

Aceasta cercetare a fost finantata prin Proiectul MedioGRID 19CEEX-I03/2005-2008,
beneficiar MEC Romania



GREENLAND

Clasificarea zonelor de vegetatie bazata pe arhitectura GRID

Cornelia Melenti, Victor Bacu, Daniel Safta, Dorian Gorgan

Catedra de Calculatoare,
Facultatea de Automatica si Calculatoare
Universitatea Tehnica Cluj-Napoca

ENVIRO 2006,
Facultatea de Stiinta Mediului,
Universitatea Babes-Bolyai Cluj
28 octombrie 2006, Cluj-Napoca

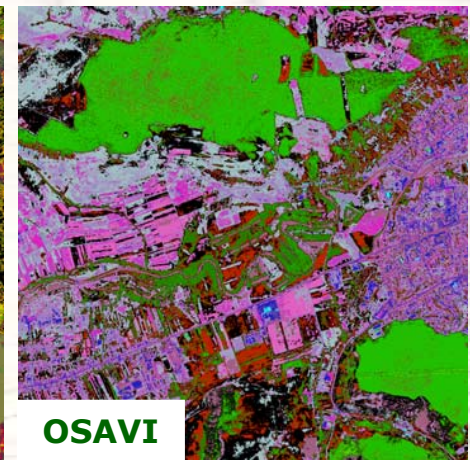
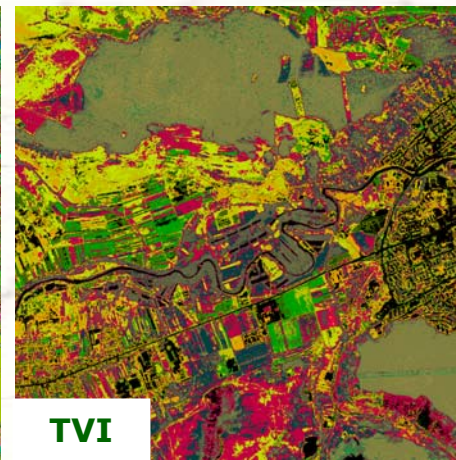
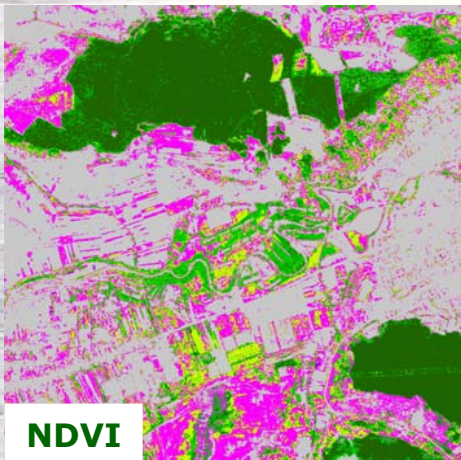


Cuprins

- Prezentarea arhitecturii GRID
- Prezentarea aplicatiei Greenland
- Experimente
- Concluzii



**Cluj-Napoca,
zona de vest a orasului
(benzile 1,2,3)**



Prezentarea arhitecturii GRID



□ Prelucrarea imaginilor satelitare pe GRID

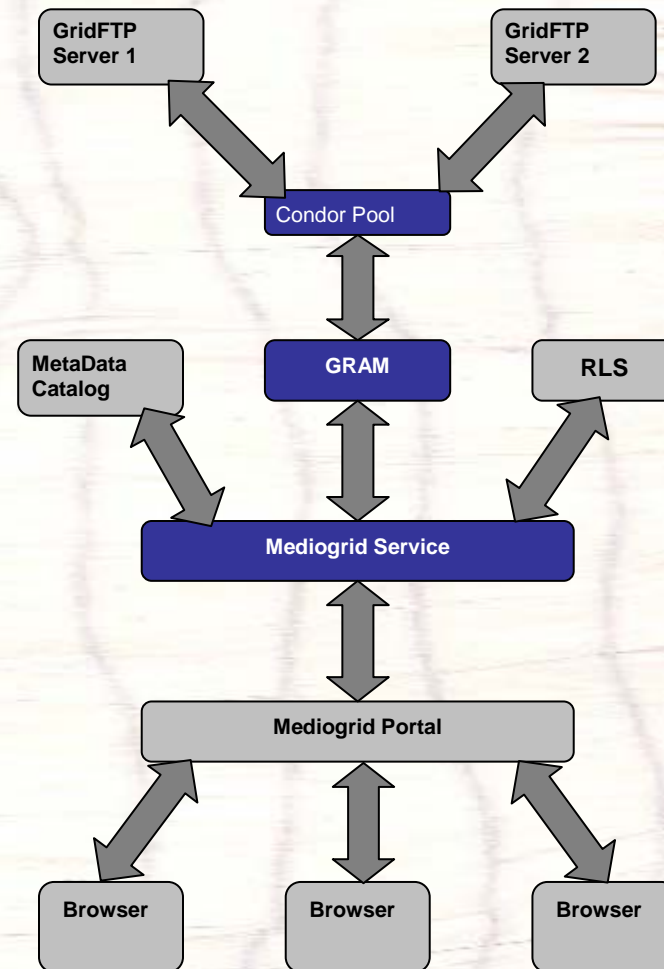
- Mediu pentru extragerea parametrilor geografici si de mediu din imaginile satelitare
- Aplicatia GREENLAND pentru clasificarea imaginilor satelitare pe baza indicilor de vegetatie oferita ca serviciu web pe GRID

Prezentarea arhitecturii GRID



Componentele arhitecturii Mediogrid

- MedioGRIDService
- MedioGRIDPortal
- MedioGRIDMyProxy
- MetadataCatalog and Replica Location Service



Prezentarea arhitecturii GRID



IMAGINE RELEVANTA	TIP DE PRELUCRARE (Indici de vegetatie)	TIP DE PRELUCRARE (Detectie zone)	THUMBNAIL
<input type="checkbox"/> cluj1	relevanta <input checked="" type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj2	relevanta <input type="checkbox"/> NDVI <input checked="" type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj3	relevanta <input type="checkbox"/> NDVI <input checked="" type="checkbox"/> IPVI <input checked="" type="checkbox"/> OSAVI <input checked="" type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj4	relevanta <input type="checkbox"/> NDVI <input checked="" type="checkbox"/> IPVI <input checked="" type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj5	relevanta <input checked="" type="checkbox"/> NDVI <input checked="" type="checkbox"/> IPVI <input checked="" type="checkbox"/> OSAVI <input checked="" type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj6	relevanta <input type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj7	relevanta <input type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj8	relevanta <input type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj9	relevanta <input type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	
<input type="checkbox"/> cluj10	relevanta <input type="checkbox"/> NDVI <input type="checkbox"/> IPVI <input type="checkbox"/> OSAVI <input type="checkbox"/> RVI <input type="checkbox"/> TVI:::	<input type="checkbox"/> APA <input type="checkbox"/> FOC	

JOB NR.	IMAGINE	view
1	cluj1_ndvi	
2	cluj2_ipvi	
3	cluj3_ipvi	
4	cluj3_osavi	
5	cluj3_rvi	
6	cluj4_ipvi	
7	cluj4_osavi	
8	cluj5_ndvi	
9	cluj5_ipvi	
10	cluj5_osavi	
11	cluj5_rvi	
12	cluj6_ndvi	
13	cluj7_ndvi	
14	cluj8_ndvi	
15	cluj8_ipvi	
16	cluj9_ndvi	

Modul de functionare a aplicatiei GREENLAND pe GRID

- Pasul 1: Selectia imaginilor si indicilor de prelucrat
- Pasul 2: Lansarea job-urilor

Prezentarea arhitecturii GRID

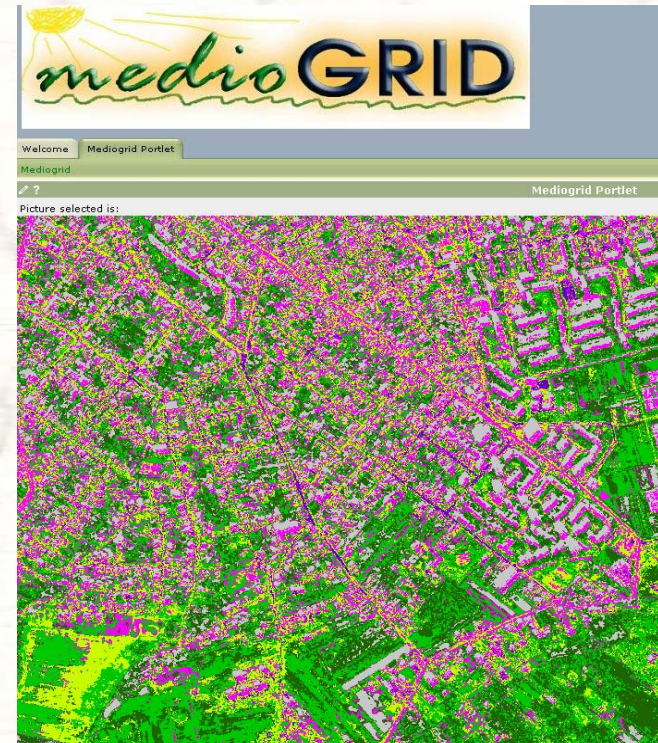


Welcome Mediogrid Portlet
Mediogrid
Mediogrid P

Selectie imagini pentru prelucrare

JOB NR.	IMAGINE	STARE	TIMP START	TIMP FINAL	THUMBAIL
1	cluj1_ndvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:16 EEST 2006	
2	cluj2_ipvi	Pending	Fri Oct 27 13:24:18 EEST 2006		
3	cluj3_ipvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:10 EEST 2006	
4	cluj3_osavi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:33 EEST 2006	
5	cluj3_rvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:10 EEST 2006	
6	cluj4_ipvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:24:56 EEST 2006	
7	cluj4_osavi	Pending	Fri Oct 27 13:24:18 EEST 2006		
8	cluj5_ndvi	Pending	Fri Oct 27 13:24:18 EEST 2006		
9	cluj5_ipvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:22 EEST 2006	
10	cluj5_osavi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:16 EEST 2006	
11	cluj5_rvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:30 EEST 2006	
12	cluj6_ndvi	Done	Fri Oct 27 13:24:18 EEST 2006	Fri Oct 27 13:25:26 EEST 2006	
13	cluj7_ndvi	Pending	Fri Oct 27 13:24:18 EEST 2006		
14	cluj8_ndvi	Active	Fri Oct 27 13:24:18 EEST 2006		
15	cluj8_ipvi	Pending	Fri Oct 27 13:24:18 EEST 2006		
16	cluj9_ndvi	Pending	Fri Oct 27 13:24:18 EEST 2006		

Refresh Job Status



Modul de functionare a aplicatiei GREENLAND pe GRID

- Pasul 3: Vizualizarea starii job-urilor
- Pasul 4: Vizualizarea rezultatelor

Prezentarea aplicatiei GREENLAND



- ❑ GREENLAND – Serviciu web de prelucrare pe arhitectura GRID a imaginilor multispectrale pentru detectia informatiei semantice pe baza indicilor de vegetatie

- ❑ Scop:
 - utilizarea imaginilor satelitare de rezolutie spatiala medie si mare pentru studiul acoperirii cu vegetatie si a structurii acesteia pentru o anumita zona geografica (Cluj - 160 Km²)

- ❑ Obiective:
 - Calculul indicilor de vegetatie prin procesarea diferitelor benzi ale imaginilor satelitare multispectrale (benzile NIR, Red si SWIR)
 - Clasificarea vegetatiei pe baza indicilor de vegetatie calculati
 - Analize statistice privind acoperirea cu vegetatie, cantitatea de biomasa
 - Actualizarea bazei de date geografice si de mediu

Prezentarea aplicatiei GREENLAND



- Indici de vegetatie calculati in aplicatia GREENLAND
 - DVI - difference vegetation index
 - RVI - ratio vegetation index
 - NDVI - normalized difference vegetation index
 - SNDVI - scaled vegetation index
 - TVI - transformed vegetation index
 - IPVI - infrared percentage vegetation index
 - OSAVI - optimized soil adjusted vegetation index
 - GEMI - global environmental monitoring index

Experimente – indici de vegetatie



- Testele au fost efectuate pe un set de imagini QuickBird achizitionate in 27.03.2003
- Bezile utilizate sunt NIR (banda 4) si RED (banda 3)

Imagini de test din zona orasului Cluj (benzile 4,3,1)



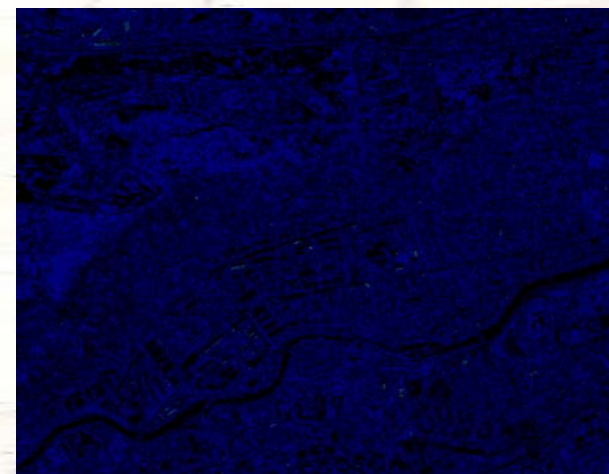
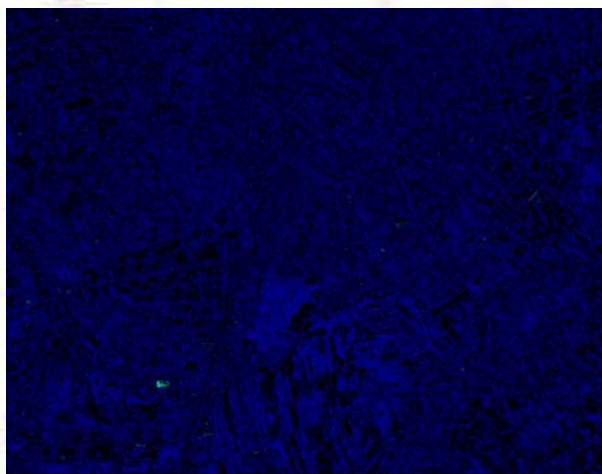
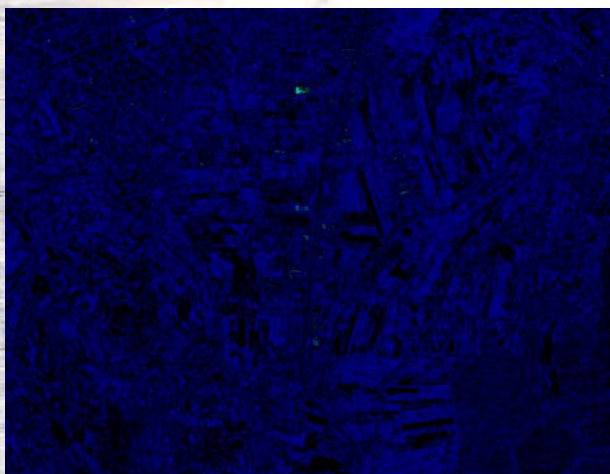
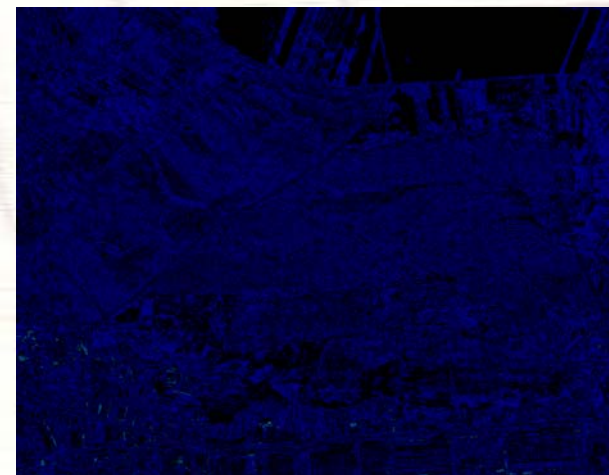
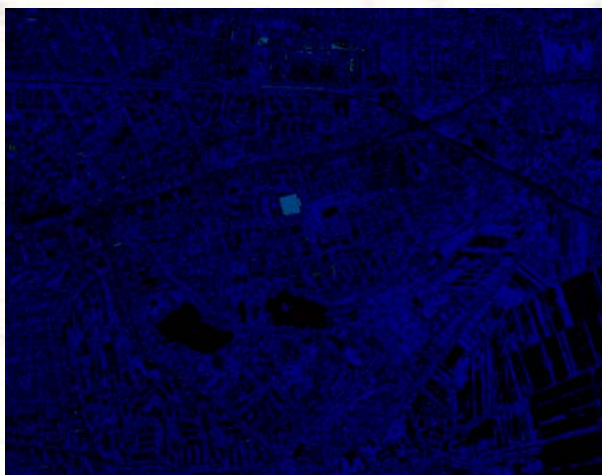
Experimente – indici de vegetatie



- Clasificarea bazata pe indicele DVI (difference vegetation index)

$$\text{DVI} = \text{NIR} - \text{Red}$$

- Imaginea rezultata este foarte segmentata si apar erori in identificarea claselor, practic este ineficienta in definirea si interpretarea claselor de vegetatie



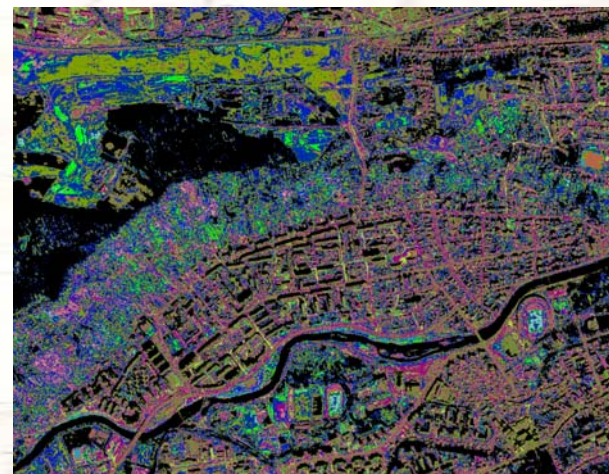
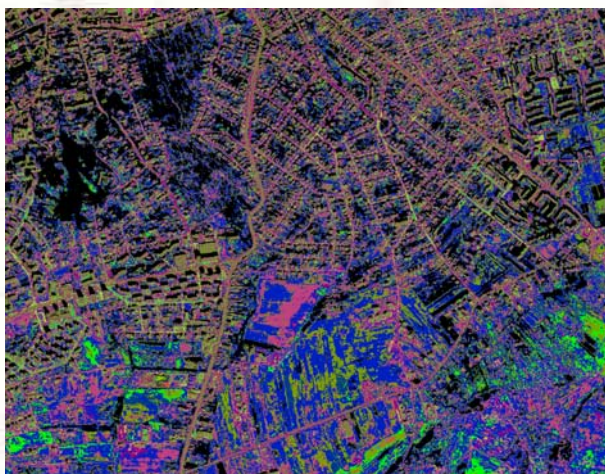
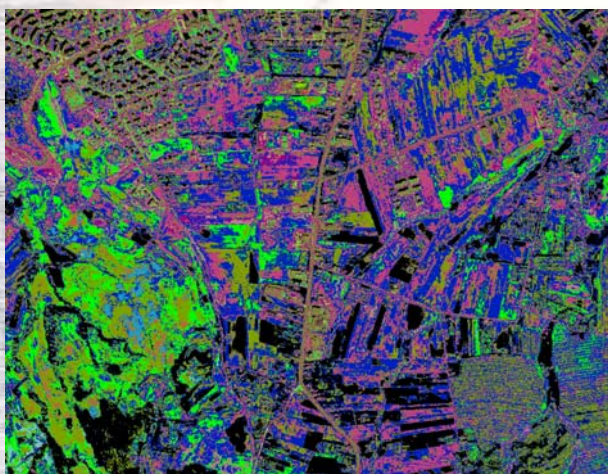
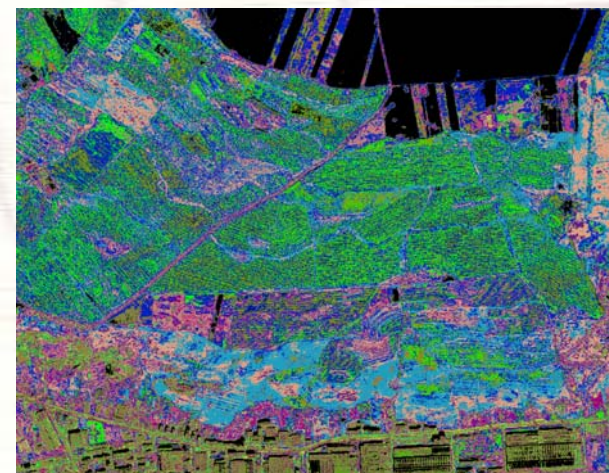
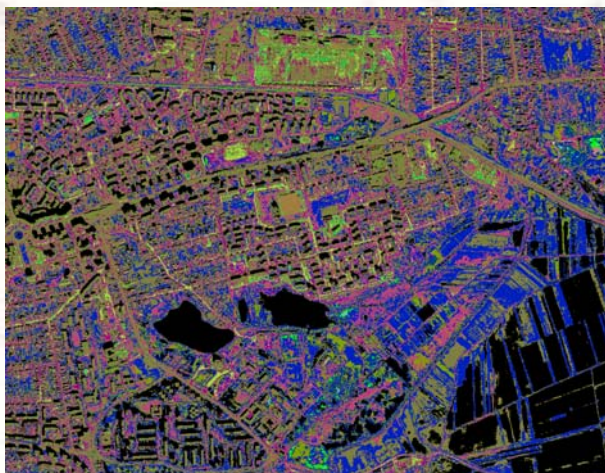
Experimente – indici de vegetatie



□ Clasificarea bazata pe indicele RVI (Ratio Vegetation Index)

$$\text{RVI} = \text{NIR} / \text{Red}$$

- Prin scalarea imaginii rezultat se obtin numere pozitive intre 0-255 (corespunzatoare nuanțelor de culoare) inșă nu se poate face o clasificare riguroasă.



Experimente – indici de vegetatie

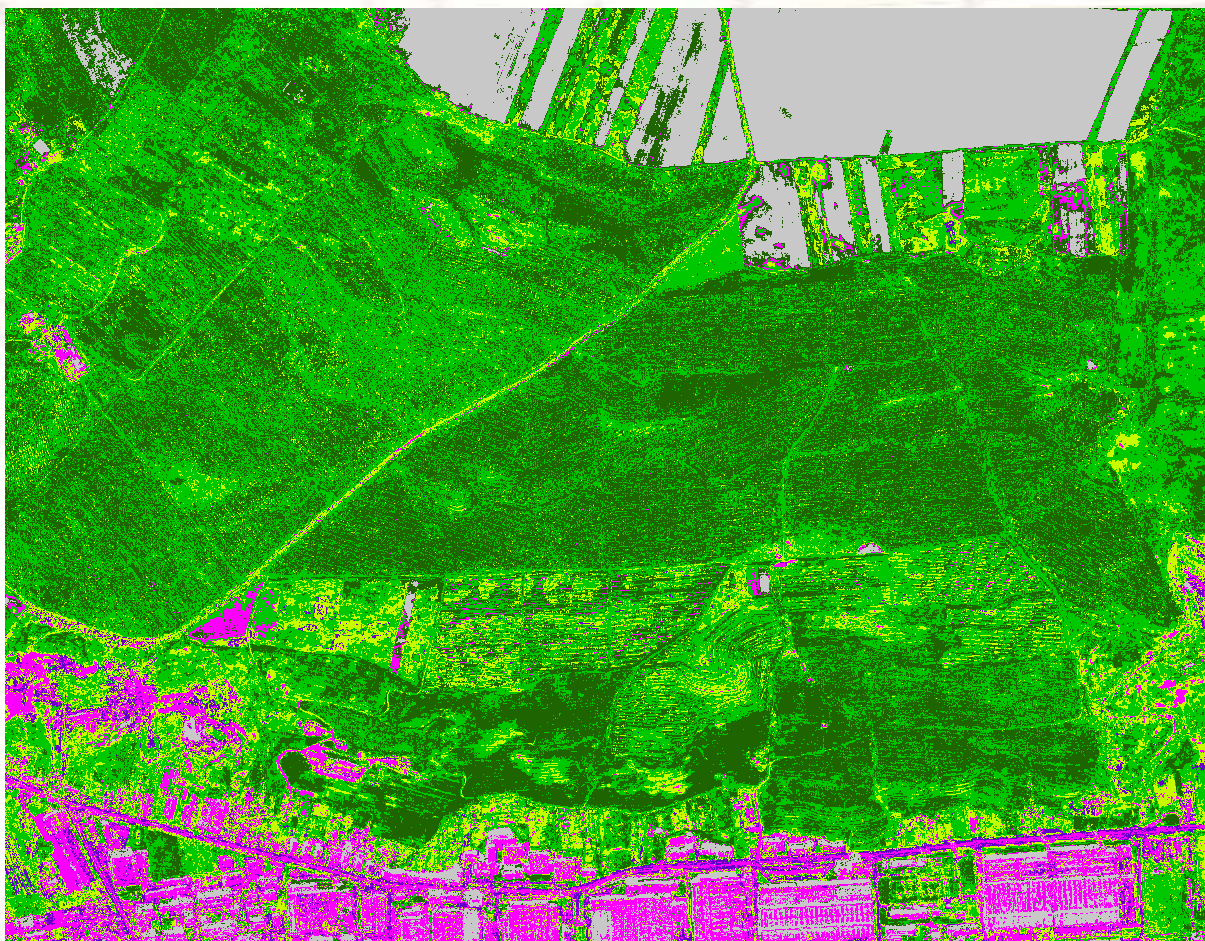


Clasificarea bazata pe indicele NDVI (Normalized Difference Vegetation Index)

$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$

• In functie de valorile NDVI (intre -1 si 1), am definit 6 clase de vegetatie/nevegetatie utilizate in cadrul unui algoritm de clasificare supervizata

Legenda claselor
obtinute:



Experimente – indici de vegetatie



Clasificarea bazata pe indicele NDVI

Legenda claselor obtinute:



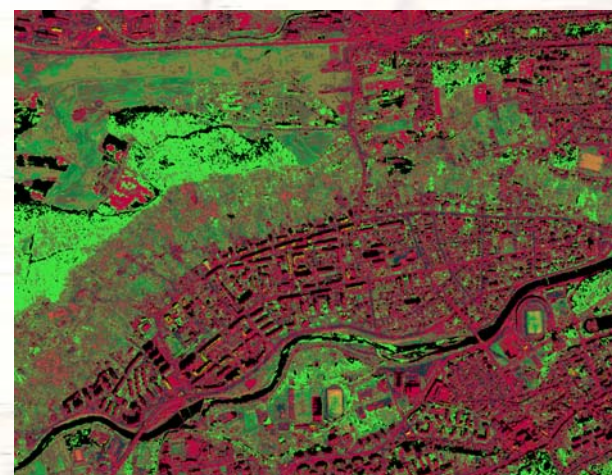
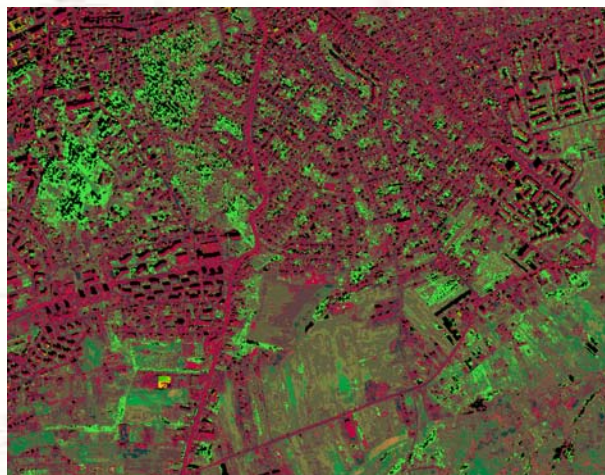
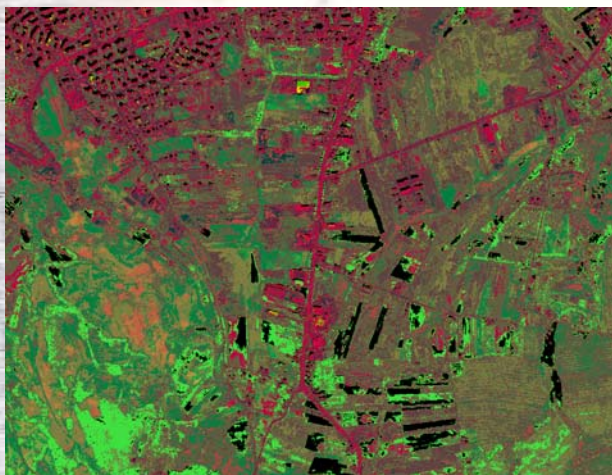
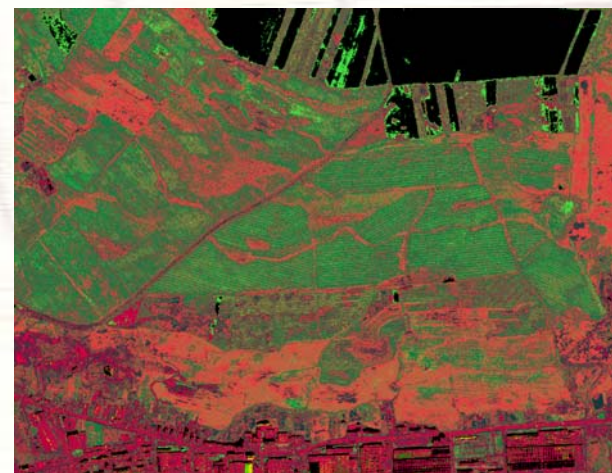
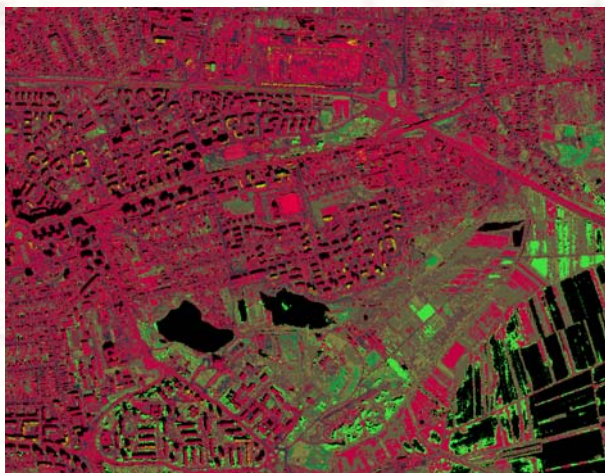
Experimente – indici de vegetatie



- Clasificarea bazata pe indicele TVI (Transformed Vegetation Index)

$$TVI = (NDVI + 0.5)^{1/2}$$

- TVI detecteaza foarte slab tipurile de vegetatie



Experimente – indici de vegetatie



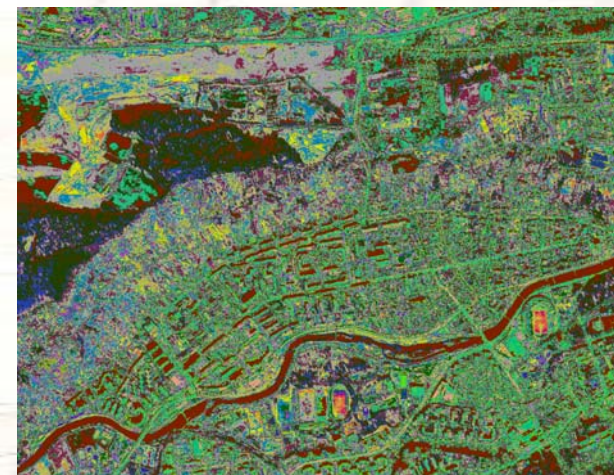
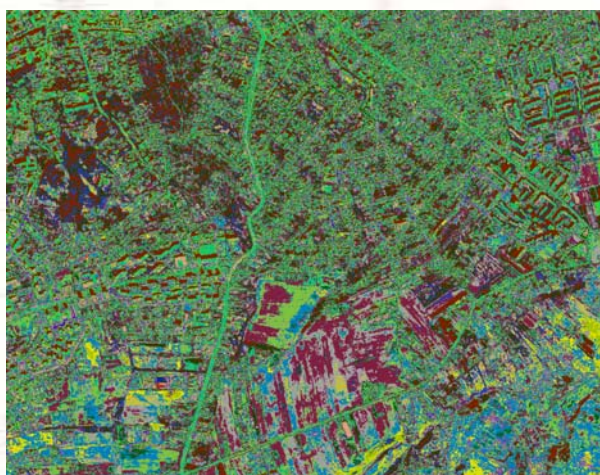
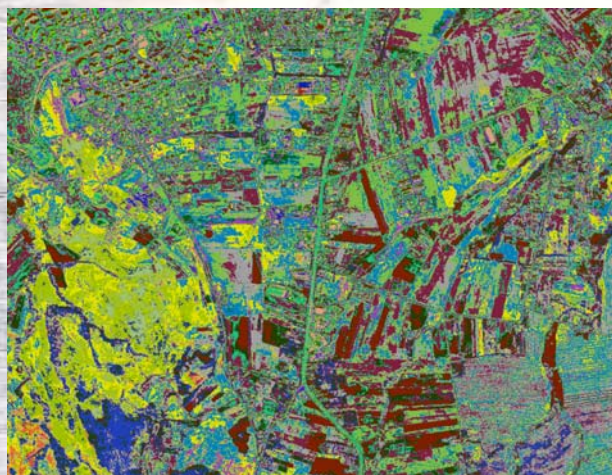
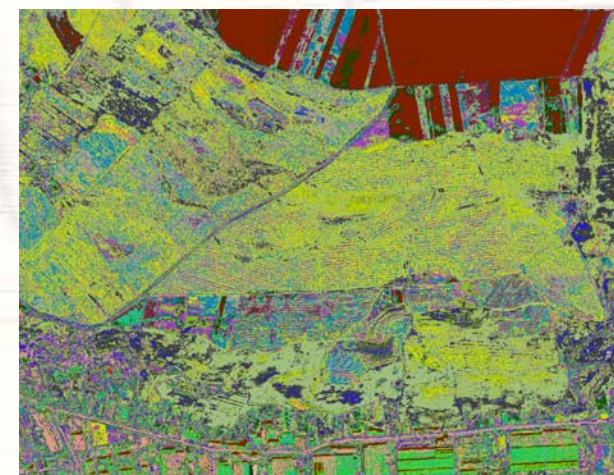
- Clasificarea bazata pe indicele GEMI (Global Environmental Monitoring Index)

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

unde

$$\eta = [2 * (\text{NIR} - \text{Red}) + 1.5 * \text{NIR} + 0.5 * \text{Red}] / (\text{NIR} + \text{red} + 0.5)$$

- GEMI ofera o mai buna clasificare a zonelor fara vegetatie inasa este slab in ceea ce priveste vegetatia

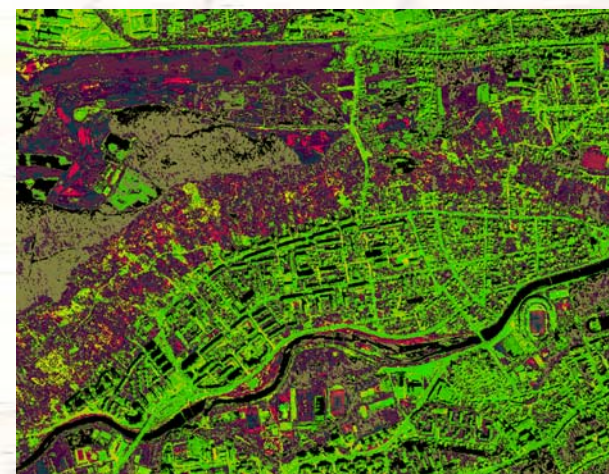
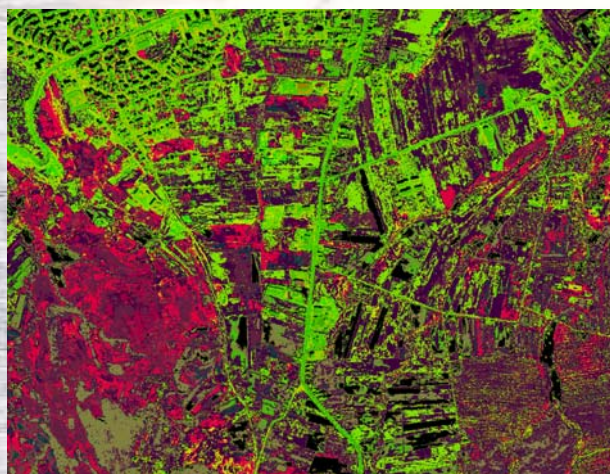
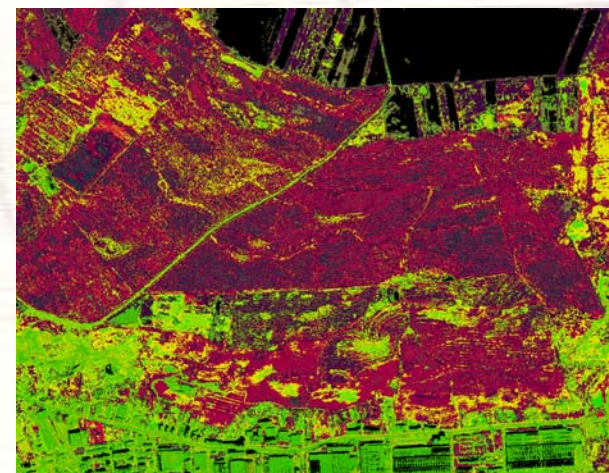
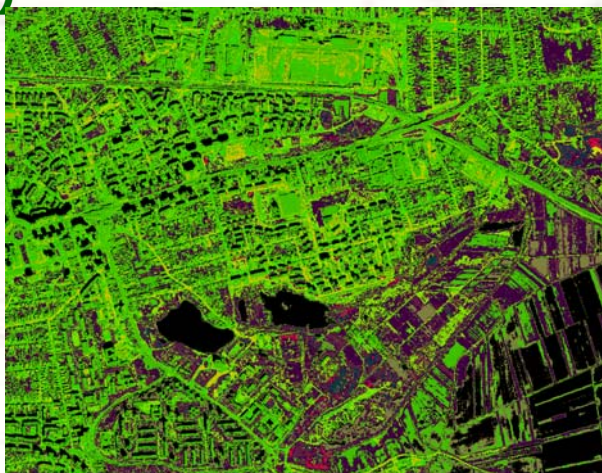


Experimente – indici de vegetatie



Clasificarea bazata pe indicele IPVI (Infrared Percentage Vegetation Index) **IPVI = NIR / (NIR+Red)**

- IPVI demonstreaza ca pentru NDVI extragerea benzii Red din NIR (o operatie matematica in plus) este irelevanta
- Lucreaza la fel ca NDVI si RVI doar ca ia valori intre 0 si 1
- IPVI ofera, la fel ca GEMI o mai buna clasificare a zonelor fara vegetatie



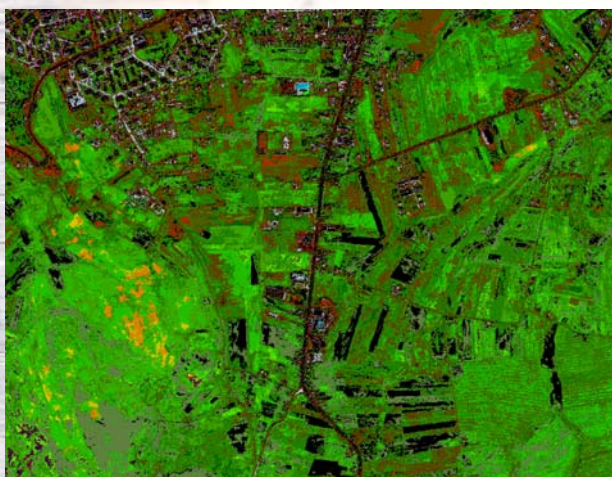
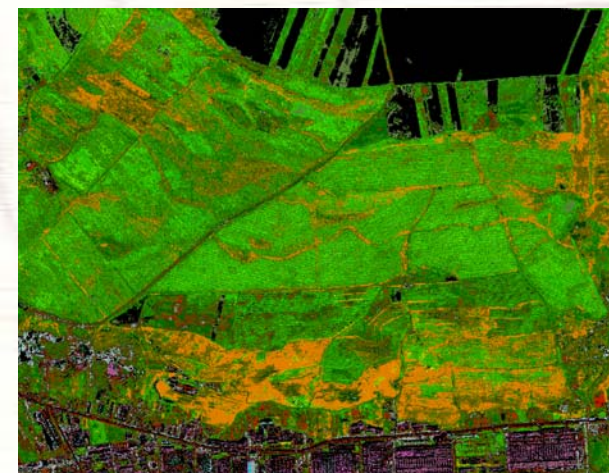
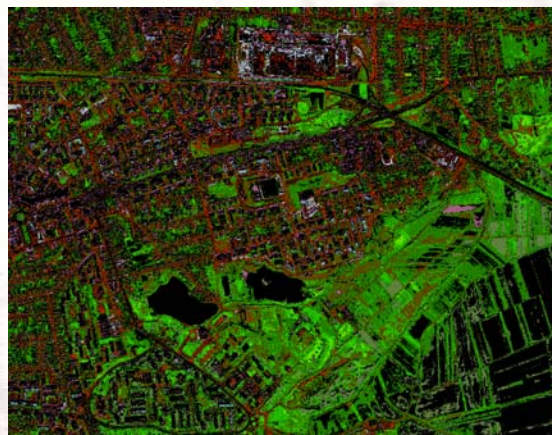
Experimente – indici de vegetatie



□ Clasificarea bazata pe indicele OSAVI (Optimised Soil-Adjustment Vegetation Index)

$$\text{OSAVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red} + 0.16)$$

- Clasificarea bazata pe OSAVI elimina inflentele solului si este superioara tuturor celor anterioare
- utilizand OSAVI pentru clasificare se obtine o foarte buna segmentare a imaginilor



Experimente – Geodatabase



The screenshot displays the MySQL Control Center interface. The main window is titled "[root@localhost:3306] Query Window" and shows the results of a query. The results are presented in a table with 20 rows and 5 columns: sol, nv, vfd, vd, and vr. The data values are as follows:

	sol	nv	vfd	vd	vr
1	1.2390900000	0.6317400000	0.2306100000	0.1792500000	0.0233100000
2	0.7521600000	0.4997400000	0.4114500000	0.4394700000	0.2011800000
3	1.2390900000	0.6317400000	0.2306100000	0.1792500000	0.0233100000
4	0.2011800000	0.7521600000	0.4394700000	0.4114500000	0.4997400000
5	0.0233100000	1.2390900000	0.1792500000	0.2306100000	0.6317400000
6	0.0954900000	1.8417000000	0.1557000000	0.0747600000	0.1363500000
7	3.7322100000	25.5142800000	2.2786800000	1.2764400000	0.6891900000
8	0.2766000000	2.7251400000	0.3918600000	0.1601400000	0.3558600000
9	3.7322100000	25.5142800000	2.2786800000	1.2764400000	0.6891900000

The status bar at the bottom of the query window indicates "Executing Query | Read Only". The console window below the query window shows the message: "20 rows in set (0.00) sec".

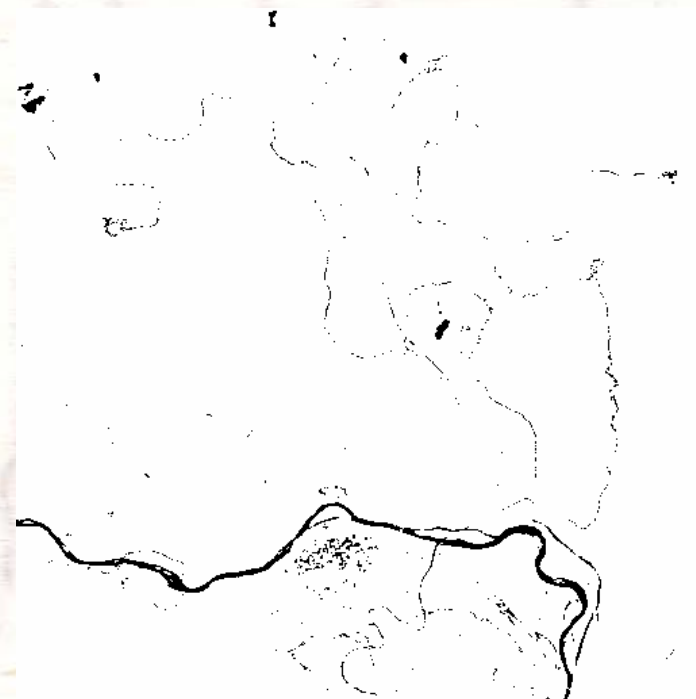
Experimente – detectia zonelor inundate



- ❑ Se face prin prelucrarea benzilor spectrale SWIR, NIR si Red
- ❑ Se utilizeaza convolutii de tip blur si operatii matematice complexe in vederea identificarii portiunilor de uscat acoperite cu apa



Imagine originala



Imagine rezultat

Concluzii si dezvoltari ulterioare



- ❑ Testele au fost efectuate pe zeci de imagini Landsat, Spot, Ikonos si QuickBird (diverse zone de pe glob si zona Clujului)
- ❑ Rezultatele obtinute pot avea aplicabilitate imediata atat in activitatea de cercetare stiintifica, cat si in activitatati de monitorizare si amenajare a zonelor cu vegetatie, indeosebi a padurilor.
- ❑ Clasificarea imaginilor satelitare implementata in aplicatia GREENLAND este nesupervizata, cu exceptia NDVI. O clasificare supervizata si avizata de experti in domeniu ar imbunatati desigur performantele aplicatiei

Dezvoltari ulterioare



- ❑ perfectionarea unui serviciu web public;
- ❑ dezvoltarea GeoDatabase;
- ❑ definirea unei palete de culori specifice pentru fiecare indice;
- ❑ integrarea in aplicatie a decodificarii formatelor stiintifice de imagini satelitare;
- ❑ obtinerea informatiilor referitoare la sanatatea vegetatiei;
- ❑ georeferentierea totala.

Va multumim!



□ Intrebari?

Cornelia Melenti, Victor Bacu, Daniel Safta, Dorian Gorgan
Computer Science Department, Technical University of Cluj-Napoca, Romania

cornelia.melenti@cs.utcluj.ro,
victorbacu@yahoo.com,
daniel.safta@yahoo.com,
dorian.gorgan@cs.utcluj.ro