Satellite image processing based on GreenLand application

MINISTRY OF EDUCATION AND RESEARCH

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Presentation topics

- ICT topics:

    - Satellite image processing overview

    - Satellite image processing applications

    - GreenLand general description

    - System related architecture

    - Vegetation indexes

    - GreenLand GUI description

    - GreenLand user scenario

    - Conclusions

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Satellite image processing overview

- ☐ Satellite image processing

  - ■ Definition: act of examining images for the purpose of identifying objects and giving them a significance

  - ■ Applicability: used in different Earth Science domains

    - ☐ Land cover

    - ☐ Air pollution

    - ☐ Hydrology

    - ☐ Ecology

    - ☐ etc

  - ■ Analysis: detecting, identifying, classifying, measuring and evaluating the significance of physical and cultural objects, their patterns and spatial relationship

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Satellite image processing overview

- □ Satellite image processing

    - ■ Types: many types of satellite images used for different purposes

        - □ Landsat

        - □ MODIS

        - □ Aster

        - □ Quickbird, etc

    - ■ Access: there are several places from where to view and download these satellite images.

    - ■ Size: depending on the geographical region size and on the containing information, satellite images could reach a couple of Gb in size

Satellite image processing applications

- GreenLand application

  - Vegetation index based classification (NDVI, EVI, IPVI, SAVI, GEMI)

  - Works with pre processed Landsat satellite images

  - Runs on GRID infrastructure

    Jobs are fast executed due to high computation and storage capabilities offered by the Grid infrastructure

  - Based on ESIP (Environment Oriented Satellite Image Processing Platform)

  - Quick and easy access

    http://cgis.utcluj.ro:4331/GreenLand1.3/

GreenLand vegetation indices

☐ The GreenLand classification process is performed based on vegetation indexes

- NDVI (Normalized Vegetation Index)

- EVI (Enhanced Vegetation Index)

- IPVI (Infrared Percentage Vegetation Index)

- GEMI (Global Environment Monitoring Index)

- SAVI (Soil-Adjusted Vegetation Index)

☐ The classification process combines different bands in the Landsat satellite images in order to correctly make the classification

GreenLand general description

□ Classification output (right image) based on input satellite image (left image)
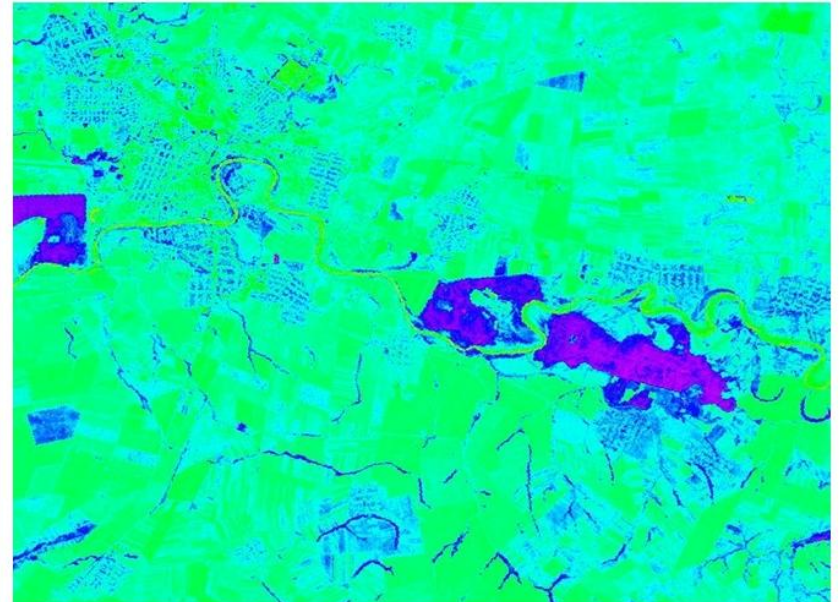
GreenLand related architecture
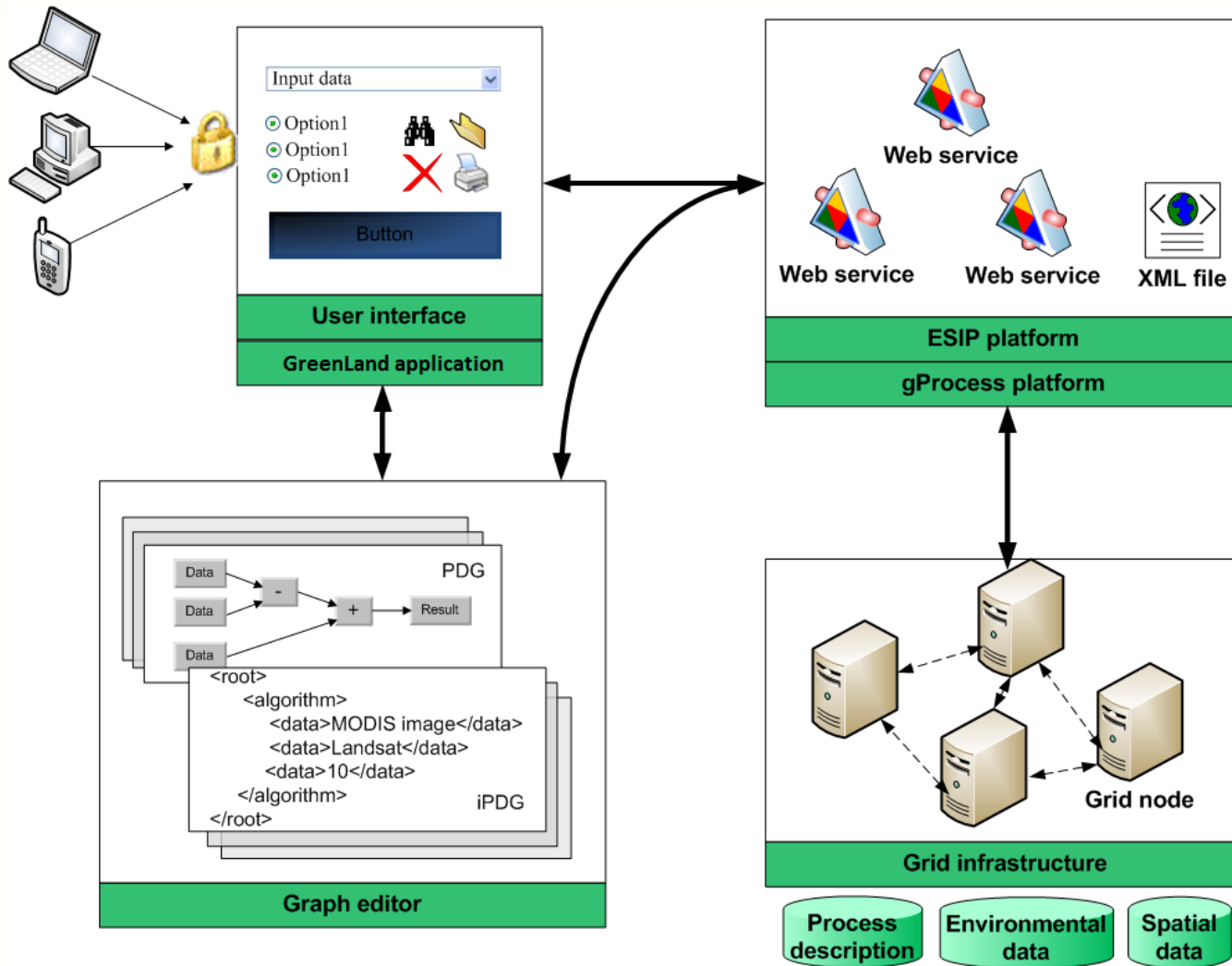
GreenLand related architecture

- Based on client-server architecture

- Relies on ESIP and gProcess platform

- Client side

  - GUI modules of the application

  - Modules are built using the Adobe Flex technology

  - GreenLand built in as a web application

- Server side contains

  - Java web services and methods that links the GreenLand application and the Grid infrastructure

  - Java web services and methods that process the user requests and send it a proper response

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GreenLand experiments outputs

GreenLand vegetation indices
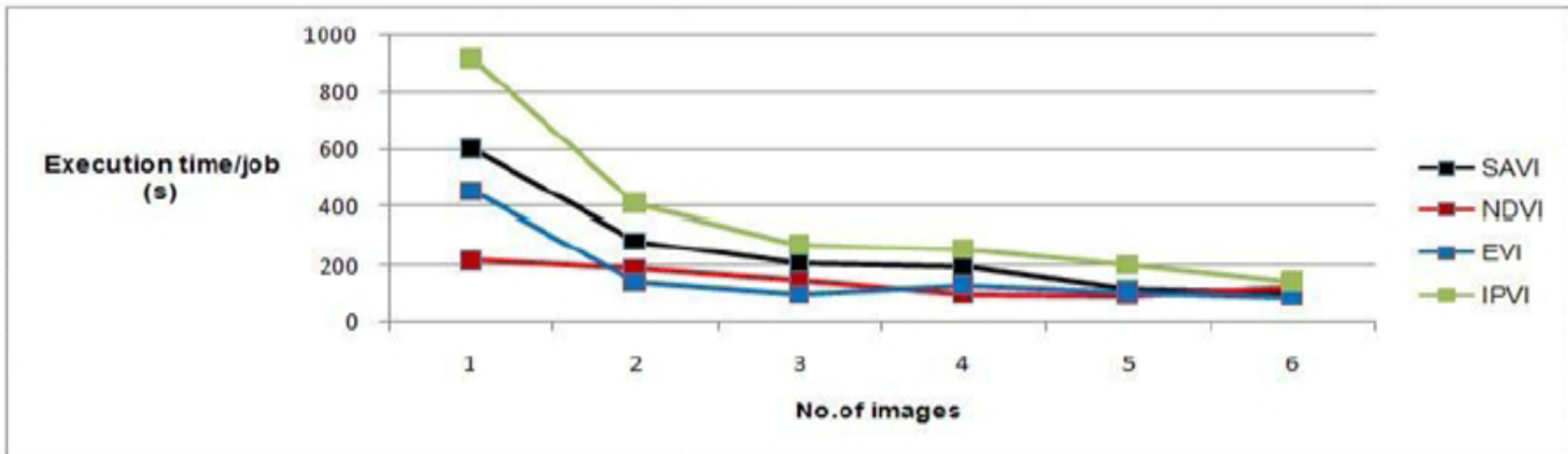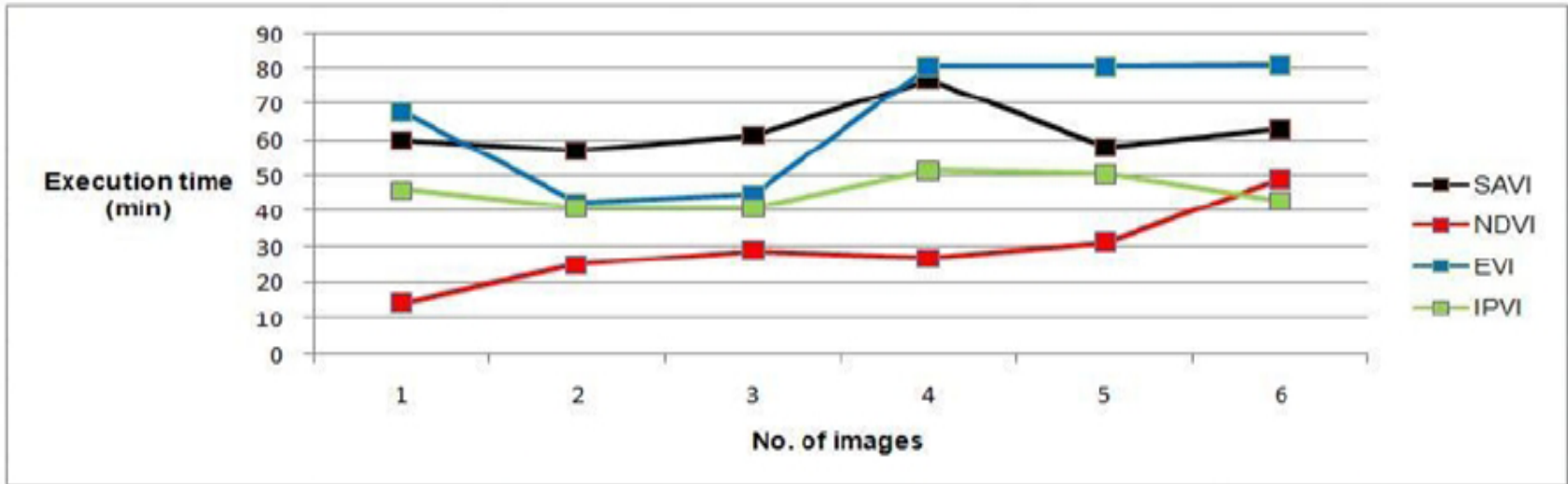
- NDVI

  - The formula used in the NDVI classification process is the following

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

  - NIR and Red represent two of the bandwidths of the Landsat satellite image

  - This vegetation index is useful in classify the land cover

  - Possible values for the NDVI are in [-1, 1]

  - NDVI -> 0 for soil surfaces

  - NDVI is in (0, 1) for vegetation area

  - Uncertainty in case of water detection

GreenLand vegetation indices

- EVI

  - Closely related with the NDVI

  - Corrects some distortions in the reflected light caused by the particles in the air or in the ground cover bellow the vegetation

GreenLand vegetation indices

- SAVI

  - One of the best classifiers

  - Accurate differentiation from vegetation and non-vegetation areas

  - Based on the following formula

$$SAVI = \frac{NIR - Red}{NIR + Red + 0.16}$$

GreenLand vegetation indices

- GEMI

  - Minimize the atmospheric influence in the classification process

  - Sensitive to the soil noise

  - Uses the following formula

$$GEMI = \eta * (1 - 0.25 * \eta) - \frac{Red - 0.125}{1 - Red}$$

where,

$$\eta = \frac{2 * (NIR - Red) + 1.5 * NIR + 0.5 * Red}{NIR + Red + 0.5}$$

GreenLand vegetation indices

□ GEMI

described

as PDG

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GreenLand GUI description

1. Input and output dataset

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GreenLand GUI description

1. Input and output dataset

   ■ This example uses three input Landsat satellite images (romania1, romania3, romania5)

   ■ For the first image NDVI, EVI, IPVI and GEMI vegetation indexes are used in the classification process
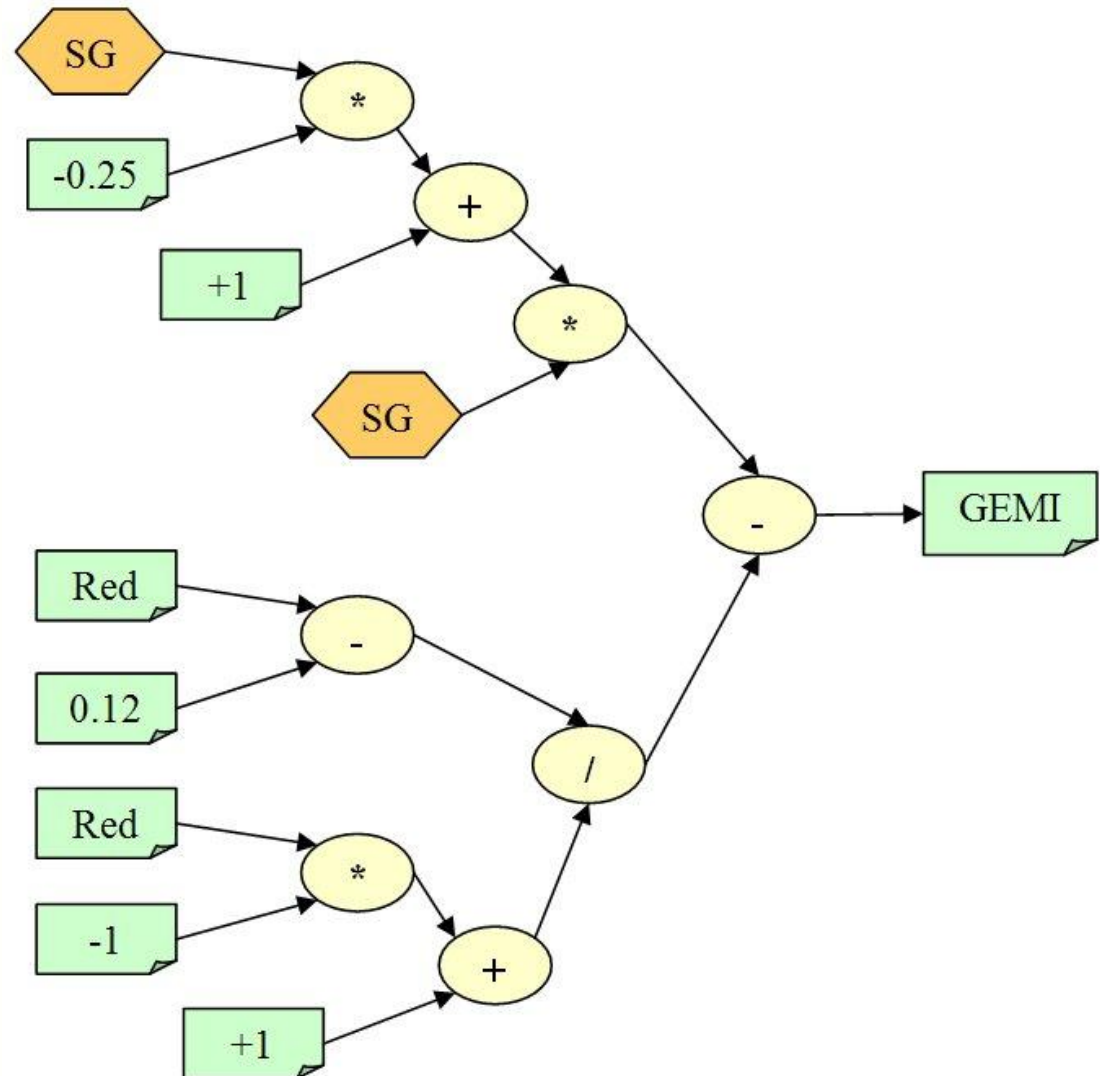
Check all	Image name	Options	NDVI	EVI	IPVI	SAVI	GEMI
✔	romania1	👁 💾 ✖	✔	✔	✔	☐	✔
☐	romania2	👁 💾 ✖	☐	☐	☐	☐	☐
✔	romania3	👁 💾 ✖	✔	✔	✔	☐	☐
☐	romania4	👁 💾 ✖	☐	☐	☐	☐	☐
✔	romania5	👁 💾 ✖	✔	✔	✔	✔	✔
☐	romania6	👁 💾 ✖	☐	☐	☐	☐	☐

Processing options

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GreenLand GUI description

2. Naming the process

   - Before launching the process to execution over the Grid infrastructure the user should name it

   - The **Start processing** button is enable only if the Process name and the Process description fields are filled in correctly by the user

GreenLand GUI description

3. Monitor the execution

  ■ Uses the GreenLand monitoring module

  ■ The process execution status is visible for the user in the GreenLand GUI

  ■ Performs periodically updates at GUI level

  ■ Information are displayed using the EditorWS and the ViewerIC modules of the gProcess platform

GreenLand GUI description

3. Monitor the execution

- This module contains a process search and a filter mechanism

- Different search criteria: name, description, status or date

- Different filters: display all the active, completed or cancelled processes

GreenLand GUI description

☐ Processes are displayed to the user in the **Process status information** table

☐ Each table input has a specific color, depending on the process execution status

Current process status information

| description	Node name	Start server time	End server time	Status	Options
	11_15_Div	2011-03-28 10:00:59		SUBMITED	
	11_14_MultFloat	2011-03-28 10:00:59		SUBMITED	
	11_12_Add	2011-03-28 10:00:59		SUBMITED	
	11_11_AddFloat	2011-03-28 10:01:00		SUBMITED	
	11_9_Add	2011-03-28 10:01:00		SUBMITED	
	11_8_MultFloat	2011-03-28 10:01:00		RUNNING	
	11_5_MultFloat	2011-03-28 10:01:00	2011-03-28 10:01:25	DONE	💾
	11_3_Sub	2011-03-28 10:01:00	2011-03-28 10:01:21	DONE	💾
NDVI: Final result	3_5_Div	2011-03-28 10:01:00		SUBMITED	
NDVI: (NIR + Red)	3_4_Add	2011-03-28 10:01:01		RUNNING	
NDVI: (NIR - Red)	3_3_Sub	2011-03-28 10:01:01	2011-03-28 10:01:27	DONE	💾

Conclusions

- This presentation highlights the main features of the GreenLand application and the land cover classification mechanisms

- For now the GreenLand application works only with Landsat satellite images, but we intend to improve its functionality by adding the MODIS, Meris, ASTER or other satellite images type

- The new human computer interactions are also the main features in extending the GreenLand application

  - Overly the output results on an interactive map

  - Simulate the evolution of natural phenomena

  - Allow the user to specify its own color legend that will be used to generate the output result

- Include and gridify the GRASS software package by ESIP to extend the standard interoperability

GreenLand sample

☐ SAVI described as PDG

$$SAVI = \frac{NIR - Red}{NIR + Red + 0.16}$$
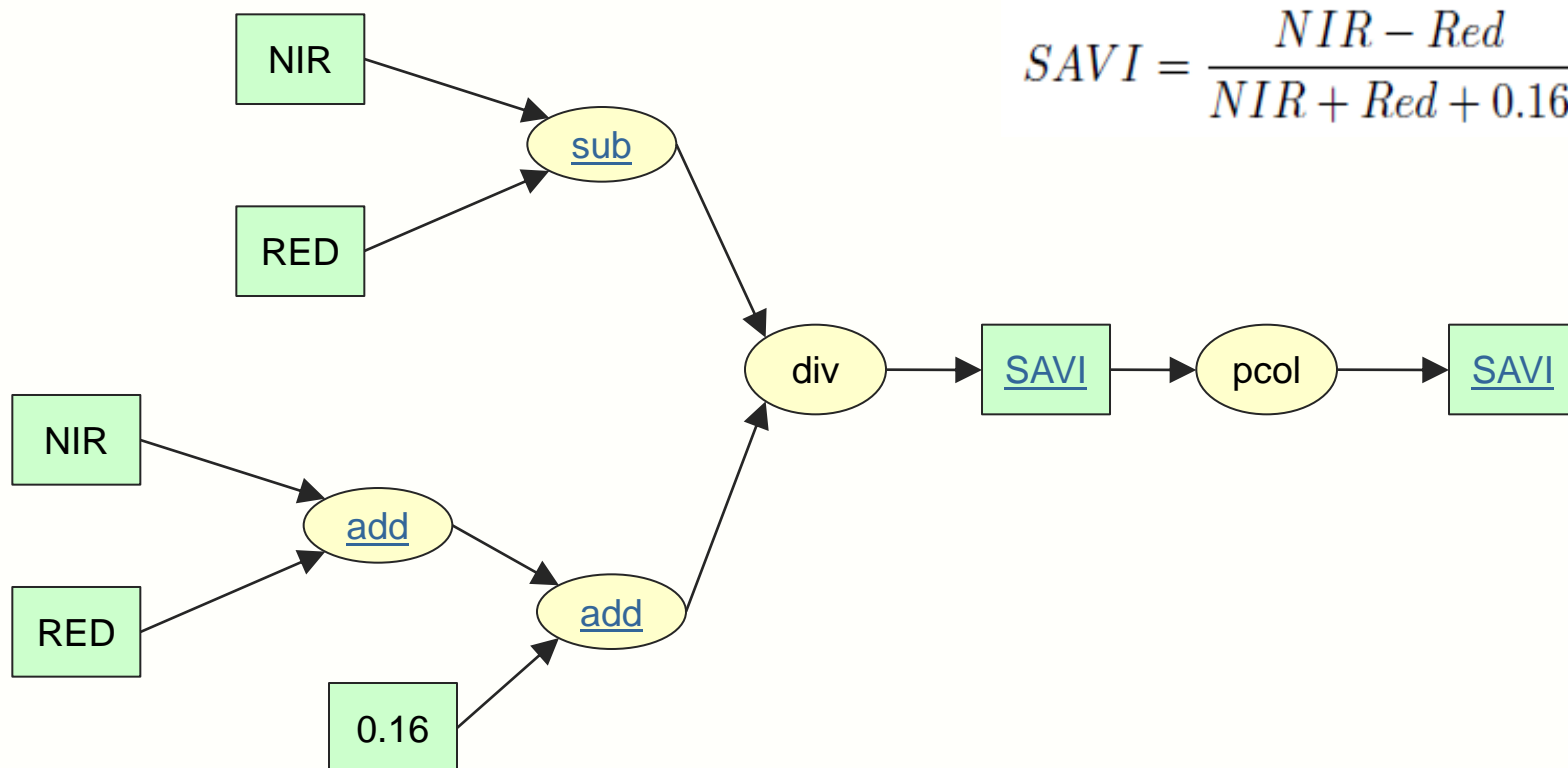
Thanks, Questions

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