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STEAME ACADEMY
TEACHING FACILITATION LEARNING & CREATIVITY PLAN (L&C PLAN) - LEVEL 2
SERVICE TEACHERS: I can build my own search engine!

S T Eng A M Ent

1. Overview

Title	Finding a needle in a haystack: I can build my own search engine!		
Driving Question or Topic	How do search engines work? How can I implement a topical search engine? What is Digital Art?		
Ages, Grades, …	16 to 18 years old	10th to 12th grades	
Duration, Timeline, Activities	18 hours	9 sessions of 2 hours each	19 activities
Curriculum Alignment	Information retrieval, search engines, computer programming, digital ats		
Contributors, Partners			
Abstract - Synopsis	Students are introduced to information retrieval, focusing on search engines. An overview of the subject is provided culminating with the discussion of the general architecture of a search engine and open libraries available to code such systems. Students are challenged to design and implement a prototype for a search engine specific for a single topic. This topic must be in arts; this plan addresses the topic of Digital Arts but we may focus on any other. Arts teachers brief students about Digital Arts. After these preliminary introductions to search engines and digital arts, we follow a guide to implement, test and evaluate a digital arts search engine. In the two last sessions students present their prototypes in plenary and discuss with all the class the pros and cons of each approach in terms of technology (search engines) and content (digital arts).		
References, Acknowledgements			

2. STEAME ACADEMY Framework*

Teachers' Cooperation	Teacher 1 (Technology) • Information retrieval (purpose, tasks, evaluation measures) • Search engines (components, architecture, challenges) Teacher 2 (Engineering) • Software libraries for information retrieval (Lucene, python, wget, other) Teacher 3 (Arts) • Digital arts Teacher 1 cooperates with Teacher 2 to: - identify the software libraries to use for deploying the search engine prototype (wget, Lucene, Python libraries) Teacher 1 cooperates with Teacher 3 to: - identify the information sources (url) for the specific topic being addressed (Digital Arts) Teacher 1 cooperates with Teacher 2 and Teacher 3 to: - create the exercises and the challenge guide - gather a validation corpus for the practical activities and final evaluation of the prototypes - annotate the validation corpus for each exercise
STEAME in Life (SiL) Organization	The last sessions are used to test, evaluate and discuss in plenary the prototypes deployed by the students and compare them to standard search engines, such as Google. Students are requested to compare their prototype with standard search engines and to suggest improvements for their prototypes covering all the components of a search engine (crawling, indexing, searching, presenting).
Action Plan Formulation	**Preparatory Phase** 1. Research search engines features, their components/phases (architecture), evaluation (recall, precision), and state-of-the-art applications for public and corporate cases; review main challenges of information retrieval. 2. Prepare a briefing on Information Retrieval, focusing on Search Engines. 3. Prepare a briefing on Digital Arts. 4. Gather and annotate corpora for exercises and validation. 5. Research search engines' technology (open-source libraries like Lucene or Python, wget, R or other). 6. Setup the programming environment (docker, repository in Github to clone,

other).
7. Draft the challenge call, the guide to follow to deploy the prototype and the final evaluation procedure.

Workshop Structure

1. Introduction
    a. Overview of Information Retrieval: historical perspective, tasks/problems, applications, use cases, search engines for public and corporate use; direct towards Search Engines. Search Engines architecture. Discuss with students.
    b. Briefing of Digital Arts: history, innovative art forms, where to find, digital art galleries, key players.

2. Search Engines
    a. Start with the general search engine architecture and explain each one of its components (crawling, corpus gathering, pre-processing, indexing, searching, browsing, filtering, presentation of results, evaluation) in terms of responsibilities, interfaces, implementation, tools and software libraries, issues/challenges.
    b. Evaluation of search results: precision, recall, other.
    c. Show examples of implementation and deployment of a search engine, distinguishing each one of its components. Students explore and use them to criticize and discuss in group.
    d. Present software libraries to implement information retrieval systems (in particular, search engines).

3. Digital Arts
    a. Where to find Digital Arts works. Digital art galleries, key players.
    b. Show examples of distinct forms of digital arts. Ask students to find more.

4. Implementation
    a. Teachers give students the challenge and clarify any doubts.
    b. Students search and retrieve sources of information to gather their corpus on Digital Arts.
    c. Introduce the software libraries to build search engines that will be used in the workshop. Explain where to find and use them (clone a repository, install a docker or any other).
    d. Each team designs the Digital Arts Search Engine (architecture, features, functionalities, interfaces).
    e. Implementation of each component
        i. Crawling
        ii. Indexing
        iii. Searching
        iv. Presenting
        v. Evaluating
    f. Deployment and testing

Evaluation and Reflection

1. Assess students' understanding and application of information retrieval concepts through project-based assessments, presentations, and written reflections.
2. Final assessment
   2.1. Each students' team evaluates the prototype deployed by another team and delivers an evaluation report of one page, covering all the components of a search engine: overview (how fit is the prototype for its purpose in overall terms, strong points, weak points, recommendations for improvement).
   2.2. Teachers provide the validation corpus (documents, queries and ideal ranking) and ask students to add it to their own corpus using their prototype.
   2.3. In plenary, each prototype is used to search the queries provided for validation; precision and recall are computed for the documents of the validation corpus.
3. Encourage students to reflect on their learning experiences, highlighting the relationship between the technicalities of search engines and the features describing digital arts works. Are the models and techniques used to search in the digital arts search engine adequate to the content/subject? What should be improved/changed? Link to search by visual features; link to visualization of search results.

[*] *under development the final elements of the framework*

3. Objectives and Methodologies

Learning Goals and Objectives	1. Understand the generic modelling and processing concepts and techniques used in information retrieval 2. Explore the critical features (technical and content wise) to address when implementing search engines to browse arts works 3. Illustrate the similarities and dissimilarities between text documents and other unstructured data sets, like digital arts works, from the point of view of automatic digital processing
Learning Outcomes and expected Results	**Learning Outcomes** A. Discuss high level topics related to the fields of information retrieval and search engines B. Discuss high level topics related to digital arts C. Apply basic techniques of information retrieval to design topical (subject oriented) search engines **Expected Results** 1. Digital arts search engine prototype 2. Evaluation report assessing a prototype of a search engine for digital arts

Prior Knowledge and Prerequisites	1. Software programming skills at intermediate level 2. Fundamental knowledge of search engines 3. Proficient use of the web, IT tools and web browsers
Motivation, Methodology, Strategies, Scaffolds	1. Assign students to small teams (3 or 4 students). 2. Design a solution, implement, test and refine in an iterative way. Use an iterative development methodology. 3. Explore search engines to showcase their functionalities and highlight the relationship with each component of search engine´s architecture. 4. Guide students through an evolutionary path from the most simple implementation to a full featured prototype, introducing challenges step by step.

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	The workshop will be held in a classroom for approximately 20 students, in groups of 3 or 4 students. Ideally the classroom layout will be organized in 5 to 7 groups of tables where students from each team can sit facing each other. The room needs a beamer and a wall for presentations to all and a white board with pens to discuss ideas.
Resources, Tools, Material, Attachments, Equipment	A repository in GDrive, Teams, Github or any other provider shall be prepared in advance with all the programming environment (R, Python, …) and the corpora needed for the hands-on sessions, exercises and validation. A document must be provided to guide students throughout all the course/workshop, explaining details, expected results, assessment and learning outcomes per session.
Health and Safety	

5. Implementation

Instructional Activities, Procedures, Reflections	**Workshop Structure** 1. Introduction (present information to students; promote active discussion when introducing concepts to engage students) [Session 1: 2 hours, 4 activities] e. Overview of Information Retrieval: historical perspective, tasks/problems, applications, use cases, search engines for public and corporate use; direct towards Search Engines. Search Engines architecture. [40 minutes expository session] f. Discuss with students about search engines architecture. [20 minutes discussion guided by teacher]

g. Briefing of Digital Arts: history, innovative art forms, where to find, digital art galleries, key players. [40 minutes expository session]
h. Discuss with students: want are the main issues to deal with when searching for digital arts that you can anticipate? [20 minutes debate guided by teacher]

2. Search Engines [Session 2: 2 hours, 3 activities]
    e. Start with the general search engine architecture and explain each one of its components (crawling, corpus gathering, pre-processing, indexing, searching, browsing, filtering, presentation of results, evaluation) in terms of responsibilities, interfaces, implementation, tools and software libraries, issues/challenges. Evaluation of search results: precision, recall, other. [60 minutes exposition]
    f. Show examples of implementation and deployment of a search engine, discuss the contribution of each one of its components. [30 minutes exposition]
    g. Present software libraries to implement information retrieval systems (in particular, search engines). [30 minutes demonstration]

3. Digital Arts [Session 3: 2 hours, 4 activities]
    e. Where to find Digital Arts works. Digital art galleries, key players. [30 minutes demonstration]
    f. Show examples of distinct forms of digital arts. [20 minutes demonstration]
    g. Ask students to find more digital arts galleries and other sources of digital arts works and discussion. [40 minutes hands-on, group discussion]
    h. Teachers give students the challenge and clarify any doubts. [30 minutes, problem solving]

4. Implementation 1 [Session 4: 2 hours, 3 activities]
    e. Students explore public search engines to criticize and discuss in group the pros and cons of such search engines (Google, Yahoo, Bing, ChatGPT and generative AI approaches) for the specific case at hand (browsing digital arts). [40 minutes, research, exploration and debate]
    f. Introduce the software libraries to build search engines that will be used in the workshop. Explain where to find and use them (clone a repository, install a docker or any other). [20 minutes, demonstration]
    g. Students' teams setup their development environment (clone a repository, install a docker or any other; following the setup guide). [60 minutes, hands-on]
5. Implementation 2 [Session 5: 2 hours, 2 activities]
    e. Each team designs the Digital Arts Search Engine (architecture, features, functionalities, interfaces). [60 minutes problem solving]
    f. Students search and retrieve sources of information to gather their corpus on Digital Arts and setup the local corpus infrastructure. [60 minutes, problem solving]

	6. Implementation 3 [Sessions 6, 7 and 8: 6 hours, 1 activity] g. Implementation and deployment of the digital arts search engine prototype, consider all its components [6 hours, problem solving] i. Crawling ii. Indexing iii. Searching iv. Presenting v. Evaluating 7. Implementation 4 [Session 9: 2 hours, 2 activities] h. Testing and evaluation [1 hour, problem solving] i. Plenary debate, conclusions [1 hour, debate, reflection]
Assessment - Evaluation	**Evaluation and Reflection** 1. Assess students' understanding and application of information retrieval concepts through project-based assessments, presentations, and written reflections. 2. Final assessment 2.1. Each students' team evaluates the prototype deployed by another team and delivers an evaluation report of one page, covering all the components of a search engine: overview (how fit is the prototype for its purpose in overall terms, strong points, weak points, recommendations for improvement). 2.2. Teachers provide the validation corpus (documents, queries and ideal ranking) and ask students to add it to their own corpus using their prototype. 2.3. In plenary, each prototype is used to search the queries provided for validation; precision and recall are computed for the documents of the validation corpus. 3. Encourage students to reflect on their learning experiences, highlighting the relationship between the technicalities of search engines and the features describing digital arts works. Are the models and techniques used to search in the digital arts search engine adequate to the content/subject? What should be improved/changed? Link to search by visual features; link to visualization of search results.
Presentation - Reporting - Sharing	1. Digital arts search engine prototype 2. Evaluation report assessing a prototype of a search engine for digital arts
Extensions - Other Information	

STEAME ACADEMY Prototype/Guide for Learning & Creativity Approach
Action Plan Formulation

Major steps in the STEAME learning approach:

STAGE I: Preparation by one or more teachers

1. Formulating initial thoughts on the thematic sectors/areas to be covered
2. Engaging the world of the wider environment / work / business / parents / society / environment/ ethics
3. Target Age Group of Students - Associating with the Official Curriculum - Setting Goals and Objectives
4. Organization of the tasks of the parties involved - Designation of Coordinator - Workplaces etc.

STAGE II: Action Plan Formulation (Steps 1-18)

Preparation (by teachers)

1. Relation to the Real World – Reflection
2. Incentive – Motivation
3. Formulation of a problem (possibly in stages or phases) resulting from the above

Development (by students) – Guidance & Evaluation (in 9-11, by teachers)

4. Background Creation - Search / Gather Information
5. Simplify the issue - Configure the problem with a limited number of requirements
6. Case Making - Designing - identifying materials for building / development / creation
7. Construction - Workflow - Implementation of projects
8. Observation-Experimentation - Initial Conclusions
9. Documentation - Searching Thematic Areas (AI fields) related to the subject under study – Explanation based on Existing Theories and / or Empirical Results
10. Gathering of results / information based on points 7, 8, 9
11. First group presentation by students

Configuration & Results (by students) – Guidance & Evaluation (by teachers)

12. Configure STEAME models to describe / represent / illustrate the results
13. Studying the results in 9 and drawing conclusions, using 12
14. Applications in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)

Review (by teachers)

15. Review the problem and review it under more demanding conditions

Project Completion (by students) – Guidance & Evaluation (by teachers)

16. Repeat steps 5 through 11 with additional or new requirements as formulated in 15
17. Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions

18. Presentation of Conclusions - Communication Tactics.

STAGE III: STEAME ACADEMY Actions and Cooperation in Creative Projects for school students

Title of Project: _____
Brief Description/Outline of Organizational Arrangements / Responsibilities for Action

STAGE	**Activities/Steps** Teacher 1(T1) Cooperation with T2 and student guidance	**Activities /Steps** **By Students** Age Group: ____	**Activities /Steps** Teacher 2 (T2) Cooperation with T1 and student guidance
A	Preparation of steps 1,2,3		Cooperation in step 3
B	Guidance in step 9	4,5,6,7,8,9,10	Support guidance in step 9
C	Creative Evaluation	11	Creative Evaluation
D	Guidance	12	Guidance
E	Guidance	13 (9+12)	Guidance
F	Organization (SIL) STEAME in Life	14 Meeting with Business representatives	Organization (SIL) STEAME in Life
G	Preparation of step 15		Cooperation in step 15
H	Guidance	16 (repetition 5-11)	Support Guidance
I	Guidance	17	Support Guidance
K	Creative Evaluation	18	Creative Evaluation