

On NCUEE's "Basics in Information Processing" Tests (1)

Yasushi KUNO*

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- NCUEE (or DNC) in Japan
- Subject "Basics in Information Processing"
- Testing "thinking abilities"

1 NCUEE's Entrance Exam Tests

- National Center of University Entrance Examinations
 - An independent administrative organization whose (primary) task is to organize joint test for university entrance exams (mandatory for national universities).
 - For us, "DNC" (Daigaku:university Nyuushi:entrance-exams Center) --- it is a TOP SECRET that a person belongs to center's test development committee, so we should use the buzzword "DNC" for daily conversations. "DNC" is also used for official mail addresses.
- The number of applicants --- approx. 570,000 (2005 school year)
- Detailed breakdown --- 32 subjects (*: major subject)
 - Japanese language --- I/I and II*
 - Geography, History, Civics --- World History A/B*, Japanese History A/B*, Geography A/B*, Contemporary Society*, Ethics*, Politics and Economics*
 - Mathematics --- I, I and A*, II, II and B*, Mathematical Science in Technology, Bookkeeping, Basics in Information Processing<==
 - Science --- Integrated Science, Physics IA/IB*, Chemistry IA/IB*, Earth Science IA/IB*, Biology IA/IB*
 - Foreign Languages --- English*, German, French, Chinese, Korean

*Graduate School of Business Sciences, University of Tsukuba, Tokyo, Japan

2 Basics in Information Processing

- Basics in Information Processing --- relatively new subject (since 1998.1-). Belongs to mathematics group.
 - Kuno was a member of test development committee during 1997-1999. (This is NOT a top secret because this information can be made open 1 year after quitting.)
 - So I will talk about relatively early stages of this test. Prof. Namiki will give talk on newer (current?) info.
- The position of "Basics in Information Processing"
 - Subject only applicable to technical high school, commercial high school, and other professional high school (to-be-) graduates.
 - In Japan, majority of university/college students come from regular high schools.
 - Consequently, "Basics in Information Processing" is quite a minor subject (approx. 600 applicants in these years --- 1/1000!)
- How about new "Information" subject? (Since 2003, for regular high schools.)
 - We have strongly hoped that "Basics in Information Processing" evolve to "Information" in the year 2006 (for graduates who took "Information" classes), and lots of applicants choose the subject.
 - However, DNC decided not to start "Information" for the time being (will continue research on desirability of such change though).
 - Hence, "Basic in Information Processing" is currently the only IT-oriented subject (and is very minor). (Mathematics include some math-oriented programming.)

2.1 Problem Structure

- 4 large questions. An applicant should answer Q1, Q2 and either of Q3/Q4.
 - Q1 --- General knowledge and thinking ability.
 - Q2 --- Programming questions.
 - Q3 --- Spreadsheet questions (target: commercial high school graduates).
 - Q4 --- Hardware/technology-oriented questions (target: technical highschool graduates).
 - overview in reverse order below.
- Q4 (selection) --- hardware system, digital circuit, etc.
 - Mainly for technical high school graduates.
 - Selection ratio is not high (Q3:Q4 = 3:1 ?)
 - Problem on information systems in general (e.g. vending machine, network, ...) might be OK for non-technical applicants.
- Q3 (selection) --- spreadsheet
 - Mainly for commercial high school graduates, but also appropriate for other applicants. (Spreadsheets are taught widely)
 - Not at the level of simple "sum and average" calculation.
 - Understanding on design of spreadsheet layout is required.
 - Many "special" functions (vlookup, rank, ...) are also used.
 - These test can be seen as testing "procedural automatic-processing" abilities.
- Q2 (mandatory) --- programming
- What programming language should we use?
 - DNC's experimental (pre-) test --- same problem was described in three languages: Pascal, C and COBOL.
 - Each language has its strong/weak points on describing specific problem ==> fairness was questioned.
- Answer: DNCL (DNC Language)
 - Pseudocode-like language (Ordinary structured control statements with Japanese keywords)

- Sufficient for describing algorithms used in test problems.
 - Weak points --- applicants have to learn new language (without actual compiler) for DNC exams only. (c.f. PEN)
 - However, this "Japanese-keyword language" approach is widely accepted. Also used for JITEC (Japan Information-Technology Engineers Examination Center) test. (JITEC tests also includes real languages ... C, Java, Fortran, COBOL.)
- Q2 and Q3 --- tests for "procedural automatic-processing" understandings: almost the same line as our claim.
 - Q1 (mandatory) --- general questions
 - Further divided into 3 to 4 small questions
 - Kinds of Q1 questions:
 - Test for some specific knowledge.
 - Test for thinking ability (from the 2nd year).

2.2 Test for Thinking Ability

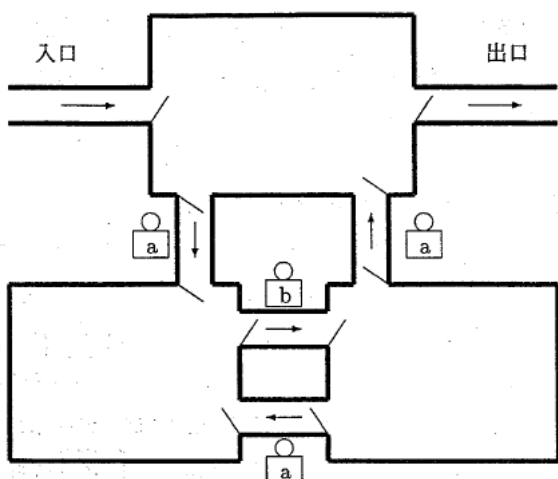
- Result 1st Year (1998.1): 249 applicants, Average 80.4/100 pts.
 - Problems were too easy --- target average: 60/100 pts. (For good discriminating performance, 60/100 is ideal.) (Other mathematics subjects: 41.3-63.9/100.)
 - Q4, Q3, Q2 --- Make the problems more difficult --- possible.
 - Q1 --- What should we do? Question more "difficult (rare/unknown)" knowledge is inappropriate.
- Principle: knowledge questioned have to be something written in textbook (in Japan, textbooks must be approved by the Ministry of Education).
 - However, textbooks were too old, many important facts were not described (no Internet, no WWW, ...); technology progress were too rapid, while text revision was being done once in several years.
 - Thus, we have to determine "standard (mandatory) knowledge" ourselves; if we make the knowledge test difficult, it will become inappropriate.

Solution: in addition to knowledge tests, we include "thinking ability" tests.

- Explain general settings/frameworks of the problem.
- Ask for some specific (procedural/algorithmic) solution.
- Applicants have to "think" themselves to craft the solution.

Example: Dark Rooms (1999.1 Q1-3).

- Several rooms are connected by one-way passages with stamps.
- One walk along the rooms, pressing stamps on his/her stampbook.
- Ask for possible/impossible combination of stamp letters.



q1. What is the IMPOSSIBLE outcome of the stamp book? Choose two. (0) (no stamp) (1) aaa (2) aba (3) ababa (4) abababa (5) abaababa (6) ababba (7) ababababa

q2. What is the CORRECT RULE of stamp characters? Chose one.

- (0) two adjacent "a"s do not occur.
- (1) the number of "a" is twice the number of "b" plus 1.
- (2) if two or more "b" occur, one or two "a" occur between adjacent "b"s.
- (3) "b" occurs at least once.
- (4) The smallest count of letters is 3.
- (5) The count of letters is always an odd number.

Example: Rewriting Strings (2000.1 Q1-3).

- A set of string rewriting rules is given.

- Ask for specific strings generated by the given rules.
- Ask for the general property of those strings.

Y --> X Y Z

Y --> g

X --> e f

Z --> f e

q1. Starting from "Y", what is the possible outcome? Choose two. (0) efefefefefefe (1) efgfgfe (2) efefgfe (3) efefefgfe (4) efefefe (5) efgfe (6) efgfegfe

q2. What is the property that is true for ALL string generated from "Y"? Choose one.

- (1) The number of "e" is a positive even number.
- (2) The number of "e" and "f" is the same.
- (3) If the number of character is divided by 4, 3 remains.
- (4) The string is one or more repetition of "ef", then "g", and then one or more repetition of "fe".
- (5) The string is one or more repetition of "ef", then one or more repetition of "gf", then "e."

These problems can be crafted from many domains of computer sciences (finite automata and context free grammars in the above examples).

These problems were successful in obtaining appropriate average points. 1999.1 -> 75pts, 2000- -> 51-58pts.

This kind of "thinking ability" seems important for IT professionals (not only as a programmer, but also as upstream planner/designer and manager...)

3 Summary

University Entrance Examinations for IT.

- Procedural automatic-processing should be tested (programming --- Q2, spreadsheet logics --- Q3).
- Knowledge test is also appropriate to some degree.
- Testing "thinking ability" will be also desirable --- such tests are actually possible (examples shown).

4 References

- NCUEE, Overview of National Center for University Entrance Examinations, 2006.
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- NCUEE "Basics in Information Processing" test problems. (in Japanese)

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5 Appendix: Answer to the Problems

- Dark Rooms --- q1 (1) and (6), q2 (2).
- Rewriting Strings --- q1 (3) and (5), q2 (2).