

# The 13<sup>th</sup> NAPROCK International Programming Contest

## Competition Section

### “Gijutsu Kaisen”

#### 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. The participants are only allowed to swap pieces that are next to each other. The team who submits an answer which reproduces the original picture with the least amount of swapping will gain the highest score.

The similar competition was executed in the 6<sup>th</sup> NAPROCK International Programming Contest (in Ichinoseki City). At that time, the team was requested to submit an answer as early as possible. However, the answering time is not required to win the game this year. Therefore, it is important to obtain the optimal answer by making full use of the assigned time. In addition, the pieces may also be rotated, which implies that it is more difficult to reproduce the original picture than the previous puzzle.

The contest is held in Akita, where is in the same Tohoku region as Ichinoseki city. Let's contend for superiority of your own skills and techniques (called “Gijutsu” in Japanese)!!

#### Terminology

##### **Original Picture**

- The *original picture* is a full color picture such as a natural image or illustration. Black and white images, gray scale ones as well as sepia colored pictures are also possible.
- The size of the picture is 32 pixels at minimum and 2,048 pixels at maximum (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 numbers of columns and rows are 2 at minimum and 16 at maximum. 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*.
- The size of each piece is 16 pixels at minimum and 256 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 same. All pieces are the same size as well.

##### **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

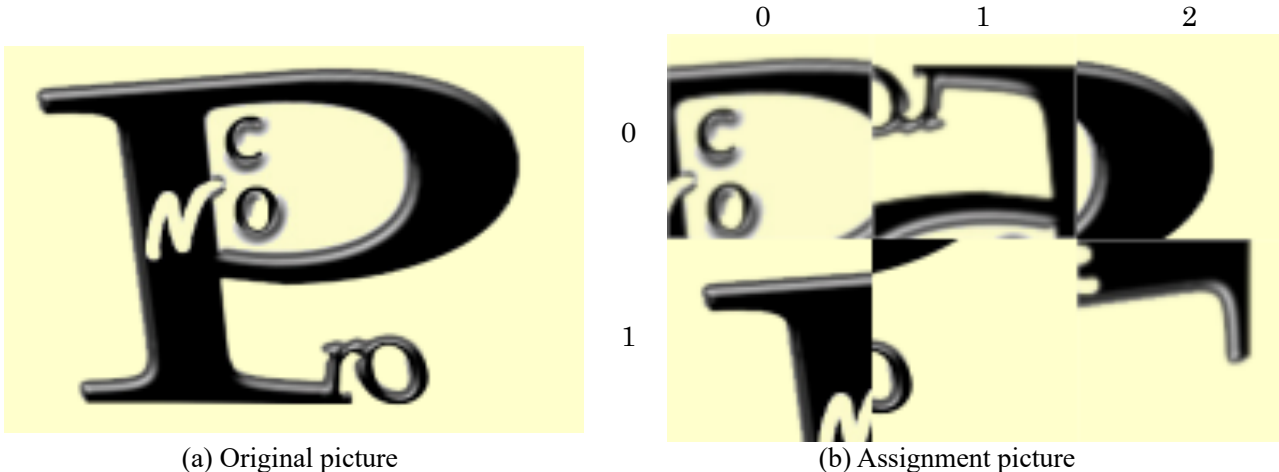


Figure 1. The original picture (a) is divided into 6 pieces (3 x 2) (width: 320 pixels x height 240 pixels). The assignment picture (b) is made of the rearranged original pieces.

**Assignment**

- *Assignment* is a picture which is composed of the original pieces that are rearranged in random positions.
- The pieces may be rotated with every 90 degrees, that is, 90, 180 and 270 degrees.
- The piece at the position 00 will not be rotated. There are no limitations or conditions for the rotation of other pieces. For example, any number of pieces can be rotated. The rotation angles for the different pieces are not related at all. All the pieces other than the one at 00 can be rotated. It is possible that all pieces cannot be rotated at all.
- The pieces are not flipped.
- Assignment picture is the same size as the original picture.

**Rotating**

- A team *rotates* a piece of the assignment with 0, 90, 180 or 270 degrees clockwise.
- The pieces to be rotated can be identified with the coordinates in the reproduced picture.

**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 times to change the selection are limited to 2 at minimum and 64 at maximum. 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.)
- There is no limit for the times of swapping. Please note that an communication error may occur at the server if any team swap the pieces too many times and the total amount of data excels the limit of the data flow.

**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 rotations, selections and swapping.
- The final picture which is reproduced by a series of rotations, 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 500. 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.

### ***Total Cost***

- The total cost is defined as the sum of the selection cost and the swapping 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 NOT returned to its original positions (an answer which contains less pieces being failed to restored to the original positions is a qualified answer)
2. The number of pieces that were NOT recovered to its right angles by rotations (an answer which contains less pieces being failed to return to the original angles by rotations is a qualified answer)
3. Total cost (an answer whose total cost is the lowest is a qualified answer)
4. Selection cost (an answer whose total number of selection is lowest is a qualified answer)

### **Method of Team Ranking**

A winner is determined based on the following factors in order:

1. The number of pieces that were NOT returned to its original positions (The team with less pieces being failed to restored to the original positions precedes)
2. The number of pieces that were NOT recovered to its right angles by rotations (The team with less pieces being failed to return to the original angles by rotations precedes)
3. Total cost (the team with lower total cost precedes)
4. Selection cost (the team with less selection cost precedes)
5. Sum of the dots on the dice (The team with the higher sum of dots on the dice precedes)

### **Time Limit**

- A time limit is set for each answering session of a match.
- Currently we are planning to set the time limit from 5 to 20 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.

### **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 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 pieces)
# 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

### **Format of Answer**

- A series of rotations is recorded on the first line.
- For each pieces, rotation angles (0, 90, 180 or 270 degrees) are recorded.
- Rotation angles are recorded as each of four integers, that is, 0 (0 degree), 1 (90 degree), 2 (180 degree) and 3 (270 degree).
- Rotation angles should be recorded in the following order: the left top piece (position 00) first, then the right-hand-side pieces follows, followed by the left most piece in the second line (position 01) and the right-hand-side pieces in that line.
- Record the number of selections (the number of series) to be made on the second line.
- 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.
  - 1<sup>st</sup> Line: The location of the piece to be selected.
  - 2<sup>nd</sup> Line: The number of swapping to be made.
  - 3<sup>rd</sup> 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 reported, 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 selection and 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 again.

As an answer, two selections and ten swapping were made. If the selection cost conversion rate and the swapping cost conversion rate are 25 and 12, respectively, the following costs are obtained: the selection cost of 50 (= 2 x 25), the swapping cost of 120 (= 10 x 12). The total cost is 170 (= 50 +120).

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

303121020  
 2  
 11  
 6  
 RDLLUU  
 02  
 4  
 URUR

(a series of rotation)  
 (number of selection(series))  
 (position at the selection #1)  
 (number of swapping in the series #1)  
 (swapping operation in the series #1)  
 (position at the selection #2)  
 (number of swapping in the series #2)  
 (swapping operation in the series #2)

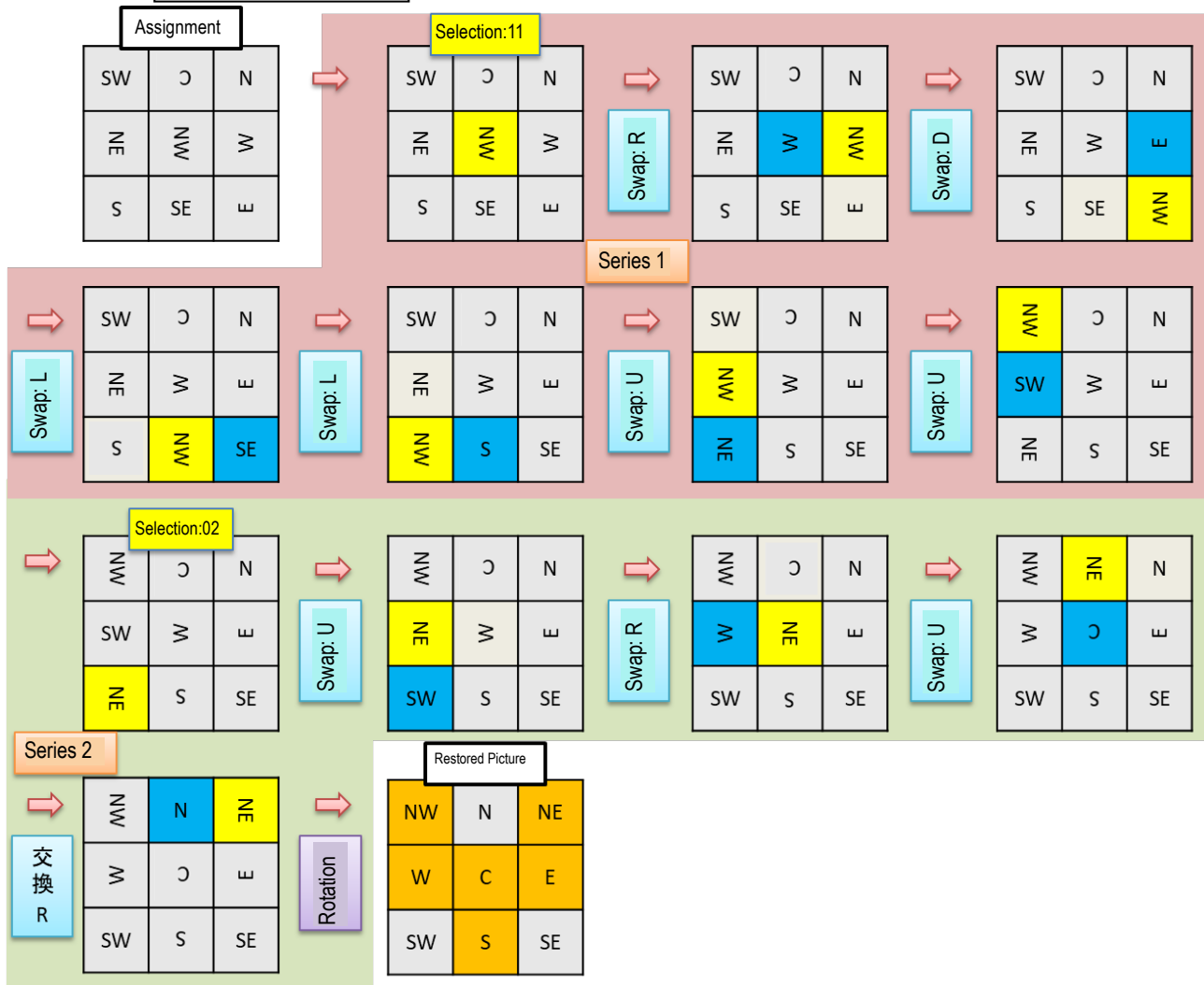


Figure 3. Sample Answer and the Swapping Details

**Method of Answering**

- The participating teams connect their personal computers with LAN cables. 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 picture).**
- 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.

### **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. At least one of these computer devices shall have a LAN cable port (RJ45) for 10BASE-T/100BASE-TX/1000BASE-T and compatible with the TCP/IP method.
- Bluetooth connections between all devices (including personal computers) brought in the tournament are allowed. However, Wi-Fi connections shall be prohibited.
- The participants are not allowed to communicate with anyone besides their own team members during the tournament.
- 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.
- 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 in alternative measures. 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.
- 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 early June.
- 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. 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). Contact e-mail address will be sent separately.