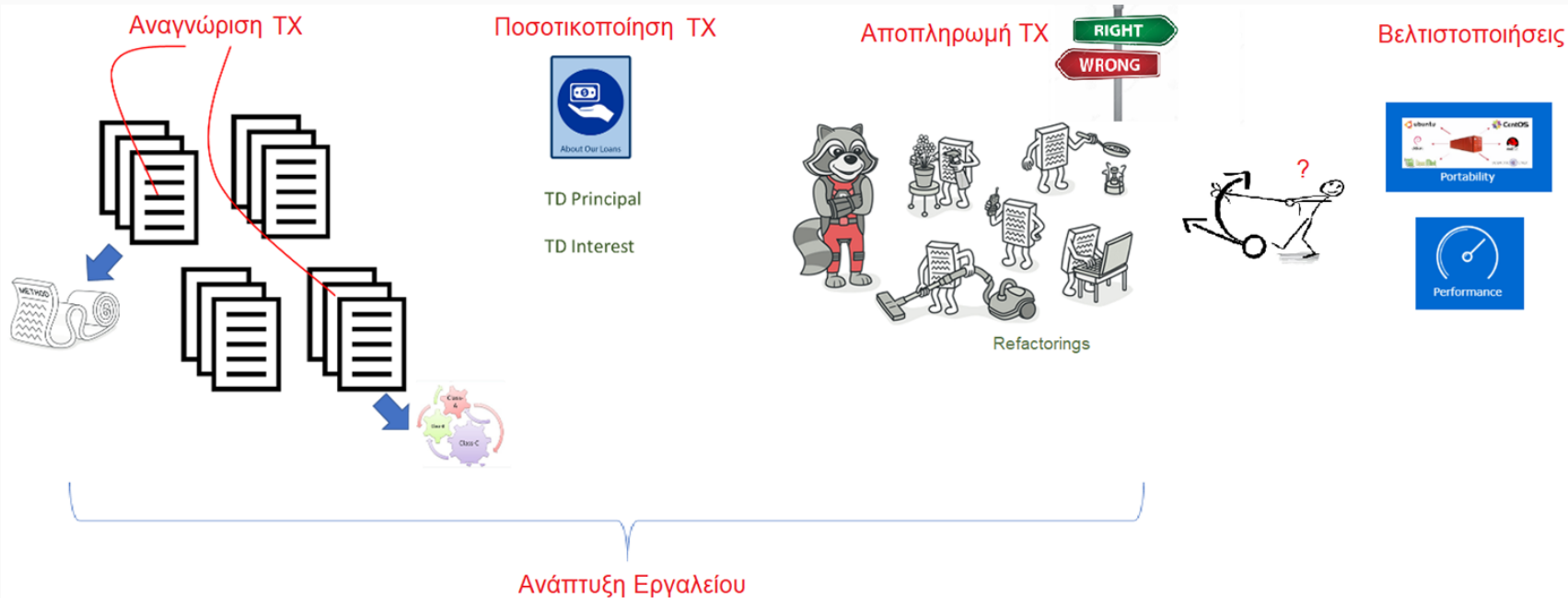


ΕΜΠΕΙΡΙΚΗ ΔΙΑΧΕΙΡΙΣΗ ΤΕΧΝΙΚΟΥ ΧΡΕΟΥΣ ΣΕ ΛΟΓΙΣΜΙΚΟ ΥΨΗΛΗΣ ΥΠΟΛΟΓΙΣΤΙΚΗΣ ΙΣΧΥΟΣ

Φοιτητής: Νικολαΐδης Νικόλαος
Καθηγητής: Αμπατζόγλου Απόστολος



Σκοπός



Ποσοτικοποίηση Τεχνικού Χρέους

- ΤΧ σε επίπεδο κώδικα (Source Code Debt)
- ΤΧ σε επίπεδο σχεδίασης (Design Debt)

Τεχνικό Χρέος Σε Επίπεδο Κώδικα



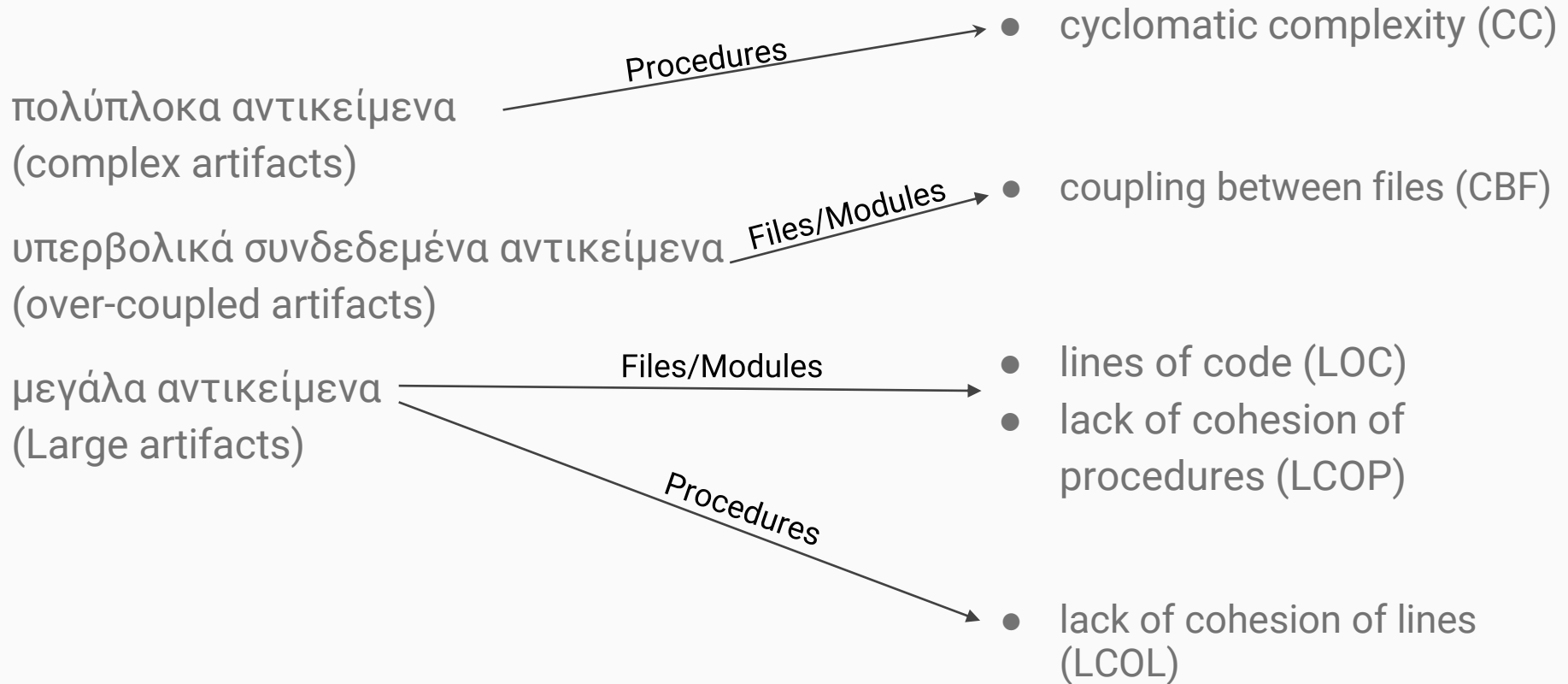
Plug-ins:

- iCode CNES
- SonarQube C ++

Τεχνικό Χρέος Σε Επίπεδο Σχεδίασης

- ορισμός σχεδιαστικών προβλημάτων
- αναγνώριση στοιχείων που υποφέρουν
- εκτίμηση χρόνου επίλυσης
- σύνθεση αποτελεσμάτων

Σχεδιαστικά προβλήματα και μετρικές



MetalWalls:

84 Extract Procedures

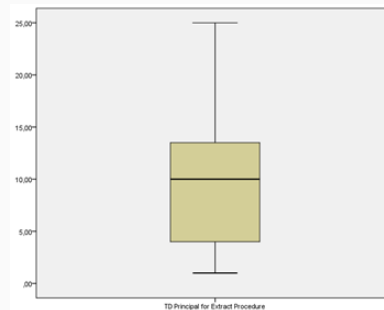
5 Extract File / Modules

CO₂Capture:

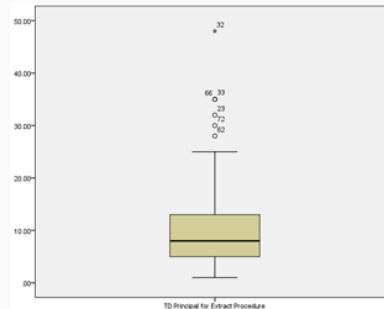
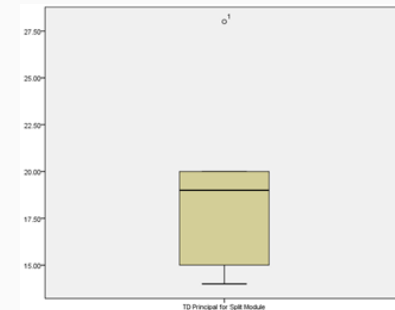
47 Extract Procedures

6 Extract File / Modules

Extract Procedures



Extract File / Modules



$$\begin{aligned} TDD_{Principal} = & (occurrences_{long\ procedure} + occurrences_{complex\ procedure}) * 6.56 \\ & + (occurrences_{large\ file/module} + occurrences_{overcouple\ file/module}) \\ & * 9.59 \end{aligned}$$

Αποπληρωμή Τεχνικού Χρέους

- Extract Procedure
- Extract File / Module

Extract Procedure

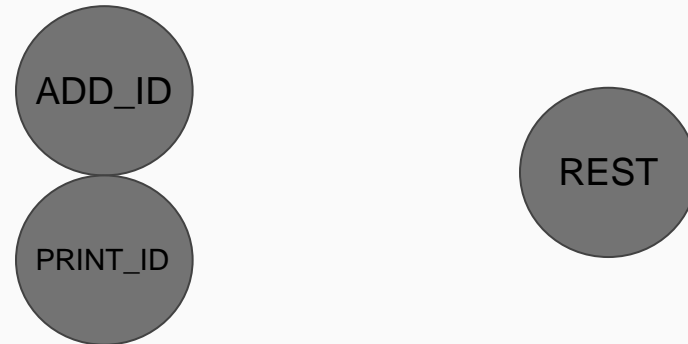
SRP Extract Method Identification (SEMI)

```
INTEGER I,J,K,ID  
  
I= J+K  
K= K+1  
CALL PRINT(I,J,K)  
  
DO ID=1, 10  
  PRINT_NAME(ID)  
ENDDO
```

```
INTEGER I,K  
  
IF (K>0) THEN  
  I= I*2  
  K= K+1  
  K, I  
ENDIF
```

Extract File / Module

```
INTEGER I,J,K,ID  
  
REST(I,J,K)  
  I= J+K  
  K= K+1  
  CALL PRINT(I,J,K)  
  
ADD_ID(ID)  
  ID=ID+1  
  
PRINT_ID(ID)  
  DO ID=1, 10  
    PRINT_NAME(ID)  
  ENDDO
```



Επίδραση Βελτιστοποιήσεων Απόδοσης και Φορητότητας στο Τεχνικό Χρέος

Ποια είναι η επίδραση

- στα αναδιαμορφωμένα μέρη του πηγαίου κώδικα
- στα νέα μέρη του πηγαίου κώδικα

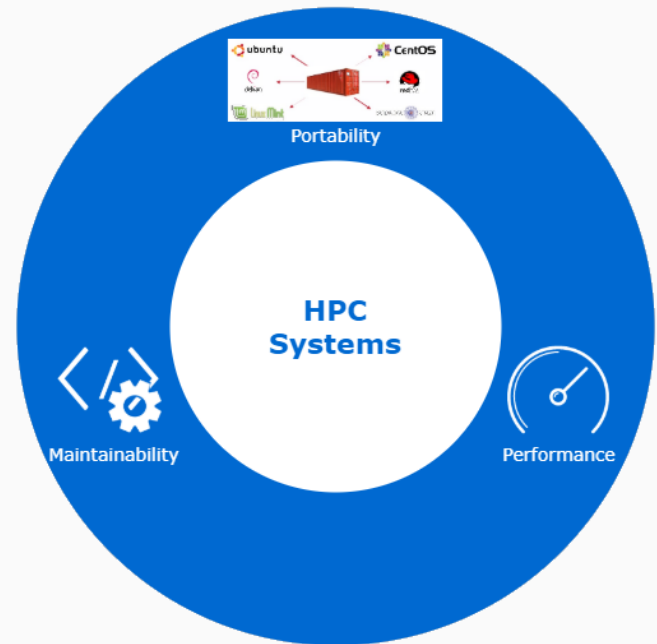
Εισαγωγή

↑ Απόδοση - StarPU

↑ Φορητότητα - SkePU



? Συντηρησιμότητα - TD

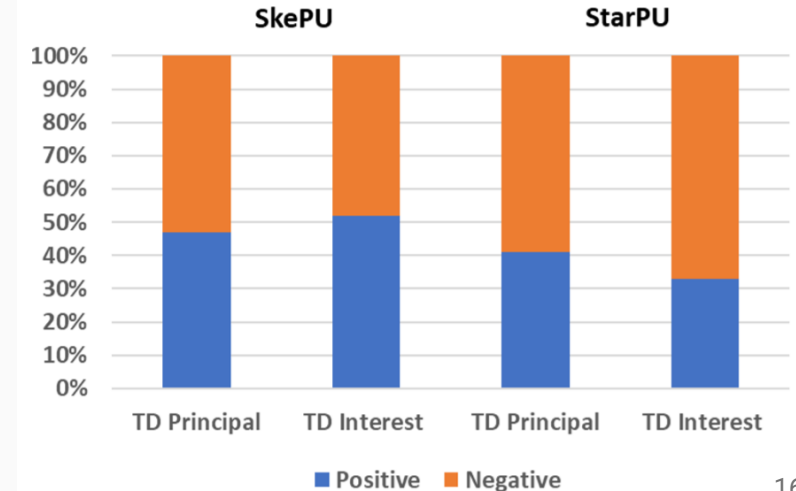


	Project	Tool	Provider
1	CO ₂ Capture	SkePU	CERTH
2	ParseC	SkePU	LIU
3	Metalwalls	SkePU StarPU	CNRS
4	Pastix	StarPU	INRIA
5	QR-mumps	StarPU	JULICH
6	Rodinia	StarPU	LIU

- Filename
 - Used Tool for Optimization (SkePU or StarPU)
 - File Type (NEW, REFACTORED, or UNCHANGED)
 - TD Principal Proxy
 - TD Interest Proxy
-
- The diagram shows two arrows originating from the left list. One arrow points from 'TD Principal Proxy' to 'Number of Code Smells'. The other arrow points from 'TD Interest Proxy' to the entire right-hand list of metrics.
- Number of Code Smells
 - Number of Functions
 - Complexity
 - Lines of Code
 - Comments Ratio
 - Fan-Out
 - Lack of Cohesion of Line

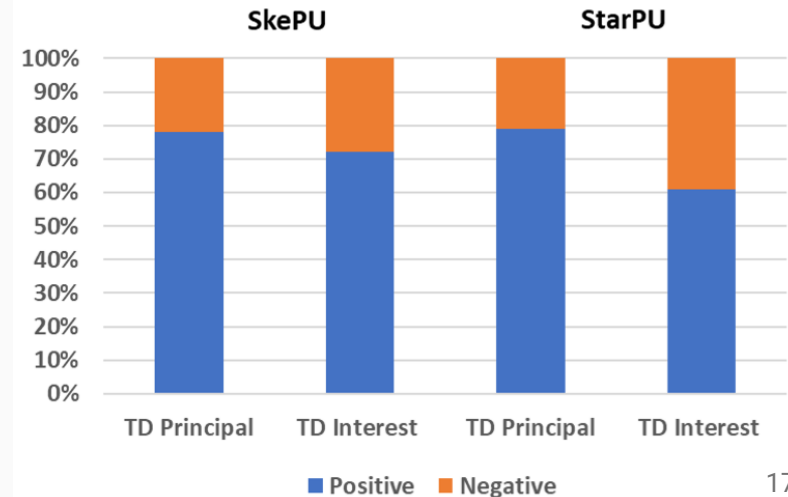
Επίδραση στο ΤΧ του αλλαγμένου κώδικα

Optimization	TD	Mean	t-value	sig.
SkePU	TD Principal	19.8%	2.591	0.014
	TD Interest	2.8%	0.989	0.336
StarPU	TD Principal	16.6%	3.256	0.001
	TD Interest	-5.2%	-2.397	0.019



Επίδραση στο ΤΧ του νέου κώδικα

Optimization	TD	Mean	t-value	sig.
SkePU	TD Principal	34.7%	2.466	0.018
	TD Interest	103.7%	3.229	0.003
StarPU	TD Principal	35.0%	3.403	0.001
	TD Interest	31.6%	2.030	0.047



Συμπεράσματα

SkePU

Δεν βλάπτει τη συντηρησιμότητα

StarPU

Φαίνεται ότι έχει αρνητική επίδραση στη συντηρησιμότητα του κώδικα που έχει αλλαχτεί

Ανάπτυξη Εργαλείου

Για την ανάλυση έργων

- Fortran
- C
- C++

Εξαρτήσεις Εργαλείου

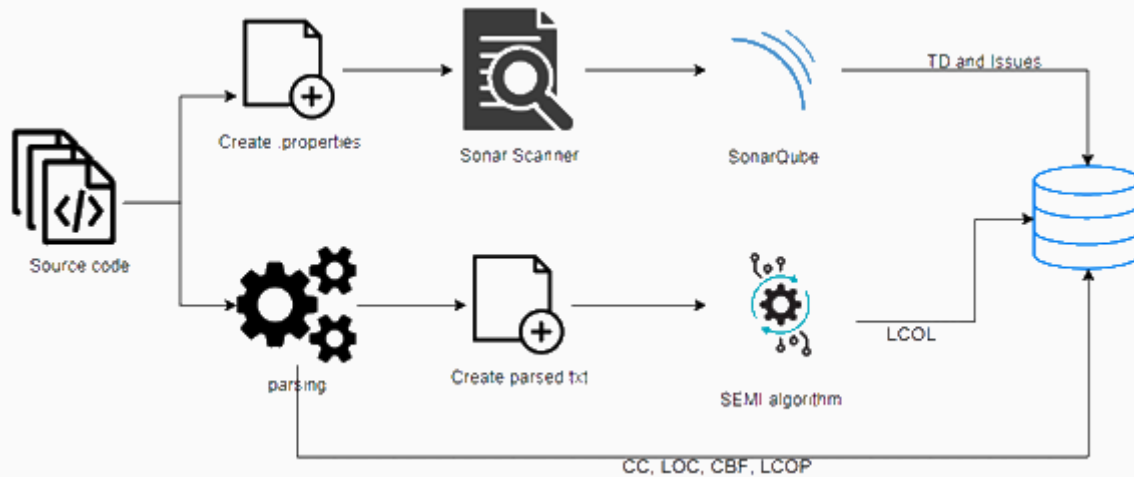
sonarqube 

- iCode CNES
- SonarQube C ++

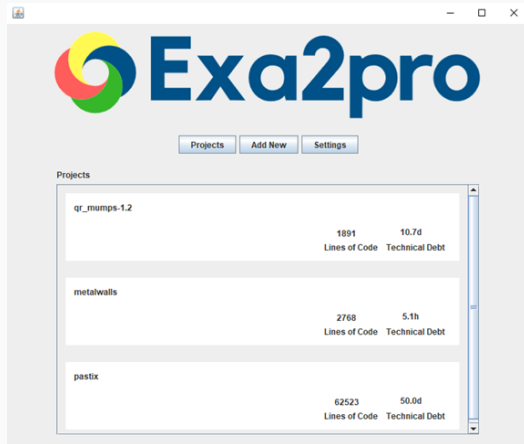
Maven  TM

 **python** TM

Ροή Ανάλυσης



Κύριο παράθυρο



The screenshot shows the Exa2pro main window with the 'Projects' tab selected. It displays a table of project statistics:

Project Name	Lines of Code	Technical Debt
qr_mumps-1.2	1891	10.7d
metalwalls	2768	5.1h
pastix	62523	50.0d



The screenshot shows the Exa2pro main window with the 'Add New' dialog open. The dialog is titled 'Add new project' and contains fields for 'Project Name' and 'Project Directory'. A 'Select Folder' sub-dialog is also open, showing a file explorer view of the 'qr_mumps-1.2' directory with folders like 'doc', 'examples', 'include', 'lib', 'makeincls', 'src', and 'test'.



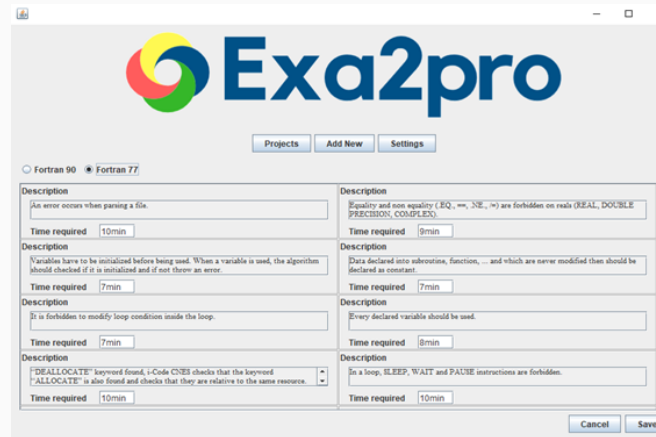
The screenshot shows the Exa2pro main window with the 'Settings' dialog open. It displays configuration options for Sonar Qube and rule effort times:

Sonar Qube URL:

iCode Path:

Sonar Qube Path:

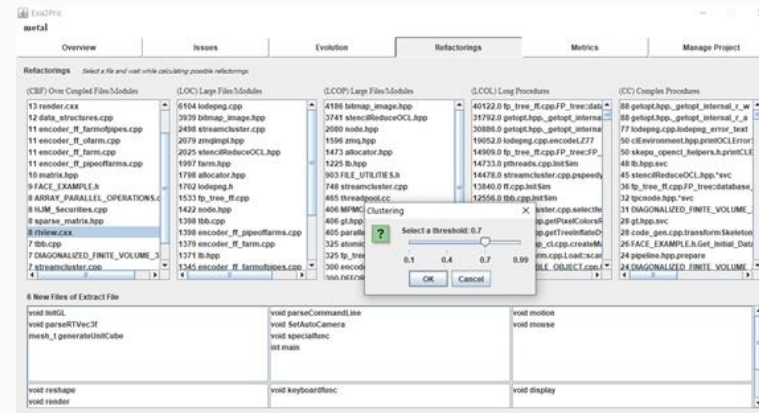
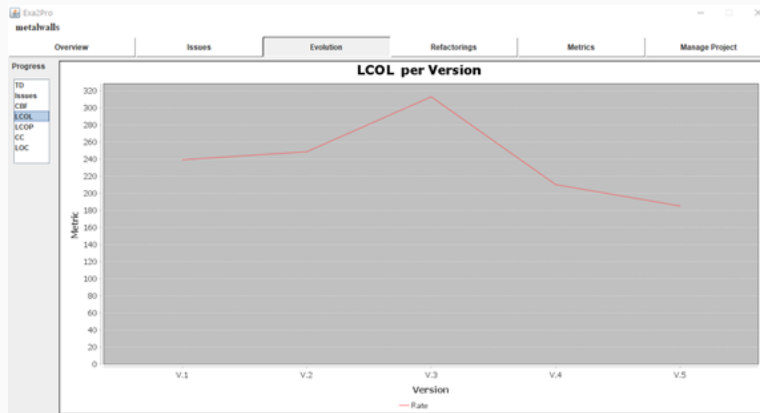
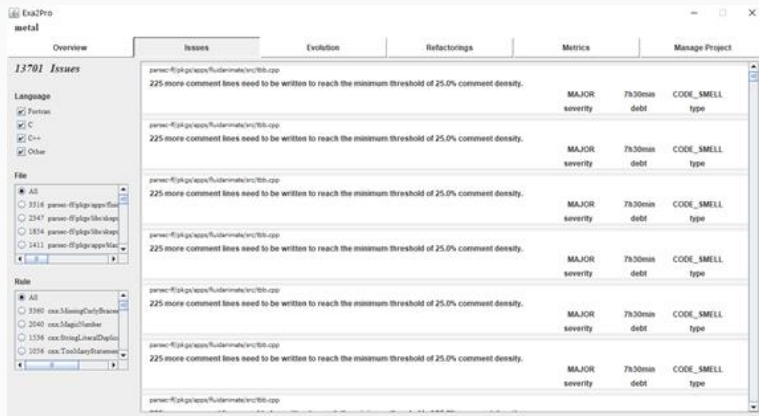
Change rule effort time:



The screenshot shows the Exa2pro main window with the 'Fortran 90' rule configuration dialog open. It displays a list of rules with their descriptions and time requirements:

Rule Name	Description	Time required
Equality and non equality (EQ, ==, NE, !=)	Equality and non equality (EQ, ==, NE, !=) are forbidden on reals (REAL, DOUBLE PRECISION, COMPLEX).	9min
Variables have to be initialized before being used	Variables have to be initialized before being used. When a variable is used, the algorithm should check if it is initialized and if not throw an error.	7min
It is forbidden to modify loop condition inside the loop.	It is forbidden to modify loop condition inside the loop.	7min
FREELOCATE keyword found	FREELOCATE keyword found. i-Code CNEI checks that the keyword ALLOCATE is also found and checks that they are relative to the same resource.	10min
Equality and non equality (EQ, ==, NE, !=)	Equality and non equality (EQ, ==, NE, !=) are forbidden on reals (REAL, DOUBLE PRECISION, COMPLEX).	9min
Variables declared into subroutines, function, ... and which are never modified then should be declared as constant.	Variables declared into subroutines, function, ... and which are never modified then should be declared as constant.	7min
Every declared variable should be used.	Every declared variable should be used.	9min
In a loop, SLEEP, WAIT and PAUSE instructions are forbidden.	In a loop, SLEEP, WAIT and PAUSE instructions are forbidden.	10min

Πληροφορίες έργου



Πληροφορίες έργου

Refactorings Select a file and ref with calculating possible refactorings

(CBF) One Copied Files/Modules	(LOC) Large Files/Modules	(LCOOP) Large Files/Modules	(CCO) C-Code Procedures	(CC) C++ Procedures
18 skipapp2.cpp	6164 lodrop.cpp	4186 bitmap_image.App	49122.0 fp_tree_fp_tree.dat	88 getoptApp_getopt_internal_w
15 main.cpp	3939 bitmap_image.App	3741 sbenc@ReduceOCL.App	31792.0 getoptApp_getopt_internal	88 getoptApp_getopt_internal_r
14 glob.h	2489 sbenc@encoder.cpp	2680 sode.App	20888.0 getoptApp_getopt_internal	77 lodrop.cpp.lodrop_error_list
13 reader.cxx	2079 pmi@mpi.h	1596 ariq.App	19052.0 lodrop.cpp.mcodeL277	50 cEnvironmentApp_printOCLError
12 data_structures.cpp	2025 sbenc@ReduceOCL.App	1473 allocator.App	14909.0 fp_tree_fp_tree.FP	50 skipapp_openccl_helpers.h.printCLE
11 encoder_fm_farm@opas.cpp	1987 farm.App	1225 lb.App	14733.0 pthreads.cpp.limSem	48 lbApp.svc
11 encoder_fm_obamr.cpp	1728 allocator.App	903 FILE_UTILITIES.h	14478.0 sbenc@encoder.cpp.papw	45 sbenc@ReduceOCL.App.*svc
11 encoder_fm_farm.cpp	Algorithm Option	13840.0 ft.cpp.limSem	12556.0 tlb.cpp.limSem	32 tlbcode.App.*svc
10 main.cpp	Would you like to use the Faster Opportunity extractor, but in accuracy drawback?	10999.0 sbenc@encoder.cpp.selectC	10999.0 sbenc@encoder.cpp.selectC	31 DIAGONALIZED_FINITE_VOLUME_
9 FACE_EXAMPLE.h	Yes No	9532.0 lodrop.cpp.getFaceColors	8966.0 lodrop.cpp.getTreeInflateC	28 gtApp.svc
8 ARRAY_PARALLEL_OPER		8869.0 mapwrap_cl.cpp.createC	8869.0 mapwrap_cl.cpp.createC	28 code_gen.cpp.transformSkeleton
8 HLM_Securities.cpp		8869.0 format@farm.cpp.LOOP@SEC	8869.0 format@farm.cpp.LOOP@SEC	26 FACE_EXAMPLE.h.Get_Initia_Data
8 sparse_matrix.App		8488.0 DEFORMABLE_OBJECT.cpp.*	8488.0 DEFORMABLE_OBJECT.cpp.*	24 diagonalized_finite_volume_
8 (f)@W.CXX				
4				

Opportunity refactorings

- 389-493 Load@scan_did: 6853.0
- 263-478 Load@scan_did: 1607.0

File	CBF	LOC	LCOOP
blackcholes.c	4	560.0	0
blackcholes_skipapp	0	373.0	0
blackcholes_skipapp.cpp	0	747.0	0
blackcholes_skipapp.cpp	0	532.0	0
main.cpp	165	532.0	36
ParticleIOEFF.h	2	129.0	3
Tracing@tcode.cpp	5	229.0	66
Tracing@tcode.h	6	164.0	0
Tracing@tcodeFF.cpp	3	166.0	39
Tracing@tcodeFF.h	2	47.0	0
FACE_EXAMPLE.h	9	469.0	0
main.cpp	6	115.0	0
ARRAY_PARALLEL_OPERATIONS.cpp	8	644.0	78
DIAGONALIZED_OBJECT.cpp	7	631.0	266
DIAGONALIZED_FINITE_VOLUME_3D.cpp	7	1240.0	231
FILE_UTILITIES.cpp	2	376.0	NonDefined
FILE_UTILITIES.h	2	497.0	903
format@farm.cpp	1	498.0	11
format@farm@opas.cpp	1	491.0	11
format@opas@farm.cpp	1	511.0	11
format@serial.c	0	331.0	6
ft.cpp	3	1213.0	122
pthread.cpp	4	1277.0	140
tlb.cpp	7	1388.0	158
fpmax.cpp	3	209.0	4
fp_tree_fp.cpp	3	1633.0	325
render.on	13	968.0	NonDefined
rtree.on	8	488.0	88
WInclude.h	3	314.0	136
HLM_Securities.cpp	0	356.0	0
Image@pool.cc	0	1071.0	466
main.c	0	1060.0	374

Options

- New Version Ready to be Analyzed
- Delete Last Analysis
- Delete Project

Εμπειρικά Αποτελέσματα Αποπληρωμής Τεχνικού Χρέους

Στα έργα:

- CO₂Capture v.1
- CO₂Capture v.2
- MetalWalls
- LQCD
- KKRnano

Ενσωματωμένα Refactorings



Project	Extract Procedure	Extract File / Module
CO ₂ Capture v.1	25/25	1/1
CO ₂ Capture v.2	36/39	6/6
MetalWalls	61/79	2/5
LQCD	0/1	-
KKRnano	0/7	1/1

Αλλαγές σε μετρικές και TD Interest

Project	CC	LCOL	LOC	CBF	LCOP	TD Interest
CO ₂ Capture-1	-10.3	-60.9	0.5	0.0	0.0	-19.0
CO ₂ Capture-2	-38.0	-80.7	-10.4	-5.3	-26.1	-21.9
MetalWalls	-16.0	-71.4	-0.4	2.0	-75.0	-31.5
LQCD	-9.1	-11.0	48.8	-7.1	-10.0	0.5
KKRnano	0.0	-7.2	-4.6	10.0	-0.1	-4.9

Αλλαγές σε χρόνο εκτέλεσης



Σύνοψη

1)



TD Principal

Ποσοτικοποίηση TX

Αποπληρωμή TX



SEMI

Agglomerative Clustering

2)



SkePU



StarPU

3)

Project	Lines of Code	Technical Debt
gr_nimble-1.2	1891	13.70
metawebs	2766	5.58
partix	62523	56.06

4)

Αποπληρωμή TX



SEMI

Agglomerative Clustering



Περιορισμοί

Μικρός αριθμός έργων

4 αξιολόγηση αποπληρωμή

6 επίδραση βελτιστοποιήσεων

Μελλοντικές Επεκτάσεις

Περισσότερα έργα

Ανάπτυξη επιπλέον λειτουργιών

Σας Ευχαριστώ

Ερωτήσεις

