MiniNotes on Computer Networks.
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Abstract
In this whitepaper, the idea of MiniNotes on Computer networks is presented. MiniNotes are very short versions of notes on a specific topic, with an upper limit of 5 pages, which can be easily produced also in paper, or in the form of an ebook, while contain links to multimedia content, accessible through QR code weblinks.

Introduction
Up to now, online education has been a complement or an alternative to the traditional methods of in class teaching, where physical presence is considered granted. And though many courses are available online, offering asynchronous and/or synchronous training, the abrupt transition from the standard, in class tutoring to entirely online, has been a big challenge. What is important here, is the fact that education stakeholders, have been asked to make this transition from the physical (presence) or cyberphysical (if you consider the online complements of courses) framework, to the purely cyber. And if up to recently the use of online resources was optional, it has now become mandatory due to the pandemic, with all consequences and challenges this means regarding equipment, connectivity, and privacy concerns.

During the current semester, we had the luck of teaching courses at graduate level which were not only able to be delivered through online education, but were also on technologies used to empower online education: Object Oriented programming and Computer Networks. And though the Computer Networks course (provided online over the eclass [1] platform) is supported by several online/offline tutoring aids including recommended books, slideshows, animations, videos, accompanying software and open source tools, what was accessed (and valued) most by the students, where short, comprehensive notes on topics, especially those having a profile closer to practice and labs.

This has given the idea of creating the MiniNotes, inspired both by the concepts of the Minute-paper [2] and the two-minute papers [3], both explained in the next section. Based on the efficiency of the first in quickly getting feedback on the level of understanding of students, and their views on the lectures, and the simple and easy way offered by the second in order to introduce even difficult concepts, the idea of the MiniNotes has emerged, trying to provide a quick way to present (either as an introduction or as a quick review) a particular topic.

Though proposals on books providing summaries on a single topic in a smaller form than a usual textbook exist, the concept of MiniNotes comes to split the necessary knowledge on a subject, into small, individual quantum of knowledge. The selection of computer networking as the application field of this concept has been done based on the fact that the corresponding course is fundamental for many others, and therefore knowledge of basic principles (or even the need for a quick reference) is quite important for any student studying in a domain related to Electrical and Electronics Engineering.

Minute paper, two-minute papers, MiniNotes
Everyone who has been involved in online teaching is aware that online time counts differently that physical presence time. Participating in an online course is quite different than presence in an amphitheater or a classroom, with the distractions and reasons to lose your attention to the lecturer being far more plenty. Therefore, the lecture time should be less with an equal need for more and
frequent attention triggers. Borrowing from good practices and successful paradigms, the idea of exploiting the “Minute” and “Two minute” papers has been conceived.

The Minute-paper [2] is a very commonly used classroom assessment technique usually used at the end of class or a topic discussion to provide rapid feedback on the students’ perception of the presented idea. The Two-minute papers [3] is a Youtube series of short videos, where many interesting research works are explained in a couple of minutes at a time, through language understandable to anyone.

Starting from the two previous examples, the idea of complementing the online teaching process with an educational supplement featuring the same philosophy, has emerged: The name we used was “MiniNotes on”, and it consists of short notes in PDF, explaining a topic, according to the following principles:

1. Each MiniNote document should not exceed five pages, including illustrations TOC and references.
2. Content should describe the basic principles of the topic addressed.
3. References to standards or explanation of core terms should be included.
4. Links to online video presentations should be also included, again following the same principle:
   a. Video presentations should be short, less than three minutes.
   b. Each video should correspond to a subsection of the document (not one video for the whole document, unless this can fit in the previous time limit).
5. The document (and the corresponding video), should be able to be used even without a computer. Therefore, the link to the video should be made available through QR code, which can be scanned from all mobile devices.

At this point, the question “Why 5 pages?” may come to mind. Since there was the need of setting a limit, which is not stressful, but a motivation to acquire the “art of summarizing”. The latter means to help the readers to build their own discrete, semi-structured cognitive schema of what is presented, even from the first reading, so that they find as soon as possible, the right connections to their long-last memory. This entails a lot of effort from the author’s site; to build the right structure to guide the reader from lower to higher cognitive skills; to “torture” the words in order to find the ones “that worth 1000 pictures”. Videos can be illustrative enough, but not advantageous for readers’ critical and creative thinking. Therefore, and based on attempts to compile MiniNotes on some topics in Computer Networks (i.e. TCP, IP, UDP, P2P concepts), the number 5 for the limit of pages has been selected.

Up to now, teaching of the Computer Networks course has been based on the use of eclass, where documentation, links, assignments to students and communication through announcements and messaging has been supported. Though the material available there has been quite comprehensive, including video lectures, PowerPoint slides, links to resources globally, we have always had the same question raised by students: How can I better prepare for the exams? Though students ranking high in the course evaluation are making use of all (or at least most) of the resources, the majority of students is interested in an efficient way to get access to information about the principles of the courses. Taking into account the “fast track” nature of communication of the Social Networks generation, and the long hours students were asked to spend online during the pandemic, one can understand the need for learning material which is short, targeted, and easy to read. The latter manifestation is in line with a spiral approach of learning – iterative move from basic ideas to more details, inspired from Bruner’s work [4] – also corresponding to the inverted pyramid style of reading in our days of mass communication [5]. The focus is on the right size and the details of each learning “chunk”. This (in
combination with the strongly practical nature of a Computer Networks course), has led to the idea and compilation of first versions of MiniNotes on Computer networks.

As it was presented in the introduction, the concept of MiniNotes has been conceived in order to serve a dual purpose:

1. To quickly introduce to a topic (in which case, some of the MiniNotes might have "prerequisites" (other MiniNotes), as is the case of congestion control mechanisms in TCP, where basic knowledge of TCP is required, or
2. to act as a reference point to key topics to a subject, in order to help the process of remembering or quickly reviewing a subject. In this case, some minimal background knowledge from the readers is assumed.

Introducing the MiniNotes in the educational process can have again two alternatives;

1. Use the MiniNotes as summary documents linked to milestones in a learning path, and therefore acting as beacons to the preparation for exams, or
2. Form a set of notes in a crash course or intro, mainly addressing to inform rather than educate on a topic.

Topics
Based on the teaching experience, also on the need to evaluate student’s knowledge, proposed topics for the MiniNotes on Computer networks include:

- Internet Protocol standards (IPV4/IPv6) with emphasis on the IP headers and the way they are handled by the routers
- Transport protocols (TCP/UDP), with emphasis on the Transport headers and how they support the different types of services over IP
- Network addressing and subnetting
- Methods to ensure reliable and adaptive data transmission (i.e. congestion/flow control)
- Open/layered protocol architectures and principles
- Service examples (i.e. DNS/HTTP/FTP/SMTP)

Creating the MiniNotes
The idea of the MiniNotes is to stimulate the interest and focus on the most important parts of a topic, instead of capturing the cognitive or affective dimensions of the student’s learning experience (pursued by in Minute-papers). Therefore, in an attempt to reverse engineer the concept of the Minute-paper, a set of guidelines for the preparation of the MiniNotes has been defined, starting from frequently used minute-paper questions, as these are reported in [6]. These are listed in the following, followed by examples (TCP protocol has been used for this demo):

- **Focus on the most memorable parts of the presented topic.** The issue of TCP could take a whole book to cover. Therefore, it is the best selection for presenting an example here: A selection of topics to be presented includes
  - TCP services
  - Ports
  - TCP header
  - Application layer message transport
  - Connection setup
  - Connection termination
Reliable data transfer and rate control mechanisms
All the above should correspond to memorable titles, as presented in the next bullet.

- Breakdown the MiniNote text in sections having corresponding titles that refer to the core ideas of the presented topic. The use of titles could even help highlight specific issues on the presented topic. For example, the process of session setup and termination could be split into two parts, each having the corresponding title (TCP session setup/TCP session termination), therefore providing a memorable link to the students.

- Include material which can be used as reference to a practical/lab exam. For this, a picture on the TCP header, such as the one provided in [8] could be used, followed by quick explanation of the TCP header sections. This could provide the basis over which lab exercises using Wireshark [9] could be offered.

- Include explanatory videos in sections where processes are involved, or provide examples of the use of tools. For TCP, videos where the three-way handshake process, session termination, numbering of segments/acknowledgment mechanism and retransmission/rate control mechanisms could be provided. Such media also include animated gifs, or small video segments, about 4-5” – in the latter, basic video editing skills might be acquired.

- Provide links/references to other relevant topics (if available to other MiniNotes). For the case of TCP, references should be made to the transport layer and its services, to the UDP protocol and to mechanisms for reliable, end to end data exchange.

- Prepare the “right” questions:
  1: For each basic concept or part, questions must be prepared following a pedagogical approach deploying all different levels of core cognitive skills (collection, organization, analysis and transcendence [7]).

Next steps
Though it is quite early to have evaluation feedback on the idea (since it has emerged out of the online training experience during the pandemic), the first results are encouraging. However, the existing (still under compilation) set of MiniNotes is focusing on the theoretical part of the course. Since the practical part is very important for every computer networks course, it should also be reflected in the notes. Here, exist two alternatives: The first is to produce a series of “practical” MiniNotes, featuring lab exercises, corresponding to the MiniNotes theory topics, and the second would be to integrate the practical/lab part to the existing MiniNotes. The first option would require that the basic knowledge on the use of tools would need to be presented, taking space on the notes, which should be allocated to the topic (practical examples). On the other hand, all tools already come with explanatory notes or videos. Therefore, the idea of supplementary material (which could exist in different versions, depending on the tool adopted) seems to be the best choice. This material could again be provided in the form of links available in a QR code format.

As regards the form of the MiniNotes, the PDF version is the most suitable, since it can be presented in all devices, and easily printed. Enhanced versions could easily be derived from it (i.e. ebook or flipbook). What would be more interesting is the scaling of the idea, towards the provision of an ebook that can “shrink” down to the size of a MiniNote. This, combined with personalization capabilities offered over a (computer/tablet/smartphone) application could allow the student to select the book version, he/she would like to read: Full book version when searching on details about a particular topic, or MiniNote, if you just want to refresh your knowledge.

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1 “There are no wrong answers, only wrong questions”, famous quote by Jerome Bruner [4]
Finally, one interesting idea of evolving the concept of MiniNotes in the course of engaging the students, is the provision of the MiniNotes in the form of electronic flipbooks, where the students could publish commentary or questions/answers, or even edit a crowdsourced version of the MiniNote itself, like a Wikipedia entry – to make it a “living document”. The latter would help identify interests of the students in the particular topic of the MiniNote, and help the compilation of future versions.

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References