Development of Online Judge Using Contestant PC As Worker of Autograder

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***Abstract*—Competitive programming is a computer science competition where the contestants compete to solve computer science problems by writing a program which satisfies the problem constraints. Autograder is used to grade contestant solutions automatically in real-time. Usually autograder is deployed in many computers to increase grading performance. In this work, contestant computers are used as worker to run autograder. By using contestant computers as worker, the number of worker will proportional to the number of contestant submissions, thus increasing grading performance. Every contestant computers have different specification and can affect grading fairness. To keep grading fairness, contestant's solution and jury's solution executed in contestant worker and compared to check whether contestant's solution satisfies problem constraints. This work tested by simulating grading process in contestant computers. The testing result indicates that using contestant computers as worker gives performance improvement in the grading process.**

***Index Terms*—competitive programming, online judge, autograder.**

I. Introduction

Competitive programming merupakan salah satu cabang lomba yang cukup populer di bidang *computer science*. Pada kompetisi *competitive programming*, peserta diminta menyelesaikan persoalan terkait *computer science* yang diberikan oleh juri secara benar dan dalam waktu yang singkat. Beberapa instansi dan organisasi seringkali mengadakan kompetisi ini secara rutin. Perusahaan teknologi besar seperti Google dan Facebook pun seringkali mengadakan kompetisi *competitive programming* secara tahunan. Kompetisi *competitive programming* ditunjang dengan menggunakan sistem *online judge*. Sistem *online judge* tersebut biasanya berupa halaman *web* dimana peserta dapat melihat soal, membuat klarifikasi, mengirimkan jawaban dan melihat *scoreboard*. Sistem *online judge* yang populer pada saat ini adalah Codeforces, URI *Online Judge* ([**?**]), Uva, dan SPOJ.

Di dalam sistem *online judge*, terdapat sistem *autograder* yang digunakan untuk menilai jawaban peserta. Jawaban peserta yang berupa *source code* dalam bahasa pemrograman tertentu akan dinilai kebenarannya oleh sistem *autograder* dengan cara melakukan kompilasi pada kode tersebut kemudian mengeksekusi program hasil kompilasi dengan *test-case* yang sudah disiapkan oleh juri atau pembuat soal. Menurut [**?**], cara tersebut disebut sebagai *black-box grading*. Dengan menggunakan *autograder*, penilaian jawaban peserta dapat dilakukan secara otomatis dan keterlibatan manusia menjadi lebih sedikit. Untuk meningkatkan jumlah jawaban peserta yang dapat dinilai dalam satuan waktu, biasanya juri menyiapkan lebih dari satu komputer yang menjalankan sistem *autograder*. Untuk menjalankan *autograder* pada lebih dari satu komputer, diperlukan komputer dengan spesifikasi yang sama untuk menjaga keadilan penilaian.

Saat ini, hampir semua kompetisi *competitive programming* menggunakan sistem *autograder*. Kebanyakan dari kompetisi tersebut juga telah menggunakan lebih dari satu *autograder* untuk meningkatkan kinerja penilaian. Kinerja penilaian didefinisikan sebagai banyaknya jawaban yang dapat dinilai oleh sistem *online judge* dalam satuan waktu. Meskipun begitu, karena banyaknya peserta yang mengikuti kompetisi tersebut, seringkali jumlah *autograder* yang disiapkan oleh juri kurang dan mengakibatkan jawaban peserta tidak dapat dinilai secara cepat. Penggunaan sistem *autograder* yang banyak juga menghabiskan banyak biaya karena perlu menyewa komputer dengan kinerja yang cukup tinggi untuk menjalankan sistem *autograder* tersebut. Oleh karena itu, diperlukan sistem penilaian baru yang dapat mengurangi biaya pengadaan infrastruktur guna menjalankan sistem *autograder*.

Dalam mengikuti kompetisi *competitive programming*, peserta umumnya menggunakan komputer pribadinya untuk menulis program yang digunakan untuk menyelesaikan soal yang diberikan. Setiap komputer yang digunakan oleh peserta umumnya memiliki spesifikasi yang cukup untuk melakukan kompilasi pada *source code* yang ditulis oleh peserta dan melakukan eksekusi program hasil kompilasi tersebut. Oleh sebab itu, komputer peserta berpotensi untuk menjadi infrastruktur yang dapat digunakan untuk melakukan penilaian program oleh *autograder*.

II. Ease of Use

A. Maintaining the Integrity of the Specifications

The IEEEtran class file is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an

independent document. Please do not revise any of the current designations.

III. Prepare Your Paper Before Styling

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections III-A–III-E below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads—LaTeX will do that for you.

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: "Wb/m^2" or "webers per square meter", not "webers/m^2". Spell out units when they appear in text: ". . . a few henries", not ". . . a few H".
- Use a zero before decimal points: "0.25", not ".25". Use "cm^3", not "cc".)

C. Equations

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

D. LaTeX-Specific Advice

Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don't use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

Please note that the `{subequations}` environment in LaTeX will increment the main equation counter even when there are no equation numbers displayed. If you forget that, you might write an article in which the equation numbers skip from (17) to (20), causing the copy editors to wonder if you've discovered a new method of counting.

BibTeX does not work by magic. It doesn't get the bibliographic data from thin air but from .bib files. If you use BibTeX to produce a bibliography you must send the .bib files.

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Do not use `\nonumber` inside the `{array}` environment. It will not stop equation numbers inside `{array}` (there won't be any anyway) and it might stop a wanted equation number in the surrounding equation.

E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.

- Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
- Do not confuse “imply” and “infer”.
- The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the “et” in the Latin abbreviation “et al.”.
- The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [7].

TABLE I
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	*Subhead*	*Subhead*
copy	More table copy[a]		

[a]Sample of a Table footnote.

F. Authors and Affiliations

The class file is designed for, but not lim authors. A minimum of one author is required f ence articles. Author names should be listed start to right and then moving down to the next line author sequence that will be used in future cita indexing services. Names should not be listed in group by affiliation. Please keep your affiliations a possible (for example, do not differentiate among of the same organization).

G. Identify the Headings

Headings, or heads, are organizational devices t reader through your paper. There are two types heads and text heads.

Component heads identify the different co your paper and are not topically subordinate to Examples include Acknowledgments and Refere these, the correct style to use is “Heading 5”. caption” for your Figure captions, and “table he table title. Run-in heads, such as “Abstract”, will to apply a style (in this case, italic) in addition provided by the drop down menu to differentiate t the text.

Text heads organize the topics on a relational basis. For example, the paper title is the prima because all subsequent material relates and elabo one topic. If there are two or more sub-topi level head (uppercase Roman numerals) should conversely, if there are not at least two sub-to subheads should be introduced.

H. Figures and Tables

a) Positioning Figures and Tables: Place tables at the top and bottom of columns. Avoid in the middle of columns. Large figures and tab across both columns. Figure captions should b figures; table heads should appear above the figures and tables after they are cited in the t abbreviation “Fig. 1”, even at the beginning of a sentence.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an

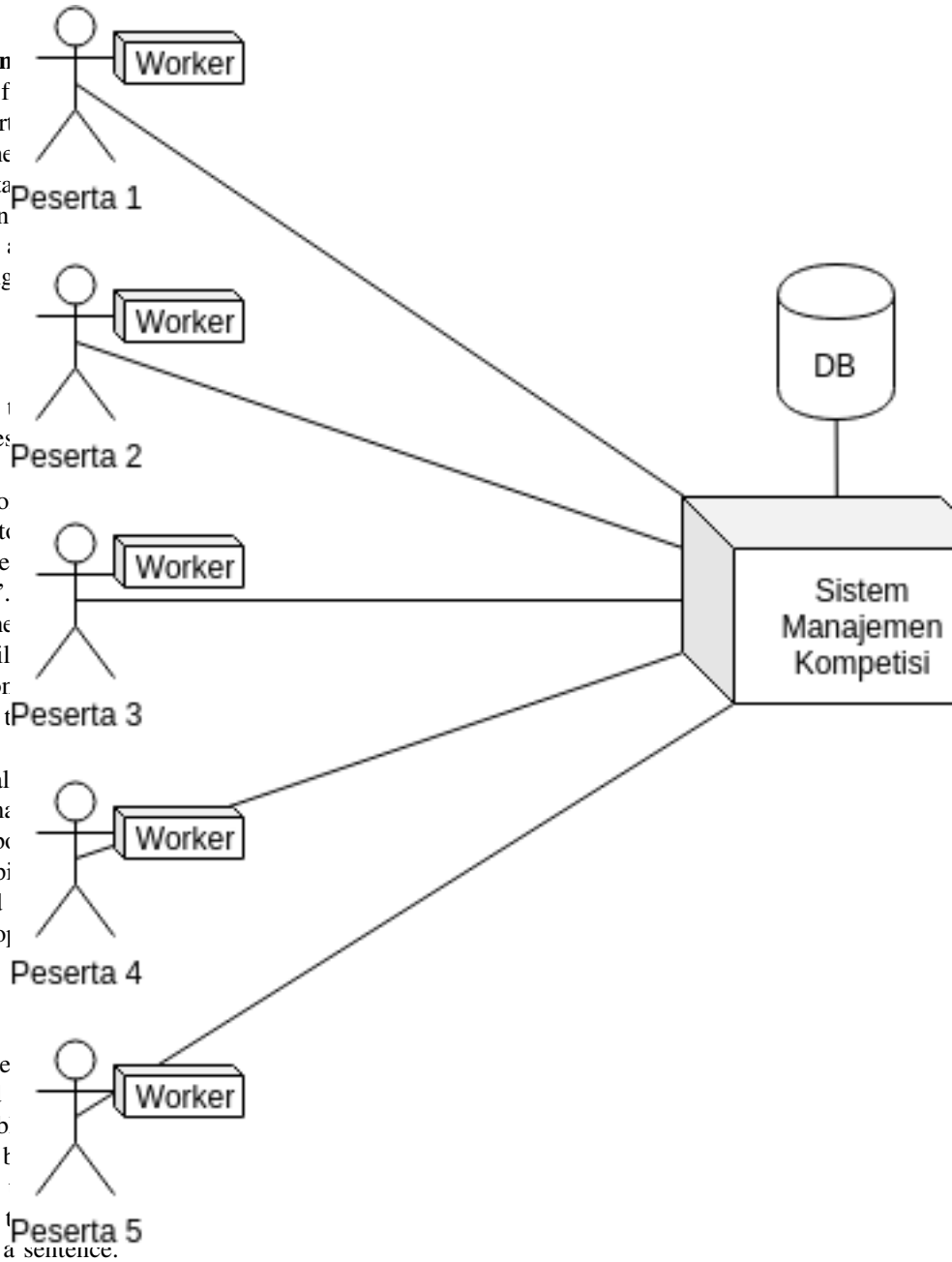

Fig. 1. Example of a figure caption.

example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks . . .”. Instead, try “R. B. G. thanks. . .”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first . . .”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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