National Colleges of Technology in Japan Presents:
The 25th Annual Programming Contest Competition Section
"Find Your *PIECE* of Mind II"

Outline of Competition

In the competition section, the participants compete over puzzles as a team. The assignment is a picture which is made of equal-sized pieces. But the pieces are rearranged in random positions. The participants are required to put the pieces back to the original positions. The assignment picture is the only reference that the participants will use to estimate the original position of each piece.

At the 15th annual Programming Contest (in Niihama-City), the competition was also made of puzzles. This time however, the participants are only allowed to swap pieces that are next to each other. The time that takes to submit an answer counts as well. In other words, the team who submits an answer which reproduces the original picture with the least amount of swapping in the shortest amount of time, will gain the highest score. A team needs to decide where to put their priorities; whether it will focus on minimizing the time to submit an answer which requires more swapping, or minimizing the number of swapping required, but takes longer to submit an answer.

In addition, this time we will create a group tournament style. Teams compete over multiple assignments per match, and those who steal the top ranks on the assignment, win the match and move forward.

Terminology

Original Picture
- The *original picture* is a full color picture such as a natural image or illustration.
- The maximum size of the picture is 1024 pixels (for both width and height). The size varies depending on the assignment.

Division
- The original picture is *divided* into equal-sized columns and rows respectively (The number of columns and rows are a divisor of the size of the original picture).
- The maximum numbers of columns and rows are 16 respectively. This will vary depending on the assignment.
- The total number of columns and rows are not necessarily the same.

Piece
- Each segment of the original picture after a division is made is called a *piece*.
- All pieces are the same size.
- The size of each piece, is 16 pixels at minimum and 128 pixels at maximum respectively (for both width and height). The size varies depending on the assignment.
- The width and the height of each piece are not necessarily the same.

Position of a Piece
- The *position of a piece* shall be indicated as shown in Table 1; the upper left corner is 00. Starting from 00, the position is read left to right from 10, 20, 30 etc. Going downwards from 00, it will read as 01, 02, 03, etc., towards the bottom.
- The position of each piece is presented in a hexadecimal number. A picture is divided into a maximum of 16 x 16. Thus, the possible positions are ranged from 00 to FF.

Table1. Position of Piece

00	10	20	…	E0	F0
01	11	21	…	E1	F1
⋮	⋮	⋮		⋮	⋮
0E	1E	2E	…	EE	FE
0F	1F	2F	…	EF	FF

Assignment
- *Assignment* is a picture which is composed of the original pieces that are rearranged in random positions.
- The pieces are not rotated.
- The participating teams will reproduce the original picture in the same size by putting back the pieces together.

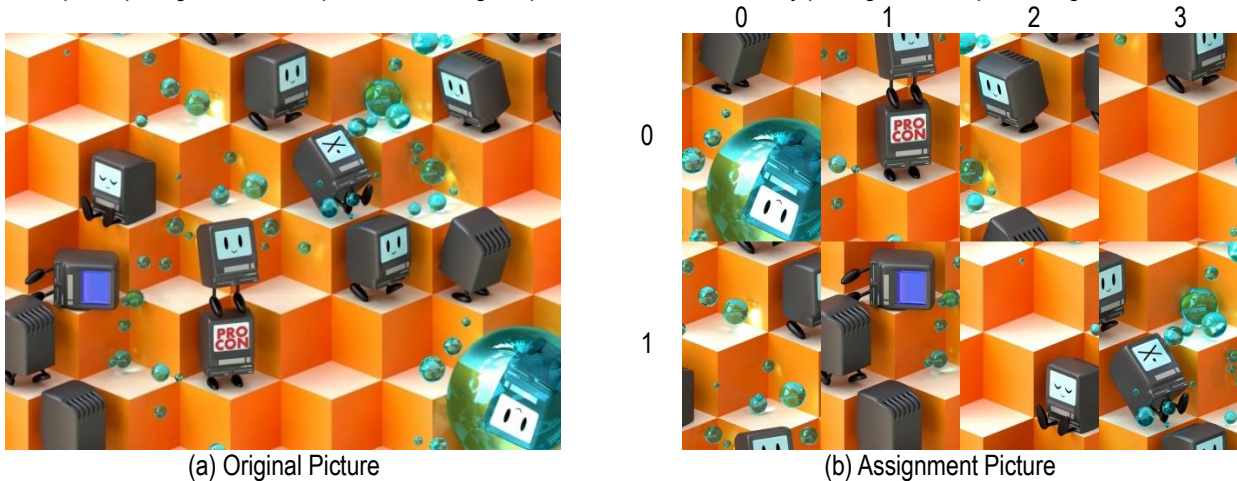(a) Original Picture   (b) Assignment Picture

Figure 1. The original picture (a) is divided into 8 pieces (4 x 2) (width: 640 pixels x height 480 pixels).
The assignment picture (b) is made of the rearranged original pieces.

Selecting
- A team *selects* a piece of the assignment.
- The piece that is selected by the team is called a *selected piece*.
- The team can change the selection for a few times. The maximum times to change the selection are limited to 16. The limit varies depending on the assignment.

Swapping
- The team *swaps* the selected piece, with any of the other four pieces adjacent to the selected piece, by either going to the right, to the left, above or below. (The number of the adjacent pieces will be two or three, depending on the position of the selected piece.)

Series
- Once the selection is made, the selected piece is moved to the target position in a *series* of swapping.

Restoring
- The selected piece is *restored* to the original position by a series of selections and swapping.
- The final picture which is reproduced by a series of selections and swapping, is called a *restored picture*.
- When the restored picture is identical to the original picture, the restoration is *absolute*.
- Depending on the original picture, some pieces may be identical to one another. Even if the pieces are identical, the participating teams are required to restore them to its original position.

Selection Cost
- The selection cost is obtained by multiplying the selection count, by the selection cost conversion rate. The selection cost conversion rate is an integer number from 1 to 300. It varies depending on the assignment.

Swapping Cost
- The swapping cost is obtained by multiplying the swapping count, by the swapping cost conversion rate. The swapping cost conversion rate is an integer number from 1 to 100. It varies depending on the assignment.

Time Cost
- The time cost, is the value obtained by multiplying the total seconds passed, until the answer is received by 100.
- The time spent to validate the format is included in the time cost.
- Format validation is expected to last about 5 seconds. It is controlled to be consistent for all answers by the organizer's server.

Total Cost
- The total cost is defined as the sum of the selection cost, the swapping cost and the time cost.

Qualified Answer
An answer is assessed in the following ranking order:
When a team submits multiple answers…
1. The number of pieces that were returned to its original positions (an answer which contains more pieces being returned to the original positions is a qualified answer)
2. Total cost (an answer whose total cost is the lowest is a qualified answer)
3. Selection cost (an answer whose total number of selection is lowest is a qualified answer)
4. Swapping cost (an answer whose total number of swapping is lowest is a qualified answer)

Method of Team Ranking
A winner is determined based on the following factors in order:
1. The total number of pieces that were returned to the original positions (The team with more pieces restored to the original positions precedes)
2. Total cost (the team with lower total cost precedes)
3. Selection cost (the team with less selection cost precedes)
4. Swapping cost (the team with less swapping cost precedes)
5. Sum of the dots on the dice (The team with the higher sum of dots on the dice precedes)

Format of Assignment
- The format of the assignment picture is in the binary version of a PPM format.
- In the header of the assignment file, the requirements are provided in the following order.
  - ➤ The total number of pieces (# x #)
  - ➤ The maximum allowed selection to be made
  - ➤ The selection cost conversion rate and the swapping cost conversion rate
- See Fig. 2 below for the sample image of the header.
  The following example of the header, is for the assignment whose original picture was divided as follows: The original picture in 640 pixels in width and 480 pixels in height is divided into 4 x 2 pieces. Each piece is 160 pixels in width and 240 pixels in height. The teams are allowed to make the maximum of three selections. The selection cost conversion rate and the swapping cost conversion rate are 150 and 20, respectively.
- The file name shall be "probXX.ppm". Make sure to add "prob" before the 2-digit assignment identification number.

```
P6
# 4 2          (number of division)
# 3            (max. number of selection)
# 150 20       (the cost conversion rates)
640 480        (size of the assignment)
255            (max. of  pixel value)
```

Figure 2. Sample Header of Assignment Picture

<u>Format of Answer</u>
- Record the number of selections (the number of series) to be made on the top.
- Next, a series of selections and swapping is recorded in the following order. Each series of selection and swapping is recorded separately in the order.
  - ➢ 1st Line: The location of the piece to be selected.
  - ➢ 2nd Line: The number of swapping to be made.
  - ➢ 3rd Line: Each swapping movement from the first to the last swapping. Do not break the line.
- Each swapping is described with U, D, R or L (up, down, right or left). Each character indicates the relative location of the selected piece to be swapped to.
- When the final answer contains more selections than allowed, only the allowed number of selections and its series of swapping shall be assessed.
- When the final answer contains more number of swapping than reported, only the reported number of swapping shall be assessed.
- The final answer that contains inoperable swapping shall be regarded as a format error.
- The answer whose number of selections or swapping are less than those reported, shall be regarded as a format error.
- Any answer which does not comply with the set format shall be regarded as a format error.
- Without further specification, use UTF-8 for the character code and CR+LF for the line break.
- The following is a sample answer. See Fig. 3 for swapping process.

  In this sample, the number of selections (the number of series) is twice. The piece on the position 11 is selected for the first selection. From there, the piece in 11 is swapped for a total of 6 times in the following manner: to the right, down, to the left, to the left again, up, and up again. On the second selection, the piece on the position 02 is selected. From there, the piece on 02 is swapped 4 times in the following manner: up, to the right, up again, and to the right.

  As an answer, two selections and ten swapping were made. The selection cost conversion rate and the swapping cost conversion rate are 250 and 75, respectively. The time limit for an answer is 1 min and 3 sec. Based on these, the following costs are obtained: the selection cost of 500 (= 2 x 250), the swapping cost of 750 (= 10 x 75), and the time cost of 6300 (= 63 x 100). The total cost is 7550 (= 500 + 750 + 6300).

  Figure 3 shows the locations to which the selected piece moves in relation to the original picture.

<u>Method of Answering</u>
- The participating teams connect their personal computers with LAN cables. The teams shall input the answers in the designated HTML form, which is available in the answering system. Alternatively, the participants shall use the software which is provided by the organizer to send the answer. The answer is submitted in the HTTP POST format.
- The personal computers used for answer submission are connected to the server in the DHCP format.
- The teams need to show a token of identification to send an answer. Tokens are distributed in advance before the tournament.
- The format of the answering form is verified once it is received by the tournament server. The server will reply with the number of pieces which are not matched with the original picture after the verification. The verification result is sent in a plain text format as follows: "ACCEPTED XX" ("XX" indicates the number of pieces which do not match with the original).
- The answer received during the format verification (before the verification result is sent out) shall be processed as an invalid answer.
- The maximum number of answers accepted per assignment is ten. Those declined as invalid are also counted in the number of answers submitted.
- An answer which size is more than 1 MB may be rejected as an error.
- The source codes of the software for the answer transmissions will be disclosed. The participants are allowed to create their own software for their answer transmissions for the tournament.

<u>Time Limit</u>
- A time limit is set for each answering session of a match.
- Currently we are planning to set the time limit from 1 to 15 minutes. However, please refer to an official time limit, which is to be announced before each match starts.
- Participating teams must complete transmitting their answer within the time limit. Anything submitted after the time limit becomes invalid.

```
2          (number of selection(series))
11         (position at the selection #1)
6          (number of swapping in the series #1)
RDLLUU     (swapping operation in the series #1)
02         (position at the selection #2)
4          (number of swapping in the series #2)
URUR       (swapping operation in the series #2)
```
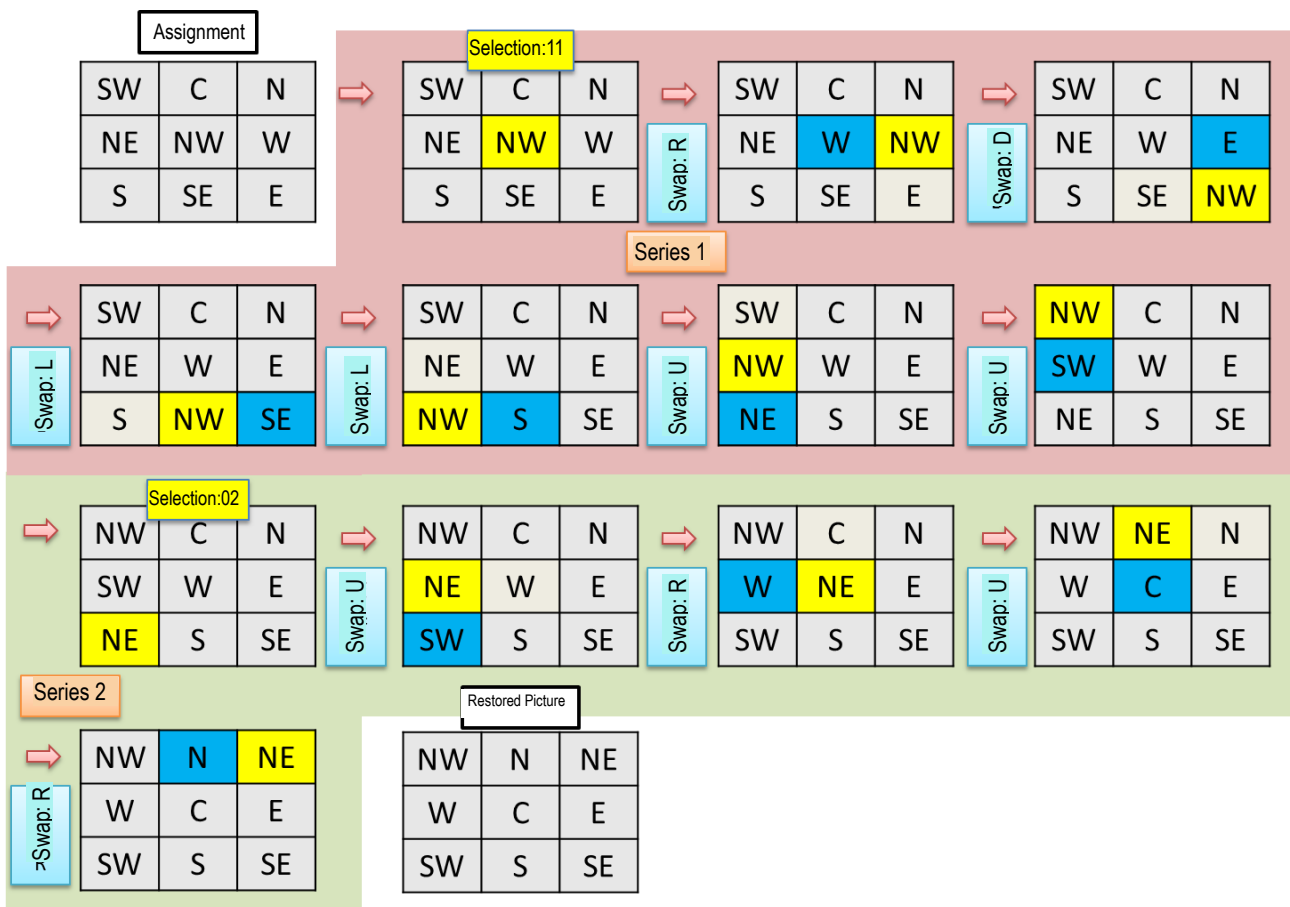

Figure 3. Sample Answer and the Swapping Details

Procedures of the Tournament

- The maximum of 24 teams compete in a match.
- Participating teams compete over more than one assignment per match.
- The number of winners of each assignment is set in advance. Those winning teams shall move to the next match.
- The total number of assignments and winners per match are to be announced in the beginning of the tournament.
- Once the team wins the match, the team is done and does not remain in the match to answer the rest of the assignments.
- The overall ranking of the tournament is determined in the following order: the winners on the first assignment come first, those on the second assignment come after, and those on the following assignments come thereafter.

Procedures of Answering

- The assignment is released at the designated server for the tournament at the start of the match. Participating teams will access the server, to obtain the assignment via a network.
- The participating team works on the assignment and submits the answer to the server via a network within the time limit.
- Once the answer is received by the server and the format is verified, the picture is restored based on the answer.
- Restorations are performed at the set intervals which are computed based on the conversion rate. Restoration is conducted at intervals of the conversion rate divided by 100 seconds.
- The restoration processes of the top-ranking teams are shown on a screen on the stage. The number of the teams which restoration steps are viewed on the screen, varies depending on the assignment. It is expected to be more than the set number of winners.
- Once all restoration steps are complete, the reproduced picture is assessed whether it is an absolute restoration or not. If the answer is an absolute restoration, the team earns the rank on the spot.
- Once all the winners are fixed, no more answers may be accepted for the assignment even before the time is up.
- If all the seats of winners are not filled within the time limit, the restoration process will continue. Based on the progress of the competition, the interval setting may be adjusted or only the result will be displayed by skipping the restoration process.

Information Projected on The Screen

- The following information of each team is displayed on the screen on the main stage:
  - Ongoing and Final Ranking (tentative ranking of those in the middle of restoration process are not included)
  - Status of Answer
    - Answer received (in format verification)
    - Qualified answer
    - Invalid answer
    - Format error
  - Status of Restoration
    - In Restoration
    - Restoration complete (non-absolute restoration)
    - Absolute restoration
  - Number of Answer Submissions
- The general status as well as restoration status of each team, may not be available on display throughout the competition.

Other Rules and Notes

- Participating teams are allowed to bring in and use a maximum of three units of portable and programmable computer devices for the tournament. One of these shall have a USB port, and come with a LAN cable port (RJ45) for 100BASE-TX and compatible with the TCP/IP method. Computers shall be placed on the tables that are provided by the organizer.
- Currently we are planning to provide two power plugs, approximately for 150W in total, per table for each team. In the case that more than three power plugs are needed, participants can bring their own accessories such as power strip. Make sure that the total size does not exceed 150W.
- Currently we are planning to provide a LAN cable per team for network connections. If the team needs to connect multiple computers to the main network, it is the participant's responsibility to bring the necessary accessories such as a HUB switch, etc.
- The participants are not allowed to communicate with anyone besides their own team members during the tournament.
- Wireless communications between all devices brought in (including personal computers) shall be prohibited.
- Any act of interference of the server or the competitors shall be prohibited.
- An act of transmitting an excessively long answer may be considered as a malicious act of interference for the competition.
- If the organizer judges that a team interrupted the progress of a competition, judgment or other activities of other teams, or if they performed other prohibited acts in the competition, the team will be disqualified to compete. A disqualified team shall receive the lowest rank in the tournament. The disqualified team cannot participate in matches following after.
- In case that the organizer's system experiences network trouble during the transmission of assignments, as well as the reception of their answers, the assignments and the answers may be provided off line by means of a USB memory stick or other devices. In this case, the rules of the tournament, such as the time limit and maximum number of answer submissions, may be adjusted.
- In case any trouble is experienced on the organizer side, teams may compete again with another assignment.
- Depending on the layout of the booths, the status of the device such as the computer screens, may be exposed to other teams.
- During the competition, participants and desks of the teams (such as computer screens, status of operation, and notepads on the desk) may be filmed, recorded and projected on the screen simultaneously by a video camera or other devices.
- During the competition, members of the judgment committee may come to view the participants and their desks of the participating teams (such as their computer screens, status of operation, and notepads on the desk) for judgment purposes.
- The data used for competition and transmitted to the server by each team, may be released to the public after the competition, such as on our website.

Software Provided for Competition

- We are planning to provide protocol for answer submissions, the simplified software for answer submissions and the source codes by the end of May.
- The above mentioned software and other information will be provided on the official website or on our facebook page..

Contact

Please send your inquiries to the designated contact available on our official website. Note that your inquiries as well as the answers are to be released on our website (Any inquiries which might affect the result of the contest are also released on our website).

Deadline to contact: 5:00 p.m., May 9th, 2014 (Fri)
Email: naprock-procon@tokyo-ct.net

※ Please make all contacts to us, through your mentor who represents your team. Provide the mentor's name and where he/she belongs to (name of his/her school and the department). If this information is not provided, an answer may not be provided.

※ No answer will be made for those contacted after the deadline.