	S4(T5)	8	20 *m*	10 days
L_{input}	MODIS	21	500 *m*	8 days

3. Proposed Fusion Procedure



1. Time Validity Weights

$$\mu_t(t_H) = \begin{cases} \frac{t_H - t_O}{t - t_O} & if\ t_O \le t_H < t \\ \frac{t_H - t_E}{t - t_E} & if\ t \le t_H < t_E \end{cases}$$

t_o and t_e can change depending on the seasonal variation of crop growth

2. Inverse Distance Weights

$$\mu_t(t_H) = \frac{1}{|t_H - t|^p}$$

p is the power value

1. Definition of desired Output Timestamps: $t_1, t_2, \ldots t_n$

2. Definition of weights for input images at output Timestamps
For each timestamp t, the weight of each input image H_i and L_i acquired before t_0 and after t_E is *Null*, otherwise it is $\mu_t(t_H)$ and $\mu_t(t_L)$

3. Pixel level Fusion
At each timestamp t, the fusion is a weighted average of input images within t_0 and t_E.

4. Results

NDVI images calculated from S4(T5) and MODIS dataset have been fused together to reconstruct **NDVI time series**.

Several **tests** have been performed **with different setting configurations**:

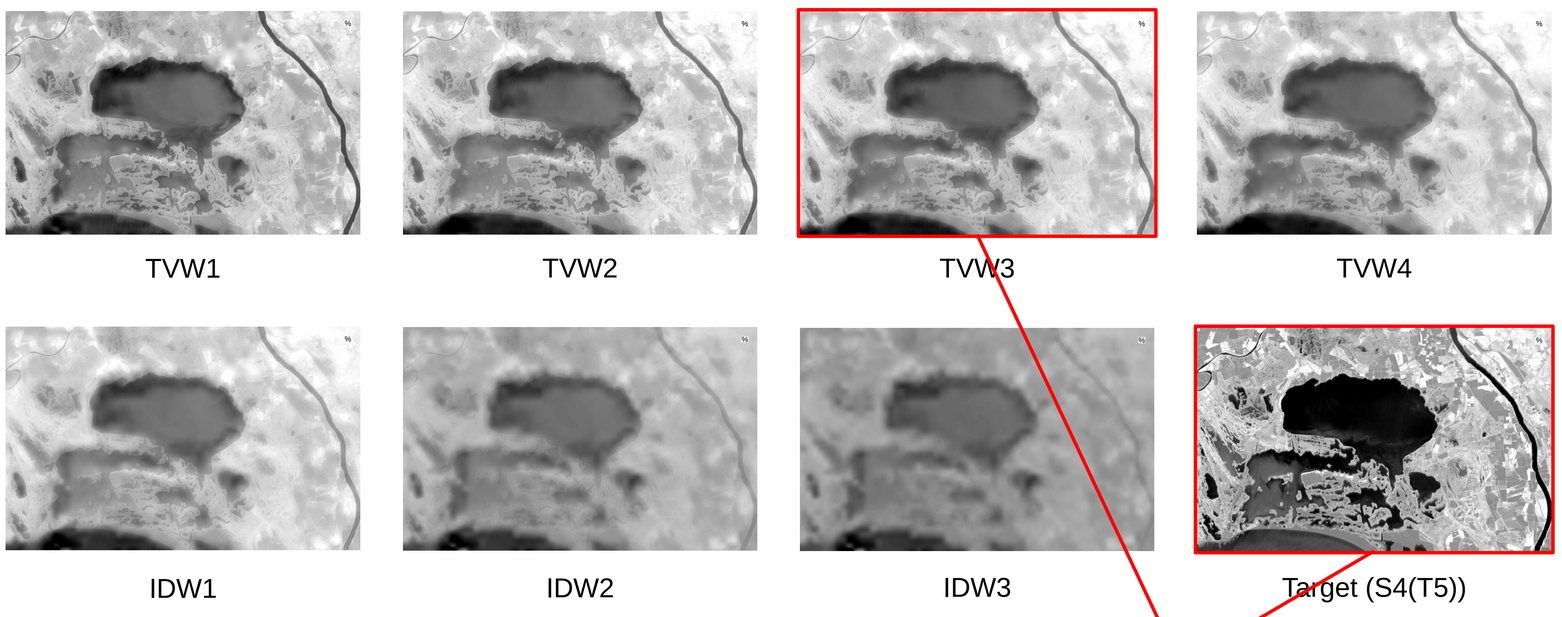
- Changing the number of images involved in the fusion at each timestamp;
- Using different weight functions (TVW or IDW with different power values).

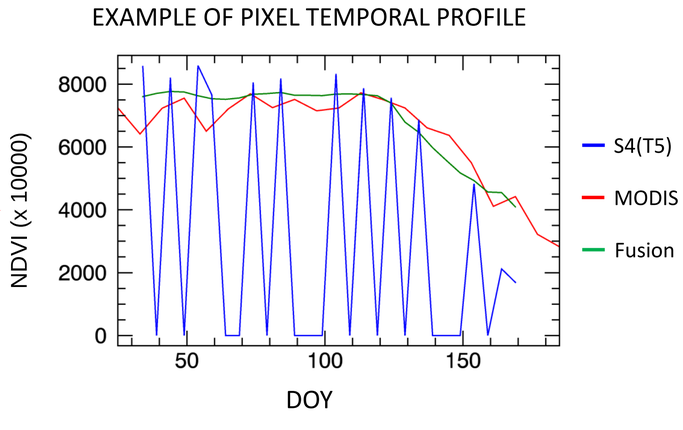
In particular, for the computation of the TVW tests, t_o and t_e have been set to -32 days and 32 days, respectively.

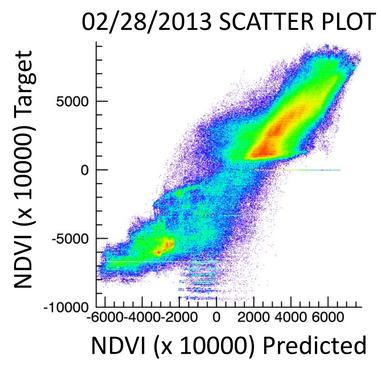
The **performances** of the different configurations are resumed in the table below.

Statistics (Simulated vs Target)					
Method	**# HR/LR**	**p**	**R**	**RMSE**	**Accuracy**
TVW1	1	-	0.815	0.169	0.933
TVW2	2	-	0.853	0.153	0.935
TVW3	3	-	0.863	0.149	0.937
TVW4	4	-	0.862	0.151	0.935
IDW1	3	1	0.806	0.181	0.926
IDW2	3	2	0.727	0.226	0.912
IDW3	3	3	0.686	0.249	0.904

Example of fusion results for 02/28/2013







Acknowledgements

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