UNIVERSITY OF CALIFORNIA
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Human computation

Gesture CAPTCHA

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Motivation

- There exists a spectrum of resources.
- People may be willing to spend from a few seconds up to hours to obtain it.
- The resources that need to be physically checked by the user having to go somewhere (Expensive)

HUMAN COMPUTATION ON A COMMON NETWORK

Example1: Car tinting violation

- Assume, your car windows are too dark, a Police officer warn you.

  The officer said

  “At least, I want to recognize people’s faces inside of your car.”

- Now, you need to remove tinting and visit police station on a certain day.

- Visiting police station may take several hours.

Simple Photo System for Car tinting violation.

Take your tinting removed car pictures and send it to the police photo system.

This is a very simple example of **Human computation**.

A officer has to judge photos. It is difficult job as image processing.

It is simple, but **highly confidence system**.

You need few minutes.

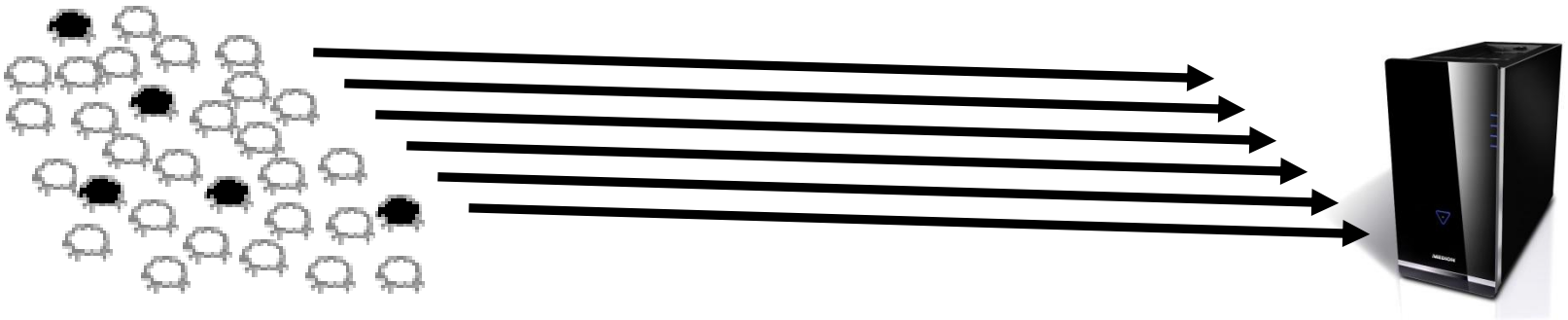
What if violators(users) are 1,000 or 10,000…

Example2: Network voting System

- Assume, there are **a lot of users**.
- Each user gets a choice and selects one answer on the voting system.
- Finally, the system shows the statistic result of the total vote.

A Typical Network System

The System does not need human computation because a server automatically counts each user's choice.

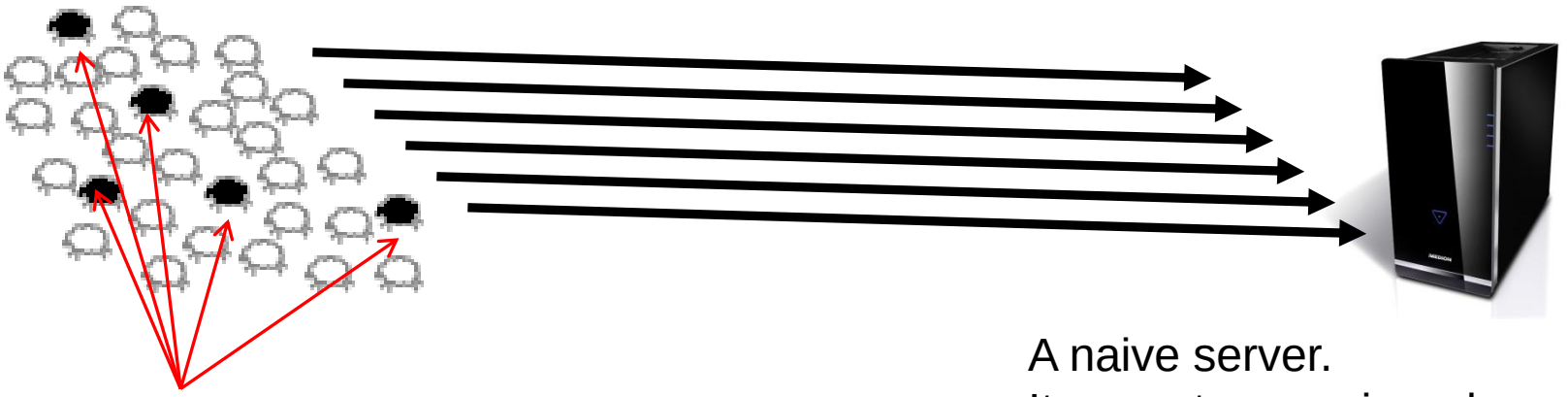


A lot of voters

The sever counts yours selection.

Existence of Black Sheep

Often, network Systems have Black Sheep users.



Black sheep

A naive server.
It cannot recognize who are the White or Black sheep.

Who are Black sheep?

- People who do not want to follow the Network system rules.
  - First, **commercial hackers**. If they penetrate The Network system, they are able to get enough benefit.
    - e.g.) Password hackers and Advertisement e-mail broadcasters.
  - Second, **fabricators** who want to archive a certain voting result.
    - e.g.) Assume there is a TV show voting network system. Someone may be capable of fabricating voting results by multiple voting. They may vote 1,000 or 10,000 times for a certain candidate.

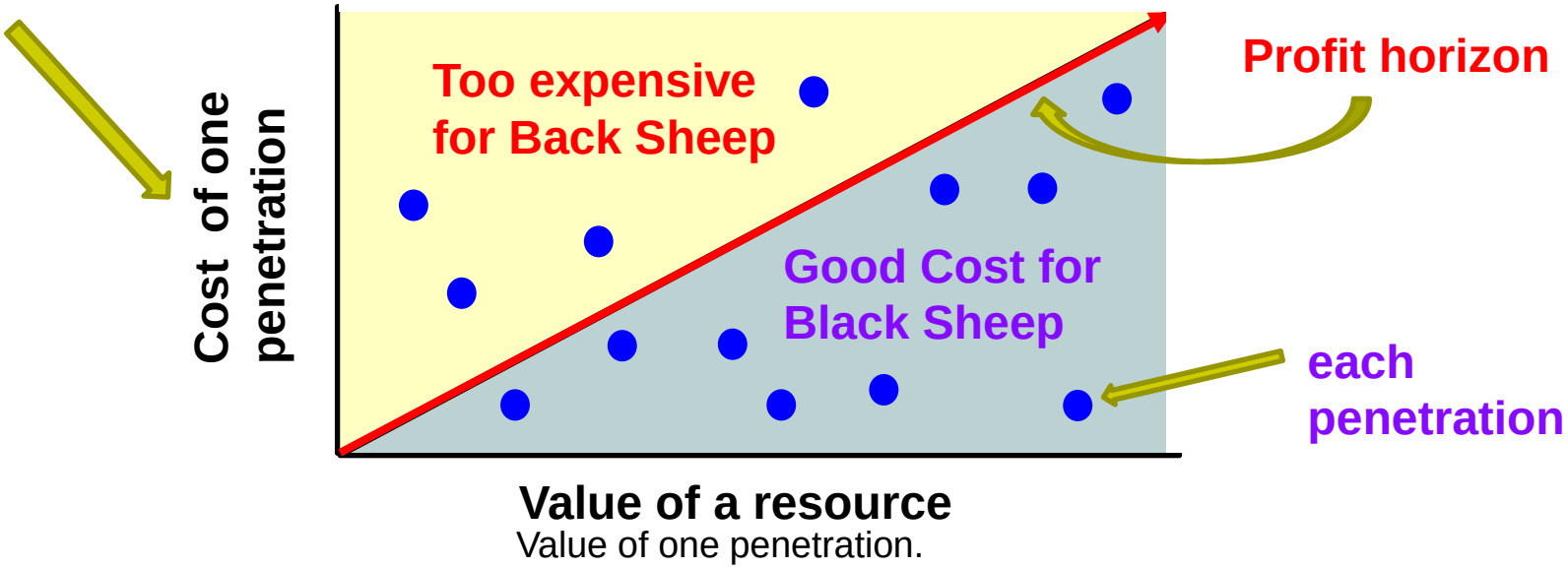
How do Black sheep attack

- They commonly use Robot programs.
  - Robots
    - Robots are **not** special Artificial intelligence programs.
    - They are extremely **diligent** and capable of attacking multiple times within a short period **endlessly**.
    - For each attack, robots can cost money or time. The costs are relatively **cheaper** than a resource on online.

Why do Back sheep use Robots?

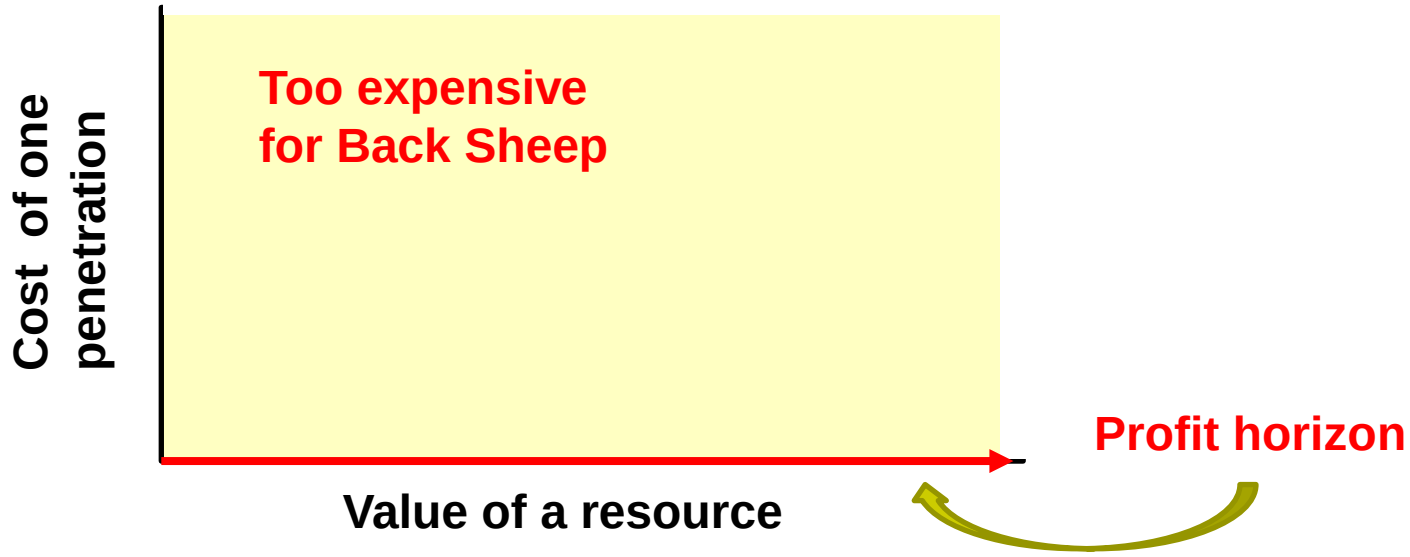
- Because the cost for one system penetration is cheaper than the wealth of resource on the system.
- Even if a Robot has to try a million times to successfully penetrate the system just once, if the resource is worth persisting, then it will continue to attack.

A Robot need 1$ for a attack
The Robot penetrate once after 10 attacks.
Cost of one penetration is 10$

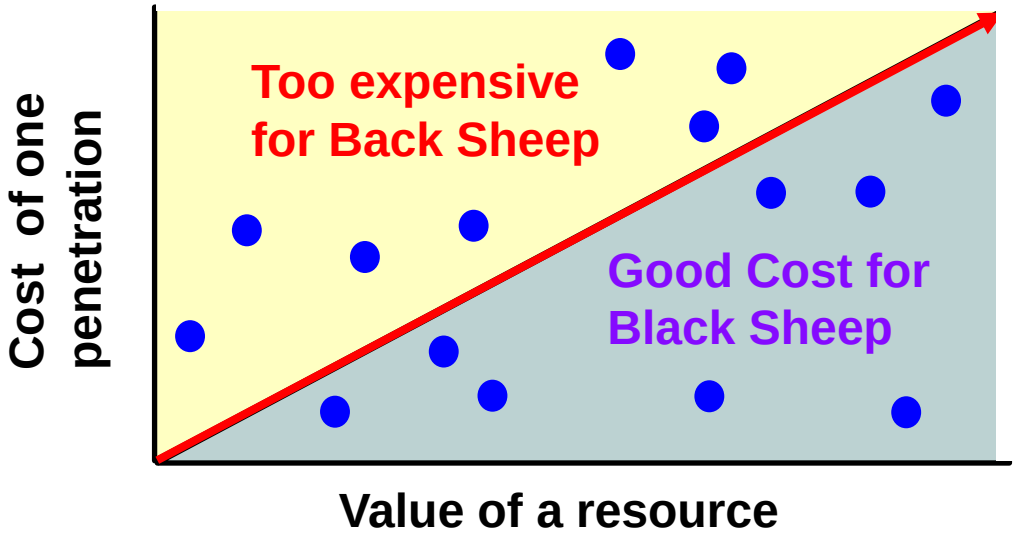


How to make penetrations expensive

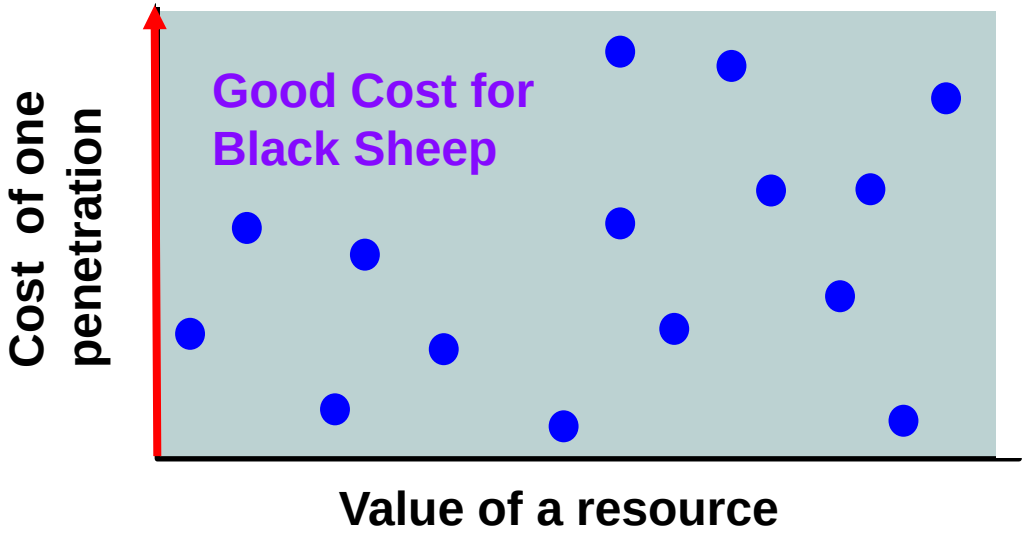
- Make robots spend more time or money on attacks penetrations.
  - Servers have to successfully judge whether user is a human or a Robot.



  - **An ideal server** would judge correctly 100% of the time, thus a Robot could never penetrate the system.

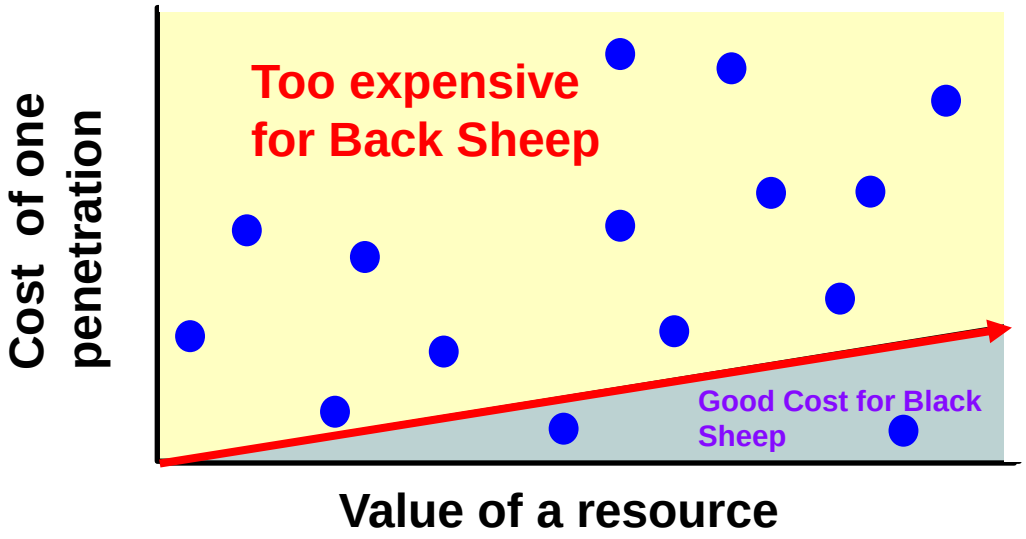


- If **A** server judge correctly 50% of the time.



- If **A server** does not have a judgment function.

Our Aim



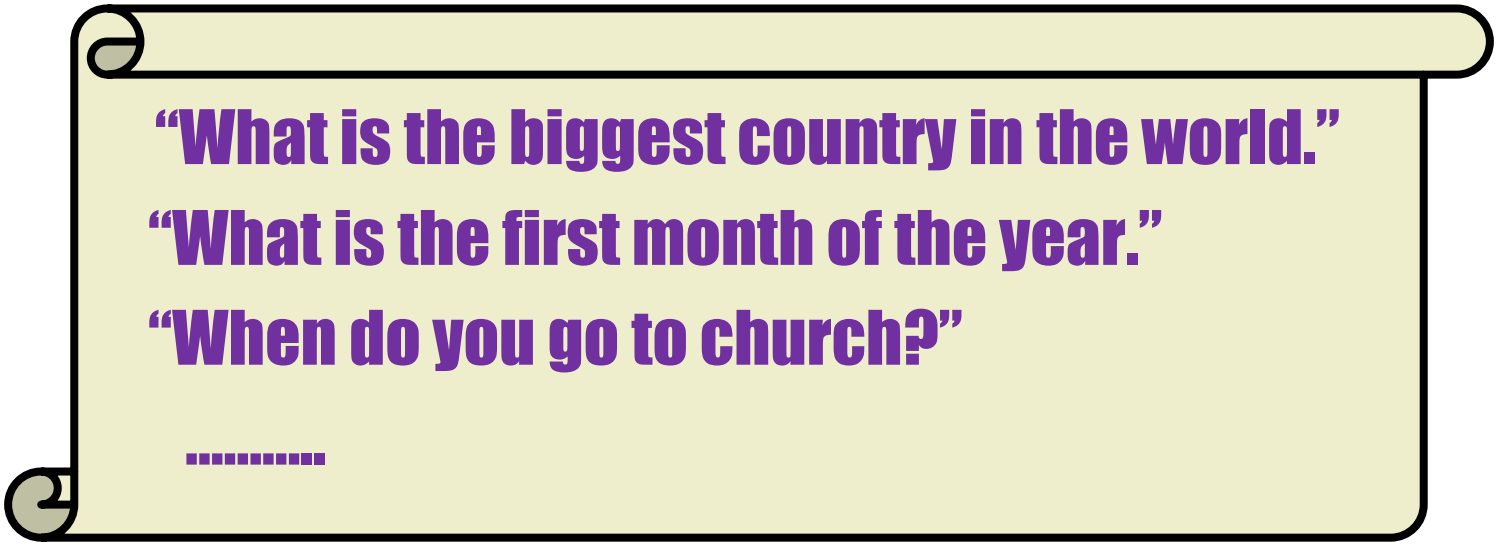
- A Practically possible judgment **server**.
- The more a robot attacks, the more money is lost.

CAPTCHA

COMPLETELY
AUTOMATED
PUBLIC
TURING TEST TO TELL
COMPUTERS AND
HUMANS
APART

CAPTCHA Example1

- Simple Question CAPTCHA.



This system expects that robots do not have general knowledge but people do, and that robots cannot understand English grammar.

- Positive
  - Very simple.

- Negative
  - Updated Robots collect every question from the system and respond with correct answers.
  - Whenever the system updates new questions, the robot collects them all.

*** A problem is the limited number of question sources.**

CAPTCHA Example2

The system anticipates that robots cannot understand the warped words but humans do.

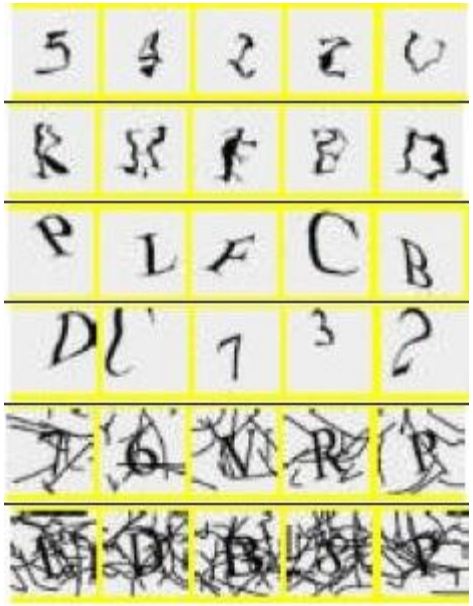
- Positive
  - Endless questions can be created.

- Negative
  - Updated Robots have image analysis function.

  - Current Robots are capable of recognizing twisted words quiet well.

*** Questions become easier for robots.**

- Recently suggested upgraded Word CAPTCHA.



Twists more

*** Even humans cannot understand.**

CAPTCHA Example3

Find a dog(s). (Object Recognition)

CAPTCHA Example4

Subject : “Futures”

Which picture is positive? (Emotional question)

- Positive
  - Object and Emotion analyses are nearly impossible questions for modern robots.

- Negative
  - There might be enough image sources but someone has to mine image data.
  - Additional labor costs are required.

*** It can not be a completely automated system.**

What is an Ideal CAPTCHA?

- It has endless sources.
- The source should be collected automatically with almost zero labor costs.
- Created questions must be difficult enough for modern robots but easy for humans.
- Most importantly, Ideal CAPTCHA must provide high rate correction.

It is…
Having automatically collectable cheap cost questions and providing highly correct results.

Project

GESTURE CAPTCHA SYSTEM

Why did we think the Simple Photo System is highly confidential?

The Network System never lost photos

Most importantly, we assumed the officer is not a poor judger.

IDEA OF GESTURE CAPTCHA

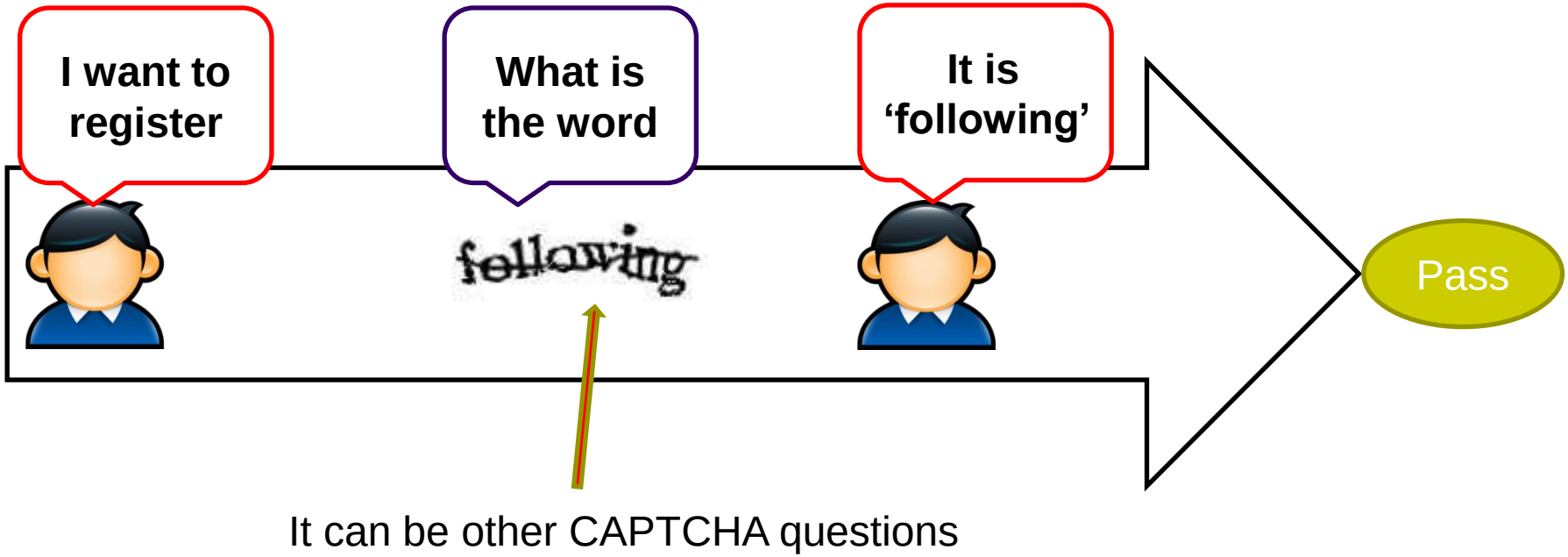
- The System does not judge.
- However, users who want to pass this system have to judge each other.
- Users take their photos and check each other.
  - Each user creates one CAPTCHA question.
  - There is a tiny cost for each user but zero cost for the system

*** Automatically collectable zero cost questions**

Assumptions for the prototype gesture CAPTCHA

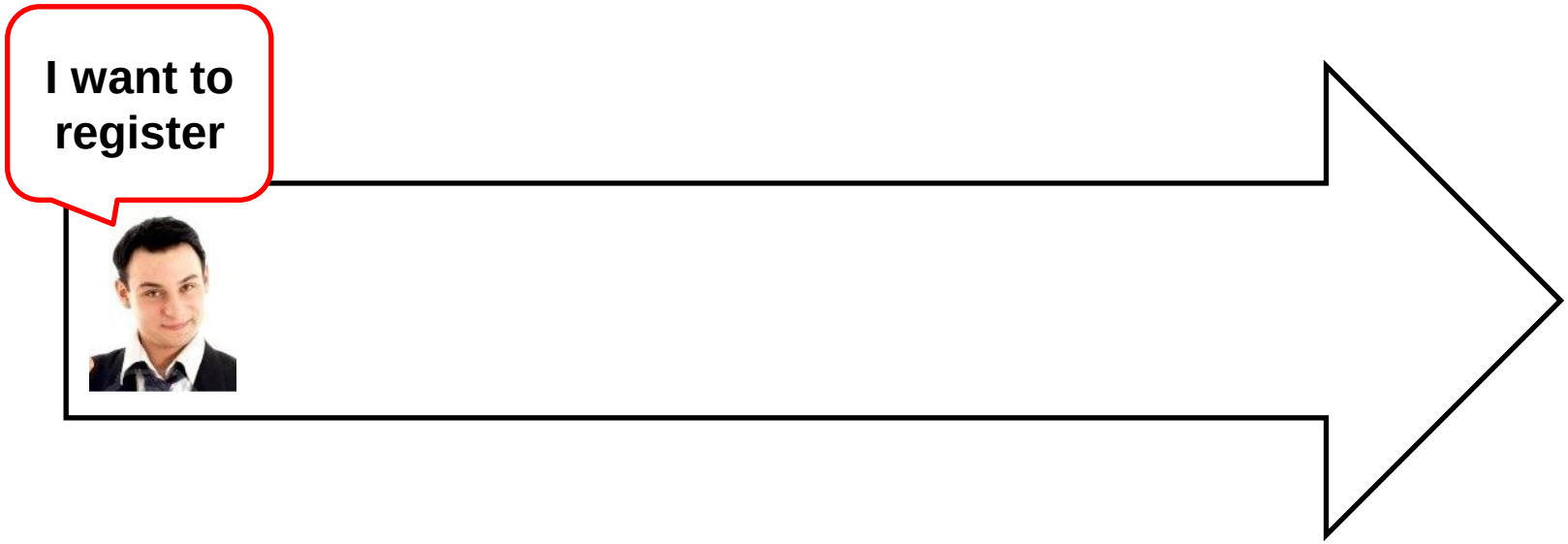
- The valuable resource is on Mobile networks.
  - We cannot expect most computers have a camera.
  - We can expect most Mobile phones have a camera.
- Users use Android Smart phone clients.
- All android Smart phones at least have a camera
- Most humans are correct judgers.

Common CAPTCHA process

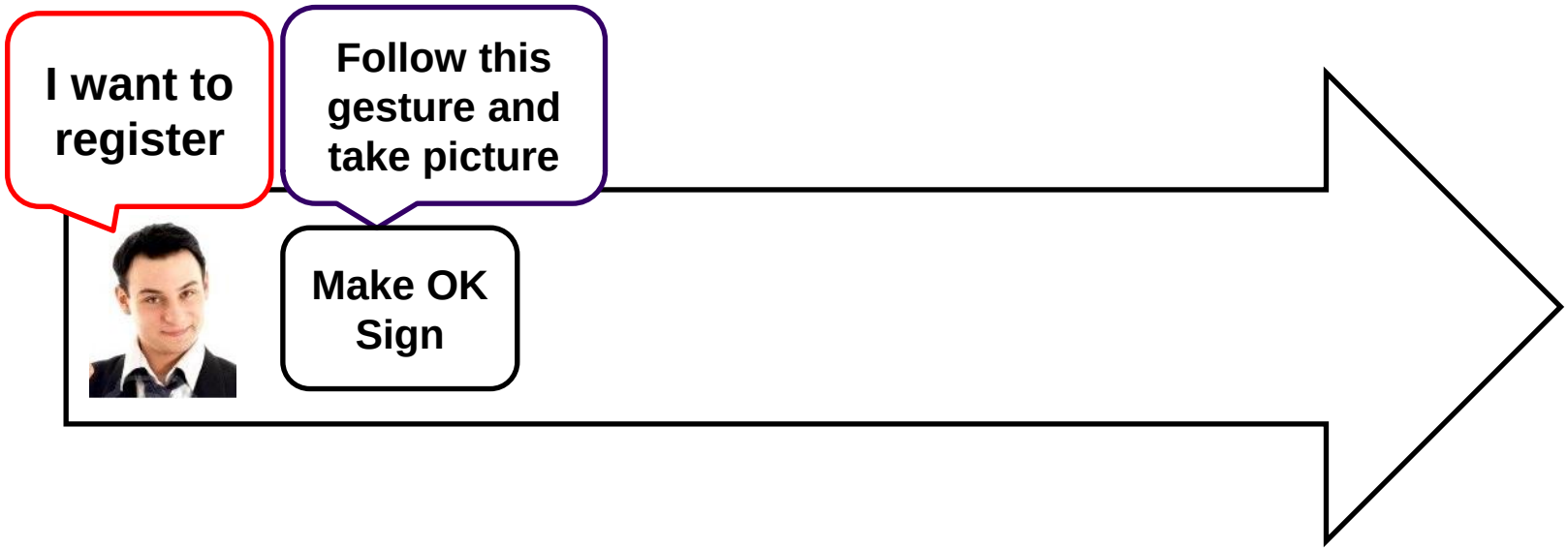


It can be other CAPTCHA questions

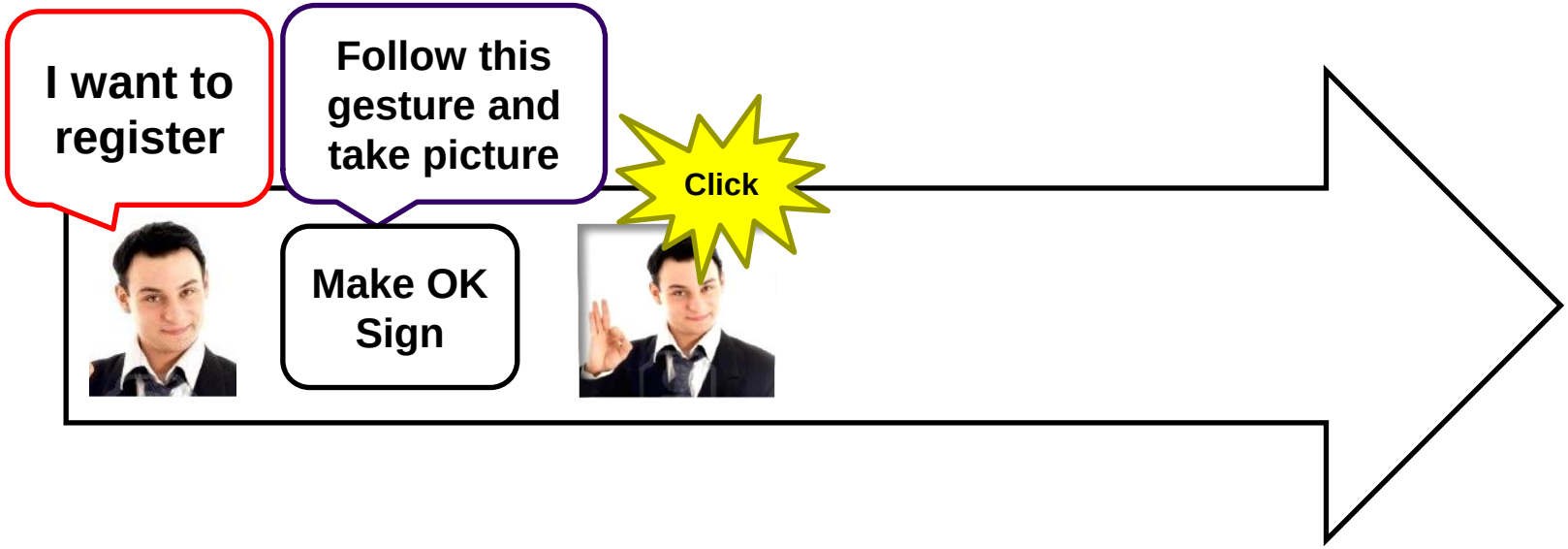
Gesture CAPTCHA process



Gesture CAPTCHA process



Gesture CAPTCHA process



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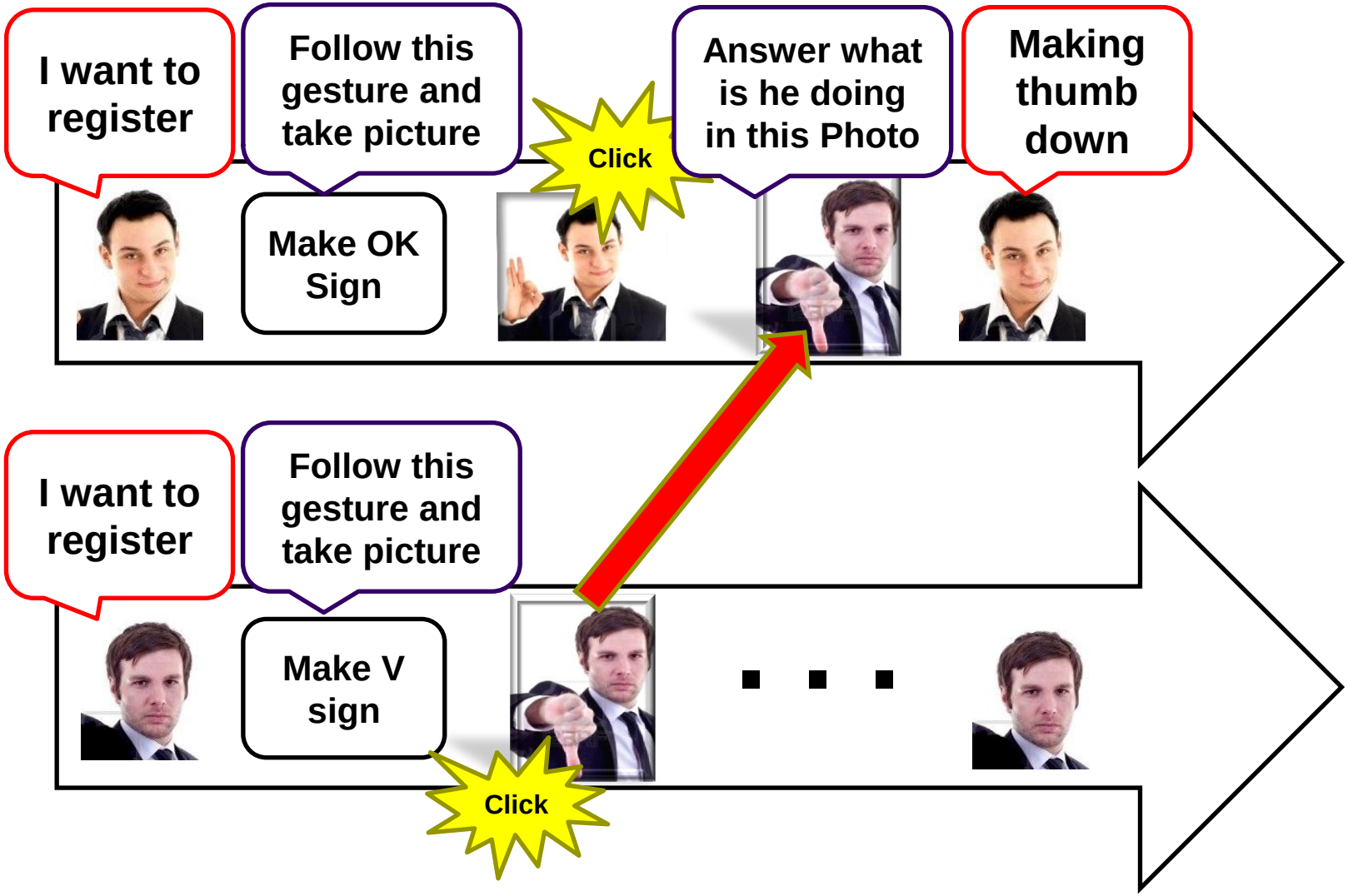
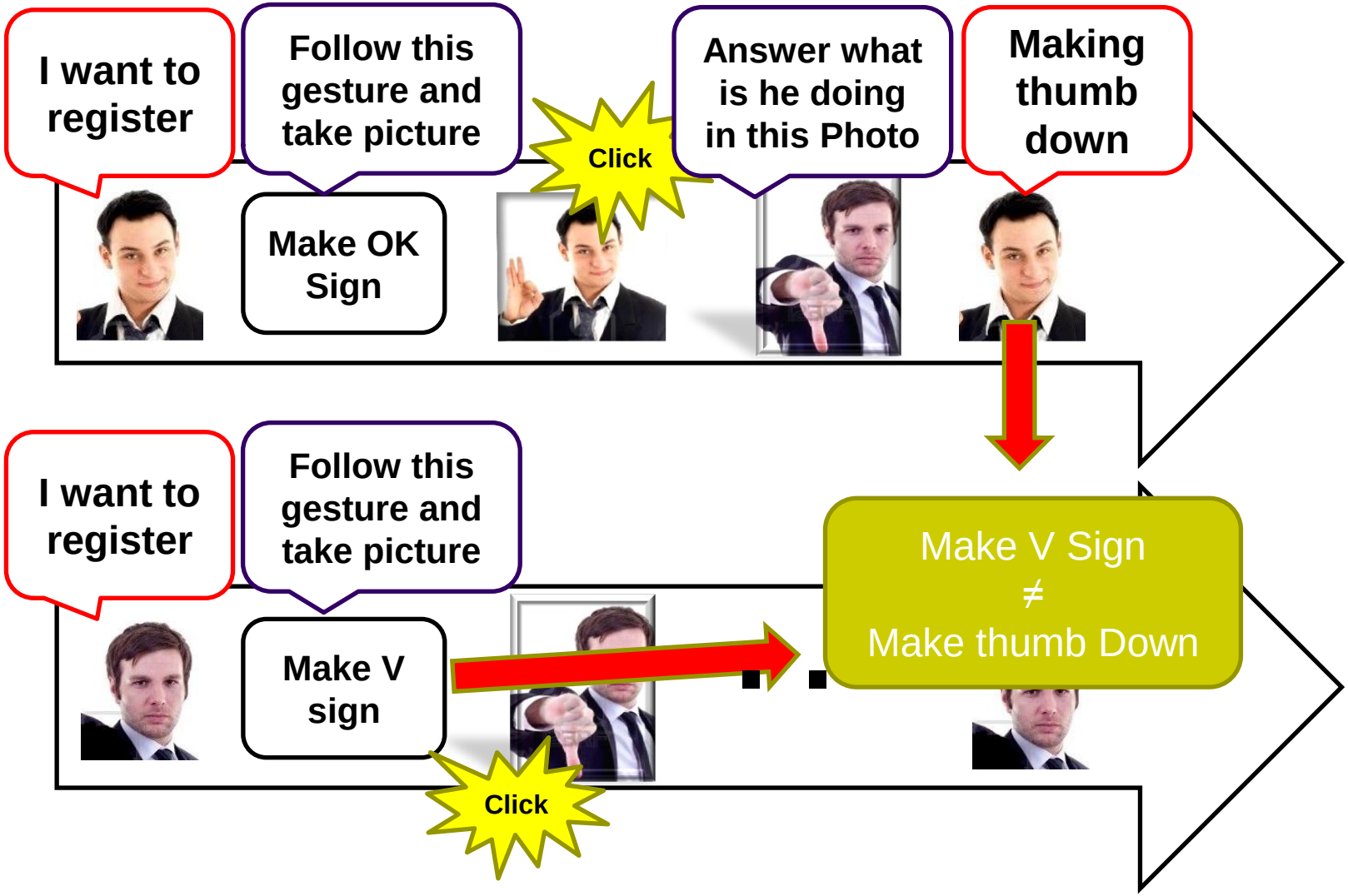
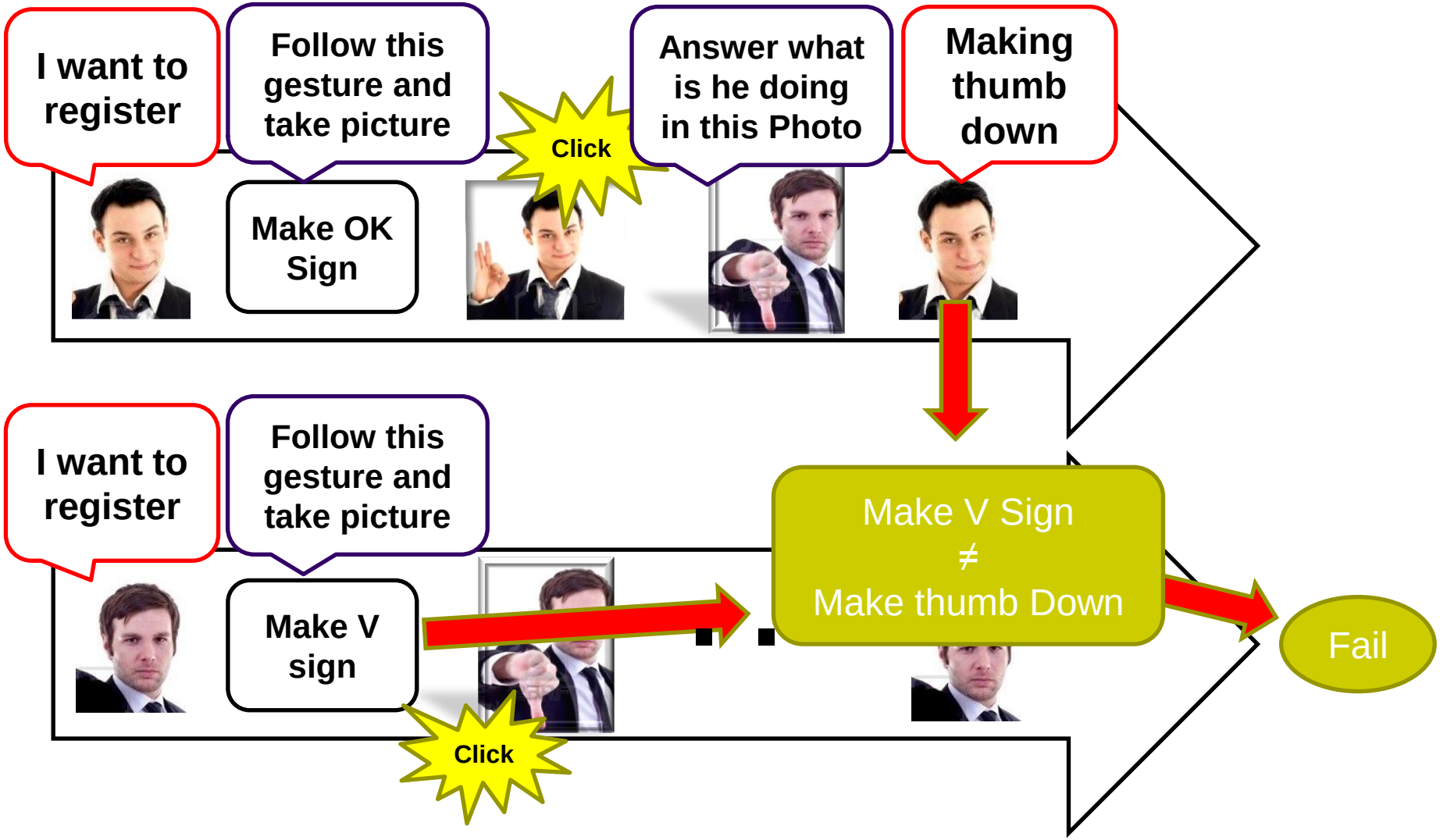


Gesture CAPTCHA process



Gesture CAPTCHA process



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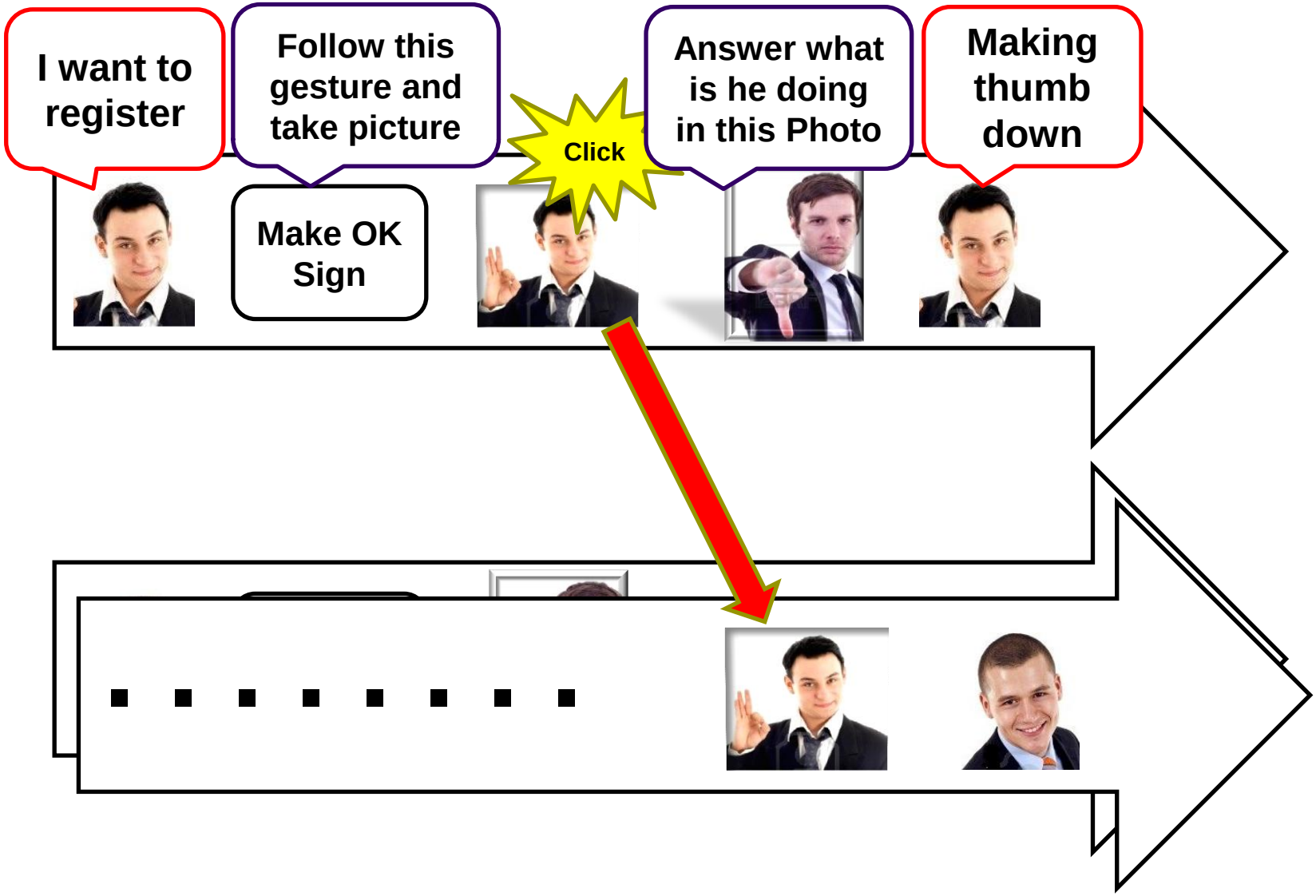
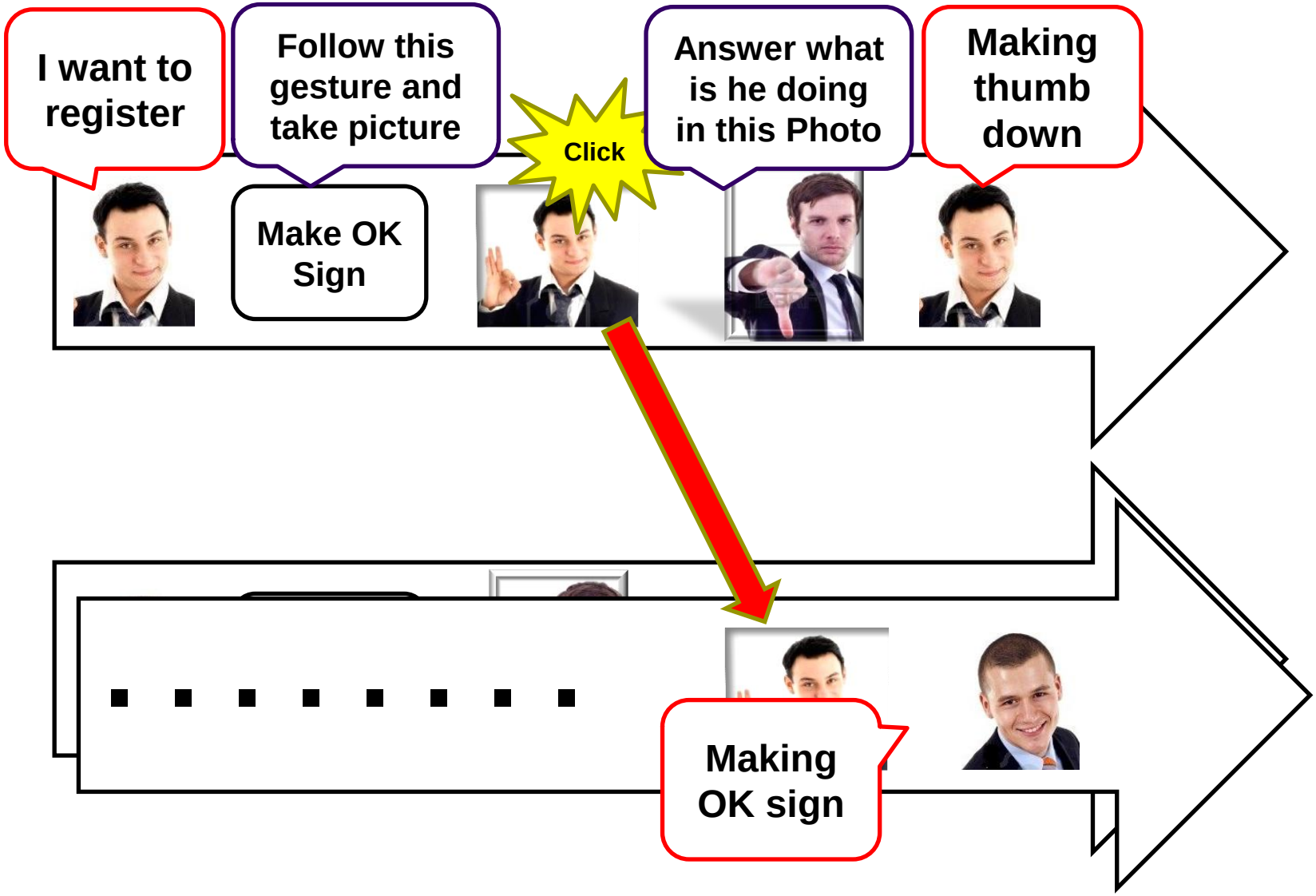


Gesture CAPTCHA process



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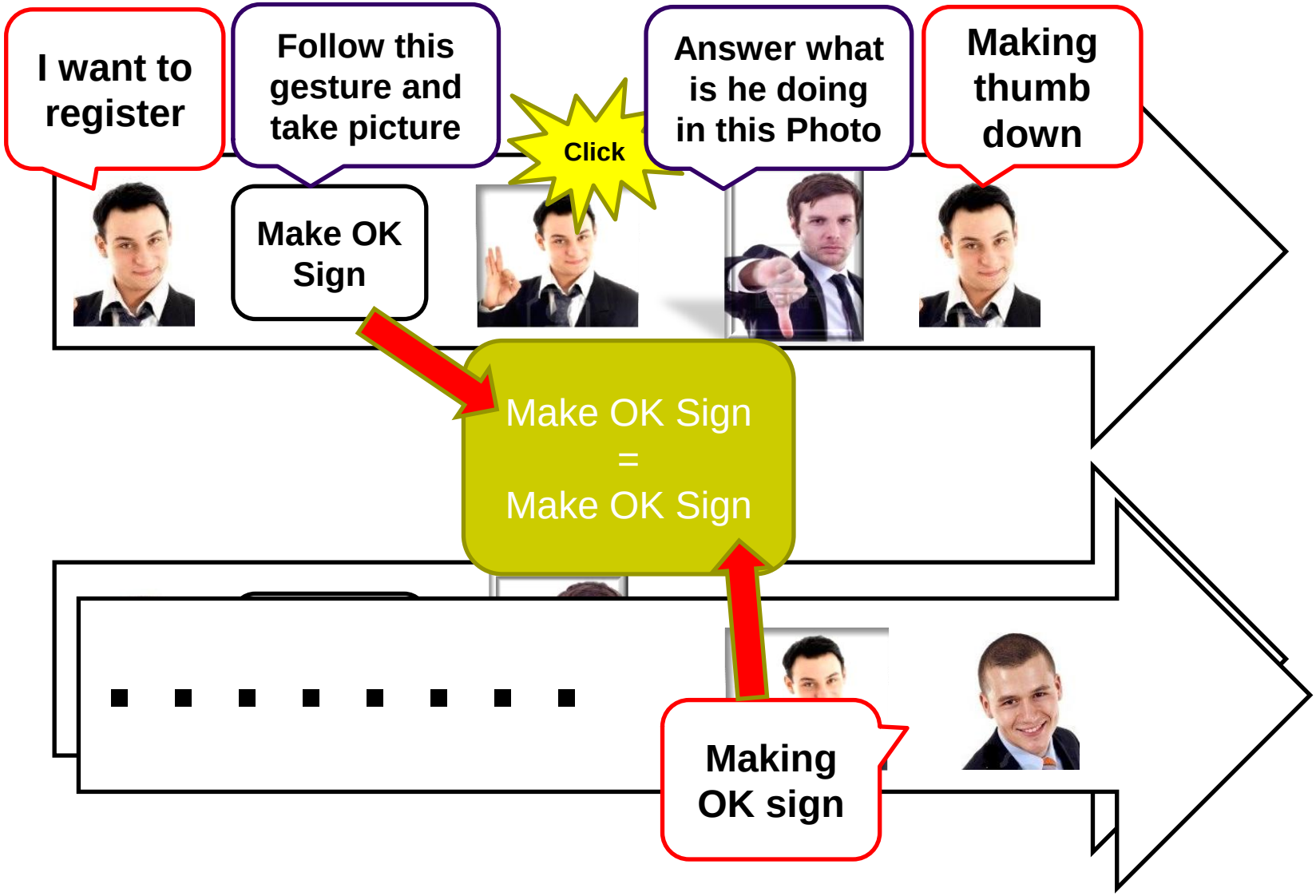

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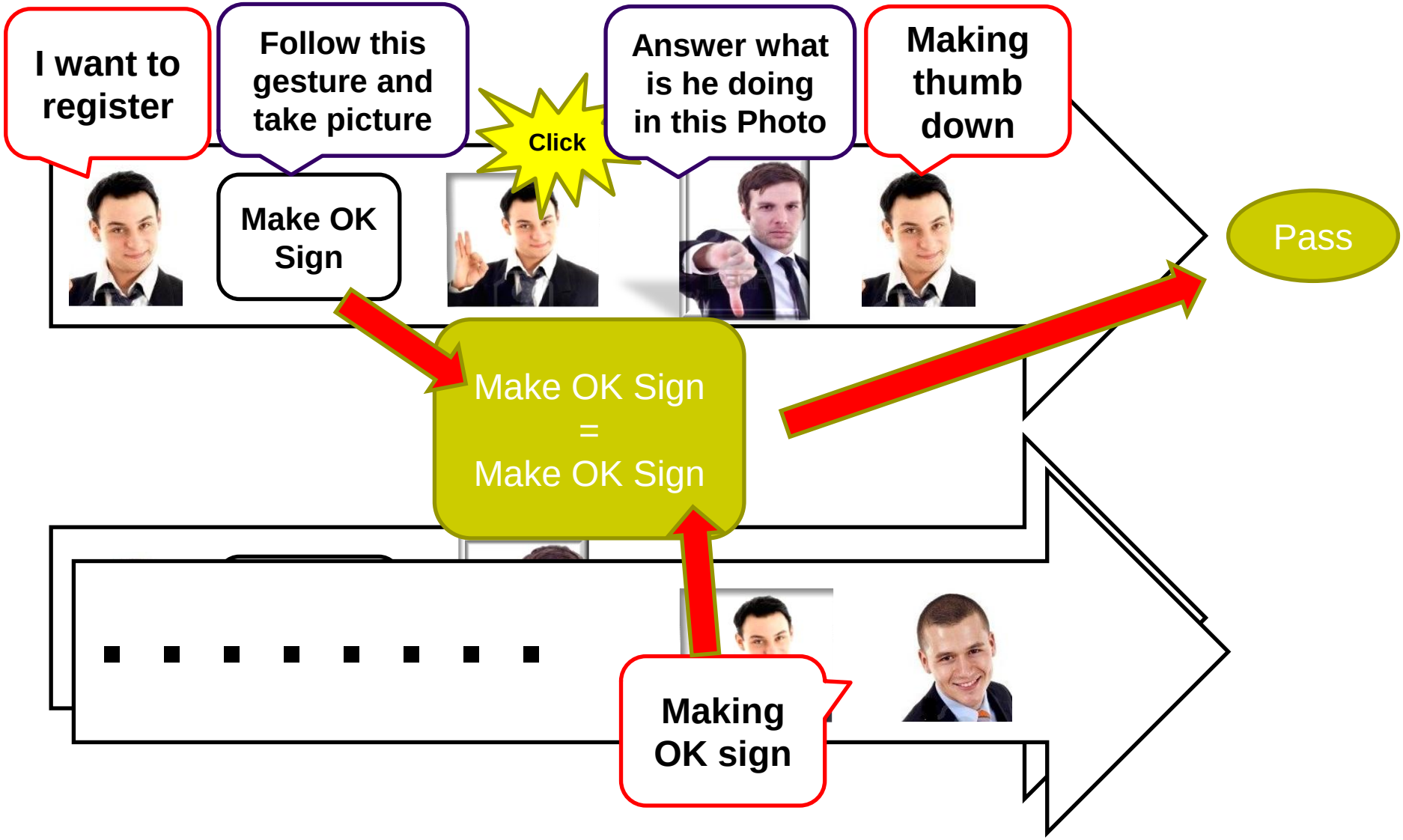


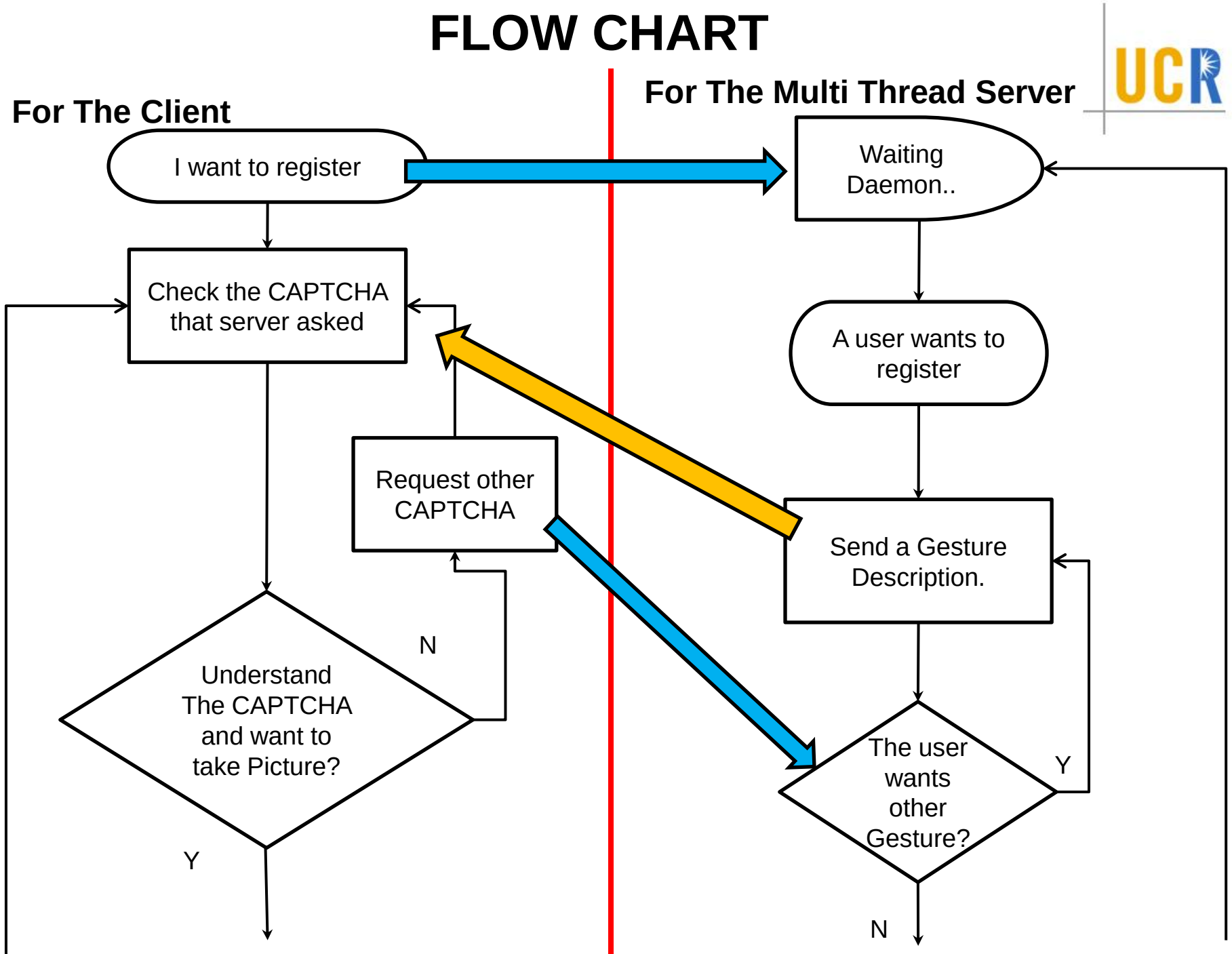
A Sever and Clients model of Gesture CAPTCHA

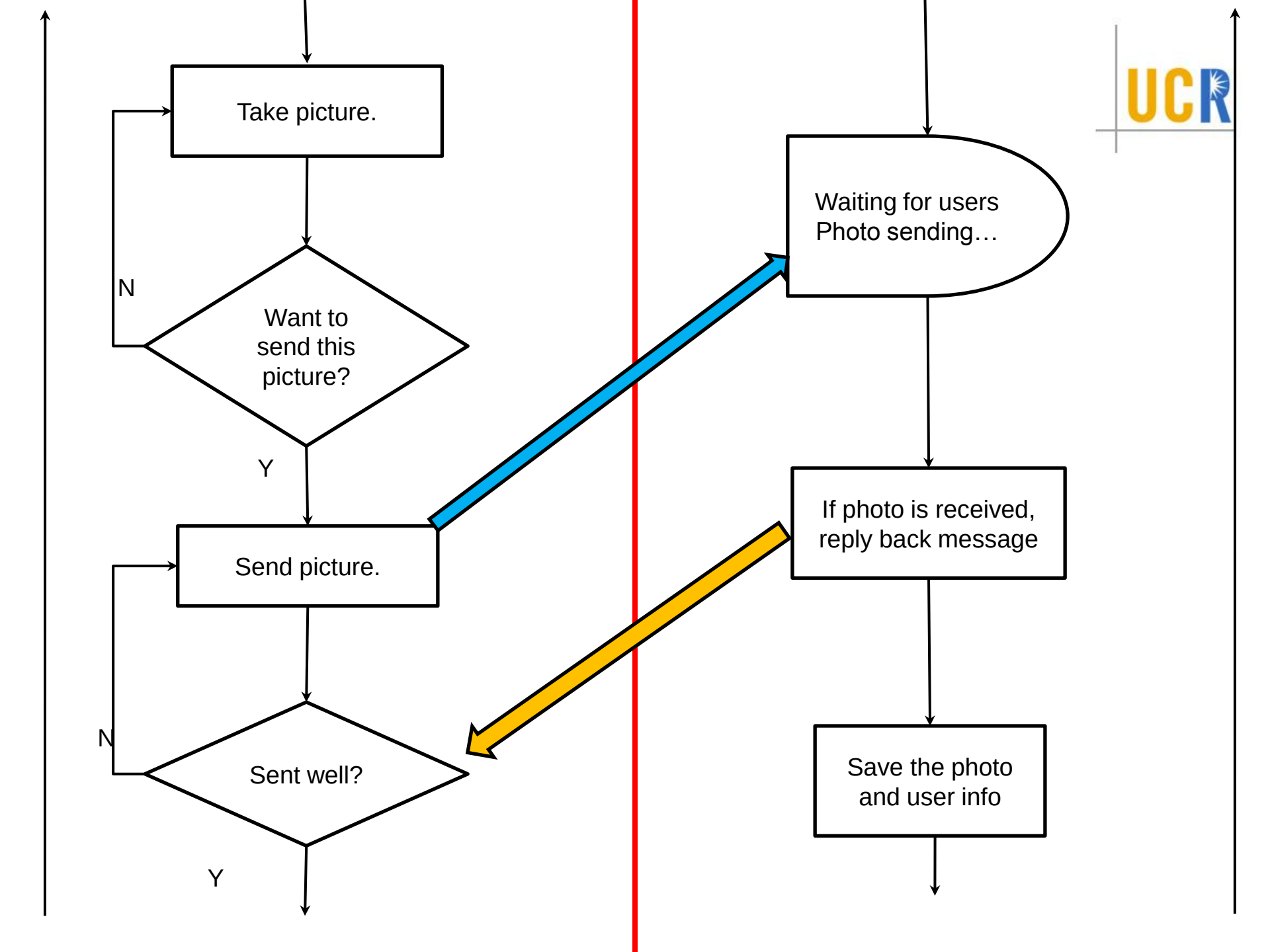
CAPTCHA Server daemon

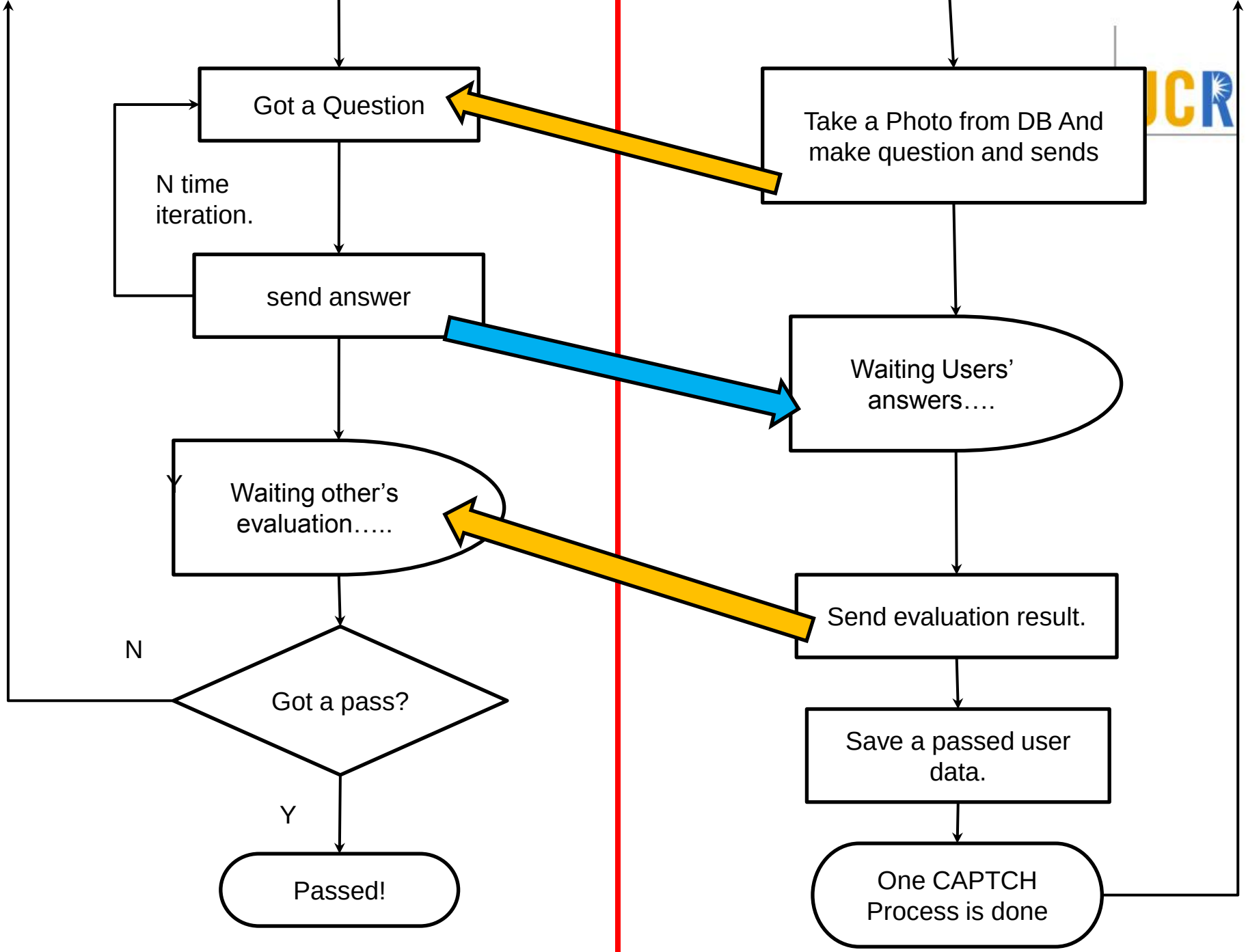
What dose the server do ?

1. ***Send Gesture messages***
2. ***Collect User Photos***
3. ***Send User photos to judgers***
4. ***Compare actual Gesture messages and Judger's answer.***
5. ***Decide 'Pass' or 'Non-pass'***

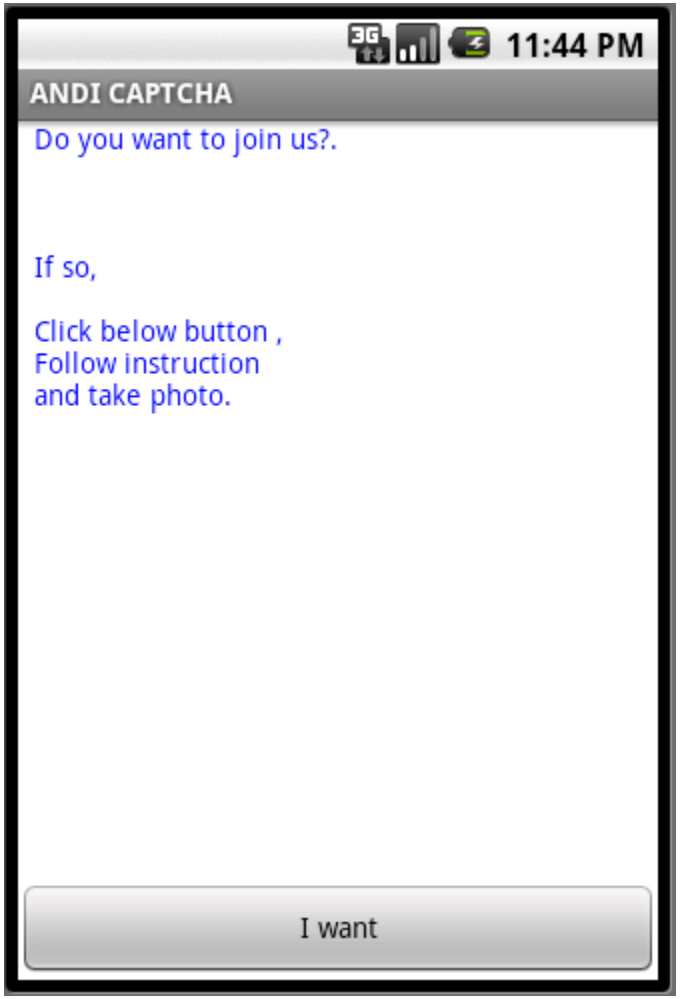
FLOW CHART


For The Client
For The Multi Thread Server
I want to register
Waiting Daemon..
Check the CAPTCHA that server asked
A user wants to register
Request other CAPTCHA
Send a Gesture Description.
Understand The CAPTCHA and want to take Picture?
N
Y
The user wants other Gesture?
Y
N


Take picture.
Want to send this picture?
N
Y
Send picture.
Sent well?
N
Y
Waiting for users Photo sending…
If photo is received, reply back message
Save the photo and user info


Got a Question
N time iteration.
send answer
Waiting other's evaluation…..
Y
N
Got a pass?
Y
Passed!
Take a Photo from DB And make question and sends
Waiting Users' answers….
Send evaluation result.
Save a passed user data.
One CAPTCH Process is done

Start


11:44 PM
ANDI CAPTCHA
Do you want to join us?.
If so,
Click below button ,
Follow instruction
and take photo.
I want

Taking a photo

A question

Select one


11:49 PM
selection
Smile
Bite your finger
Make a V sign
Wink
'NO RIGHT ANSWER'
OK
See Photo

Project Gesture CAPTCHA System

PROBLEMS

A problem of HUMAN COMPUTATION

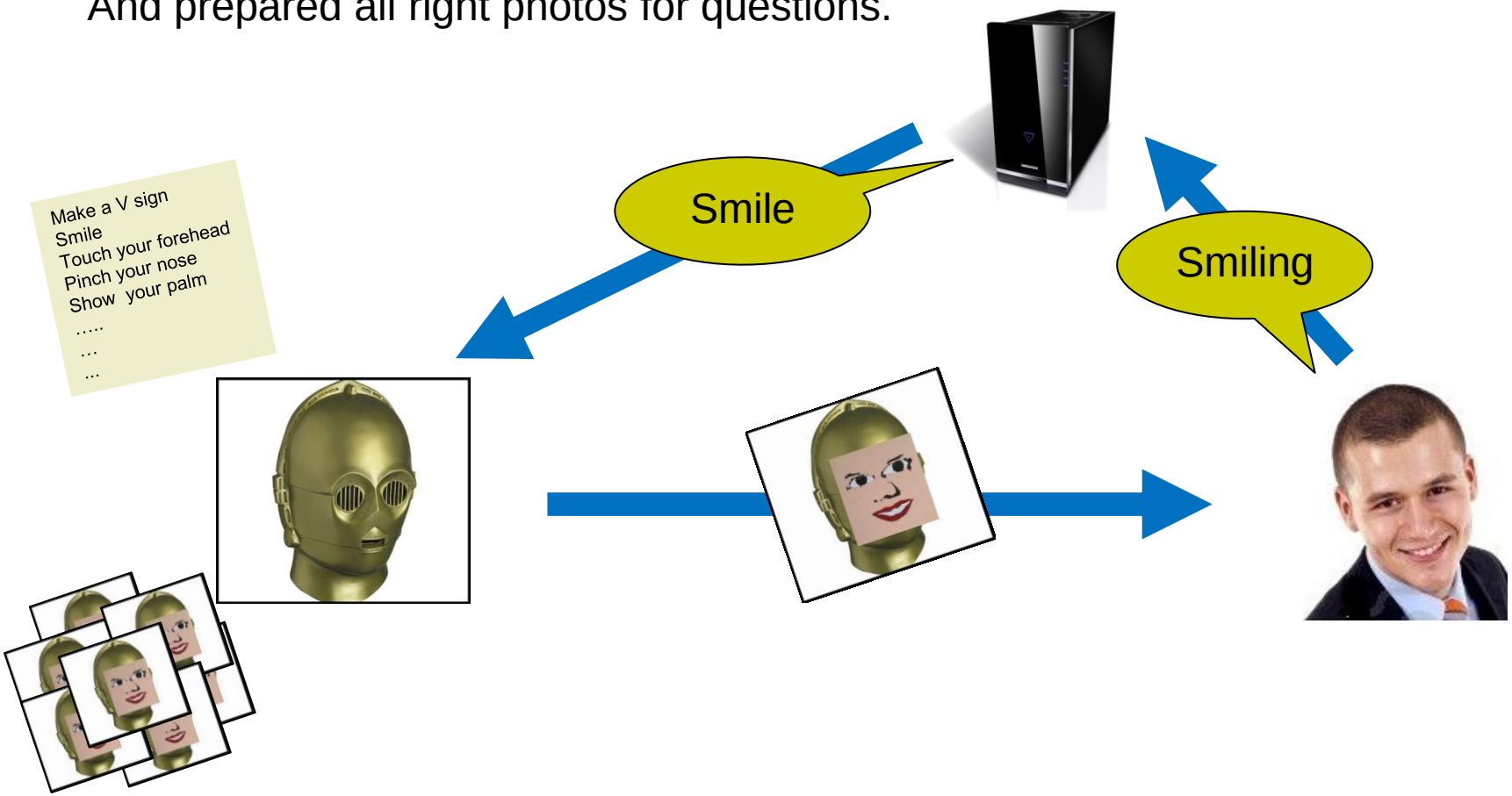
- **What if the officer is a bad judger.**

Actually, he is a corrupt Cop!!

Counter Example. New Robot

- There is new robot

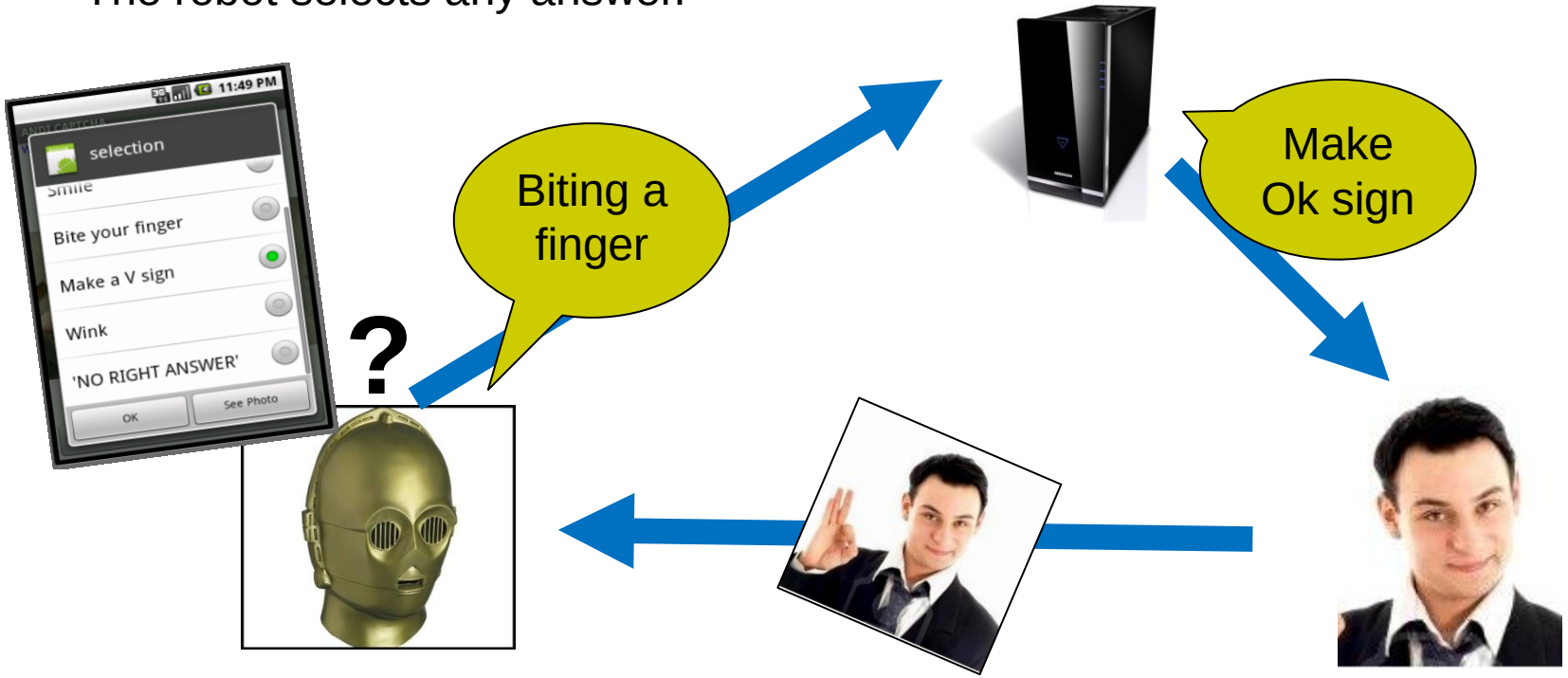
which have collected all gesture questions.
And prepared all right photos for questions.



Counter Example. New Robot

- New robot is also a bad judger

The robot selects any answer.



Counter Example. New Robot

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An innocent user gets a fail

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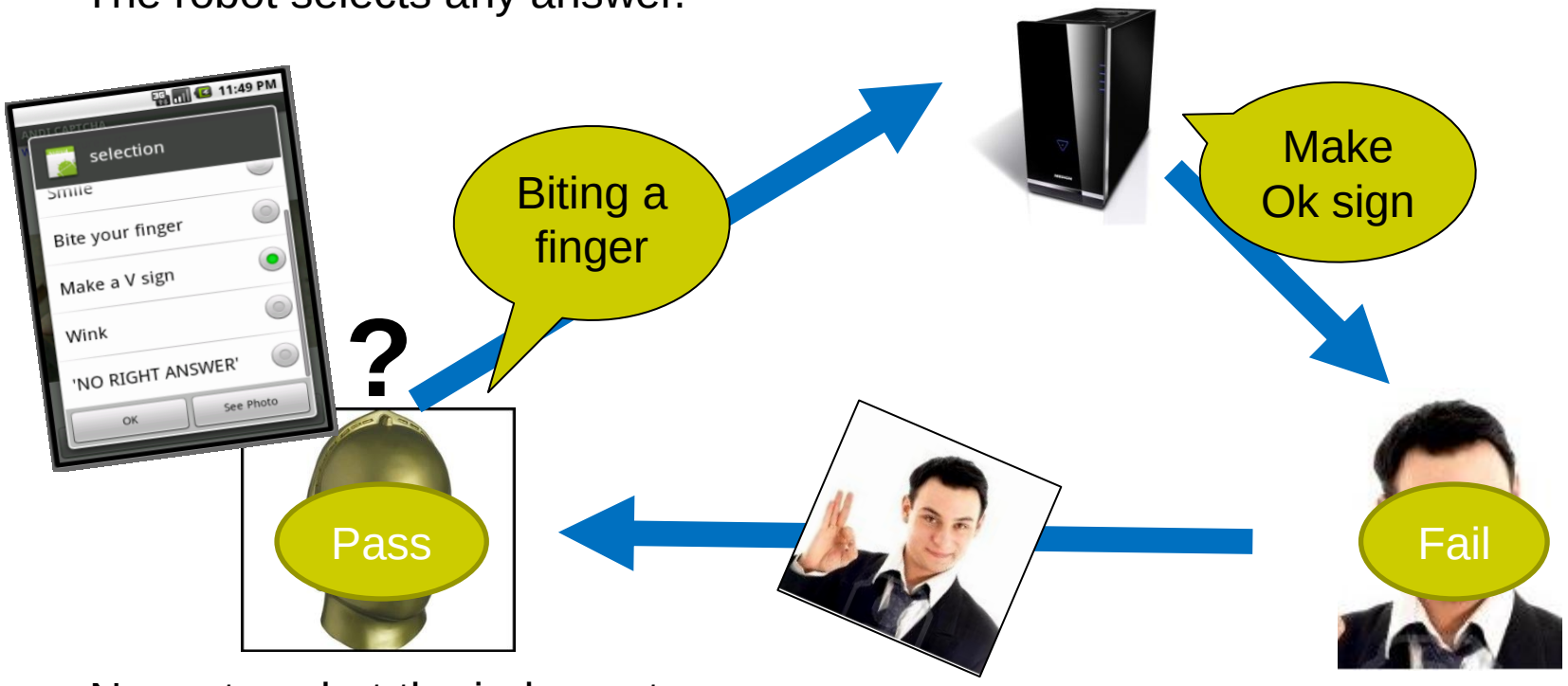


No mater what the judgment was, new robot gets a pass

An innocent user gets a fail

Upgraded Gesture CAPTCHA

MULTI QUESTIONS SYSTEM

This idea from below paper :

von Ahn, L., Maurer, B., McMillen, C., Abraham, D., and Blum, M.
reCAPTCHA: Human-Based Character Recognition via Web Security Measures.
Science. pp. 1465-1468. (2008)

Upgraded Gesture CAPTCHA

- Now, each user has to answer 3 questions.

First question is **USER CHECKER**.
A User needs to answer other's gestures (same as before).

Second question is **JUDGE CHECKER**.
Server knows what the answer is. If a judge selects the wrong answer, then the system would consider the user as a **'BAD JUDGER'.**
Failure's USER CHECKER answer is not considered as judgment.

Third question is **STATISTICAL COLLECTOR**.
Users' answers of the photo are counted.
Eventually, if the system gets 'Enough' same answer, then it becomes, a photo for **JUDGE CHECKER**.

Process of Questions

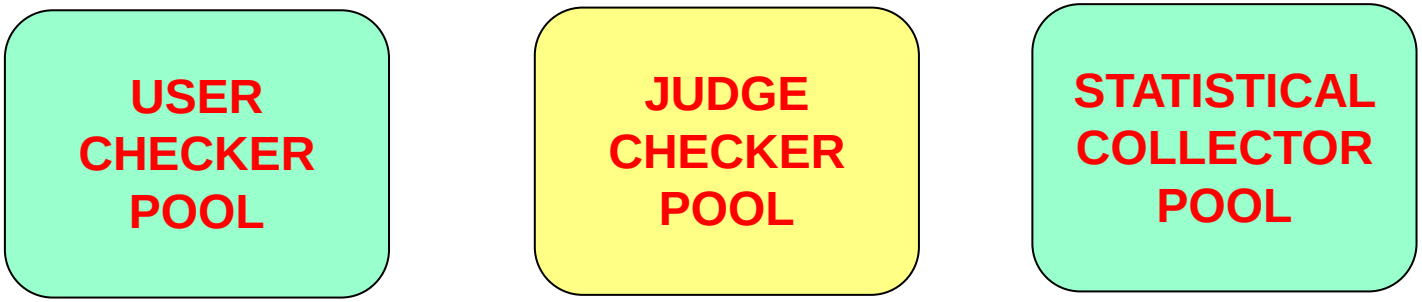
USER CHECKER POOL

JUDGE CHECKER POOL

STATISTICAL COLLECTOR POOL

A User takes his gesture picture.

Process of Questions



Another user's photo comes from the USER CHECKER POOL.

The user answers ,"He is **Making a thumb up**"

Process of Questions

USER CHECKER POOL

JUDGE CHECKER POOL

ST CAL CO TOR

This Picture statistic
- **0** : Make thumb down
- **1** : Make thumb up
- **0** : show your palm
- **0** : make ok sign.
- **0** : make One sign

……

sum : **1**

Process of Questions

USER CHECKER POOL

STATISTICAL COLLECTOR POOL

This Picture's answer is - **Make a thumb down**

This User is a good judger

Make a thumb down = Make a thumb down

Next question comes from JUDGE CHECKER POOL but the user does not know which question is.

The user answers ,"He is **Making a thumb down**"

Process of Questions

USER CHECKER POOL

JUDGE CHECKER POOL

STA AL CO OR

This Picture statistic
- **3** : Make thumb down
- **2** : Make thumb up
- **0** : show your palm
- **5** : make ok sign.
- **89** : make One sign

……

sum : **99**

Last question is from
STATISTIC COLLECTION POOL

Process of Questions

USER CHECKER POOL

JUDGE CHECKER POOL

STATISTICAL COLLECTOR POOL

This Picture statistic
- **3** : Make thumb down
- **2** : Make thumb up
- **0** : show your palm
- **5** : make ok sign.
- **89** : make One sign

……

sum : **99**

Last question is from
STATISTIC COLLECTION POOL

The user answers ,“He is **Making One sign**”

Process of Questions

USER CHECKER POOL

JUDGE CHECKER POOL

This Picture's answer is
- **Make One Sign**

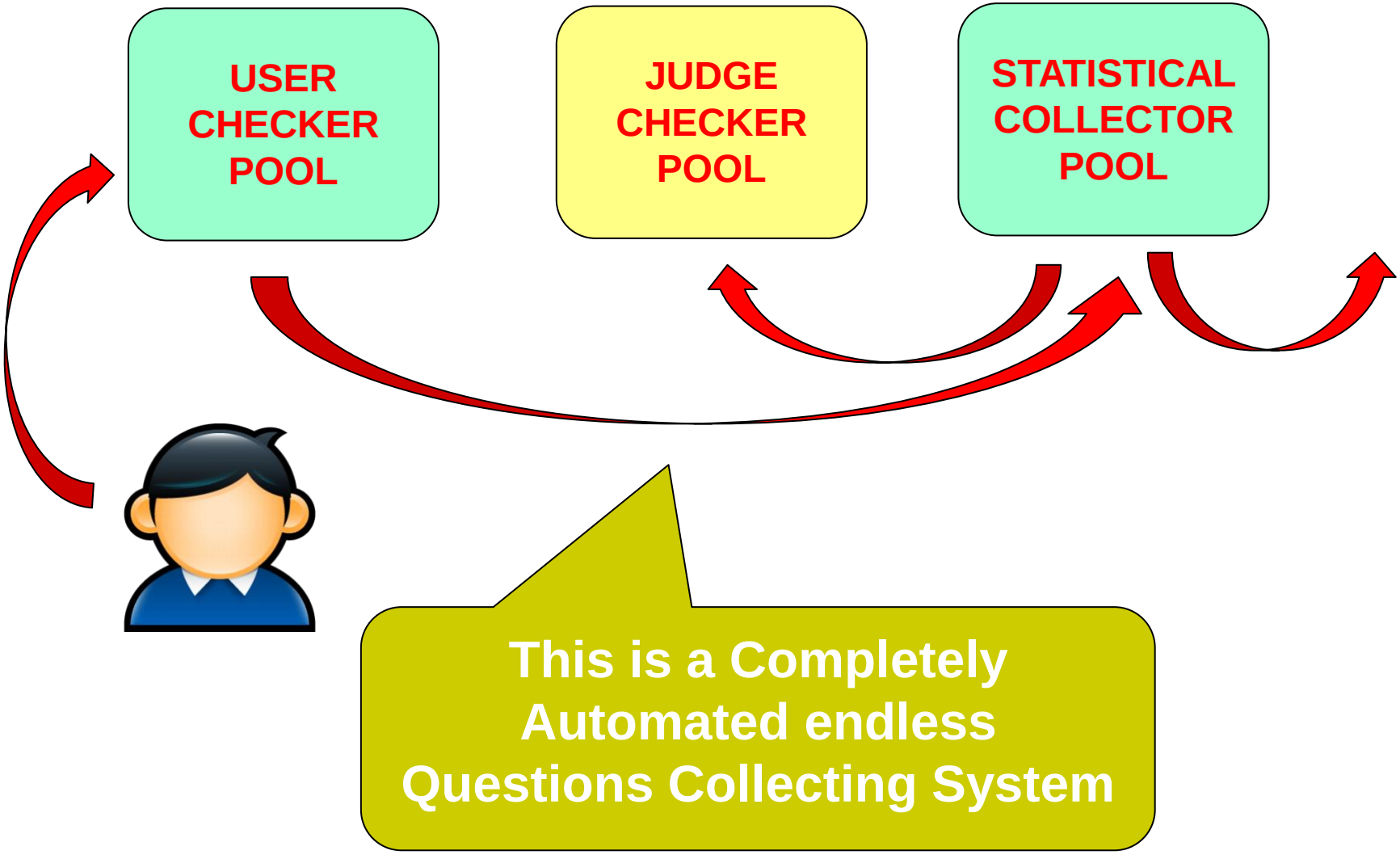
STA AL CO OR

This Picture statistic
- **3** : Make thumb down
- **2** : Make thumb up
- **0** : show your palm
- **5** : make ok sign.
- **90** : **make One sign**

……

sum : **100**

Process of Questions



If a Judger Checker proves insufficient

- Example
  - A Robot needs 1$ for an attack.
  - **A Judger Checker** has 5 selections.

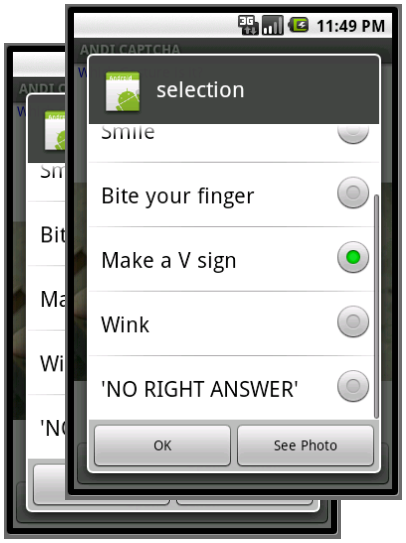
Statistically, the robot can penetrate this system after attacking 5 times.

1$ X 5 times = 5$

5$ is needed for one penetration probabilistically.

If there are two Judger Checkers

- Example
  - A Robot needs 1$ for an attack.
  - **A Judger Checker** has 5 selections.



Number of attacks to achieve one penetration is,
5 times **X** 5 times = 25 times

5$ X 5$ = 25$

25$ is needed for one penetration probabilistically.

If there are three Judger Checkers

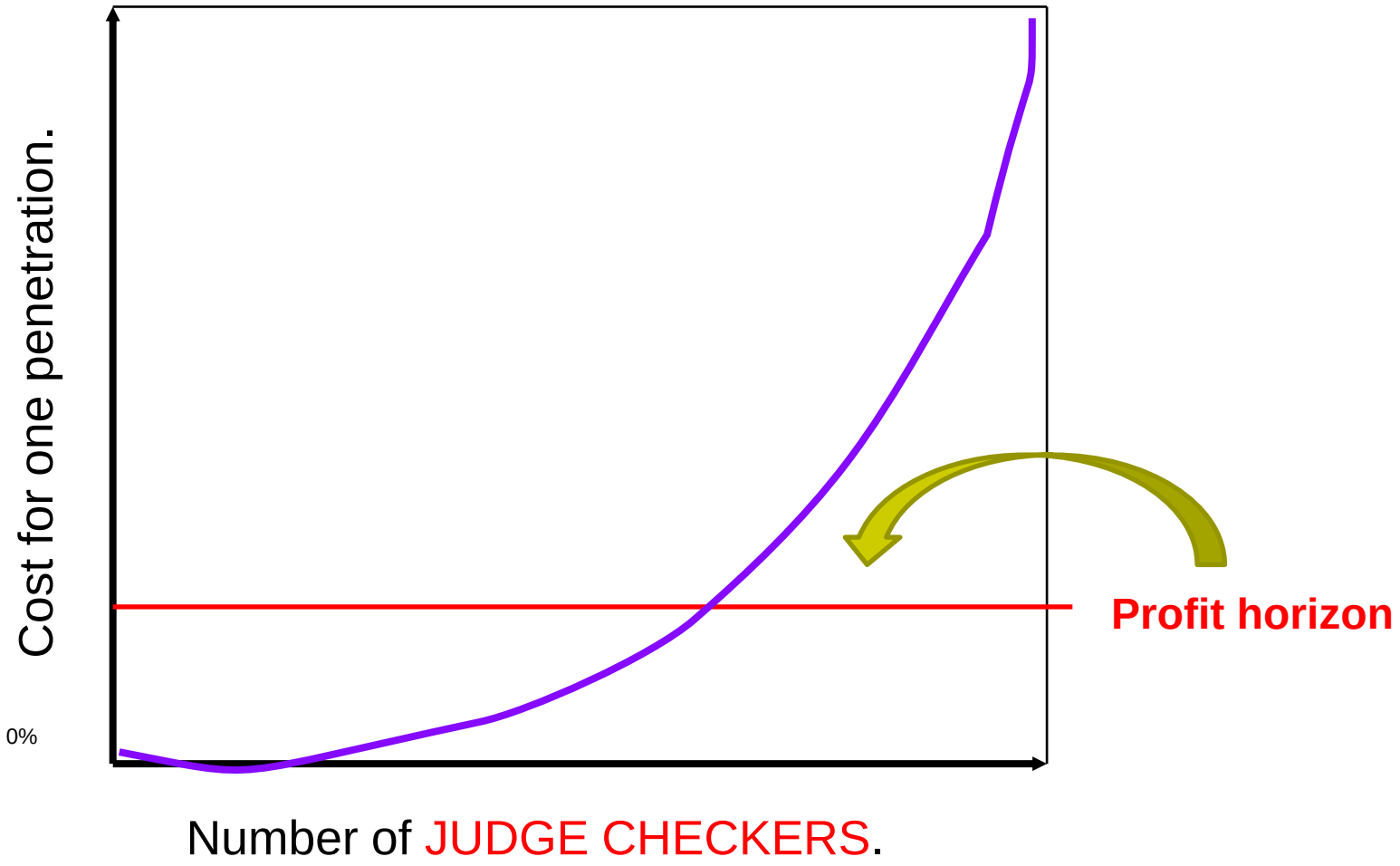
- Example
  - A Robot needs 1$ for an attack.
  - **A Judger Checker** has 5 selections.

Number of attacks to achieve one penetration is,
5 **X** 5 X 5 = 125 times

5$ X 5$ 5$ = 125$

125$ is needed for one penetration probabilistically.

Exponential graph:
How many JUDGE CHEKER are needed



What is an Ideal CAPTCHA?

- It has endless sources.
- The source should be collected automatically with almost zero labor costs.
- Created questions must be difficult enough for modern robots but easy for humans.
- Most importantly, Ideal CAPTCHA must provide high rate correction.

It is…
Having automatically collectable cheap cost questions and providing highly correct results.

Conclusion

- It has endless sources.
- The source are collected automatically with almost zero labor costs.
- Created questions can be difficult enough for modern robots but easy for humans.
- Most importantly, This CAPTCHA can provide high rate correction.

Q & A