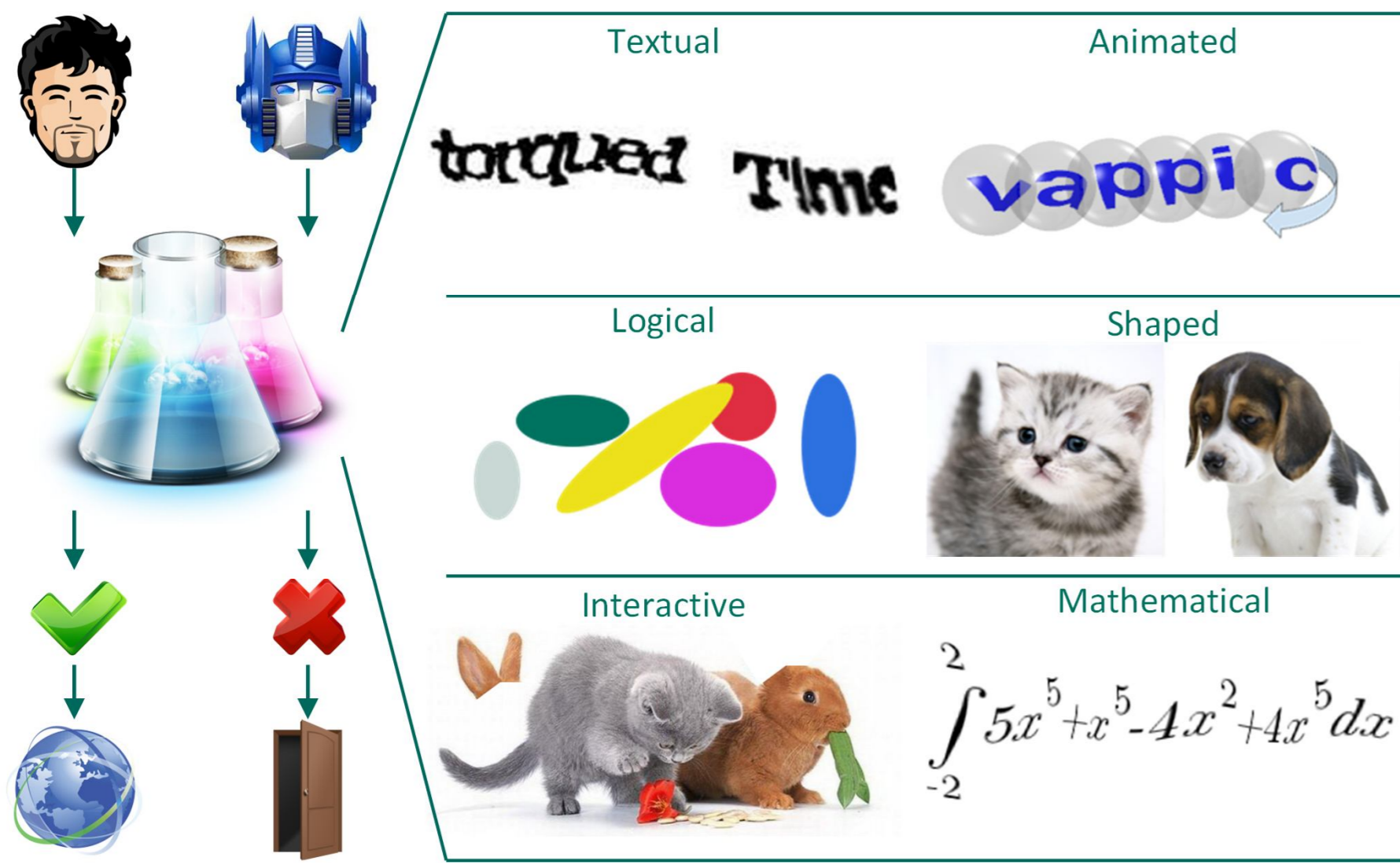
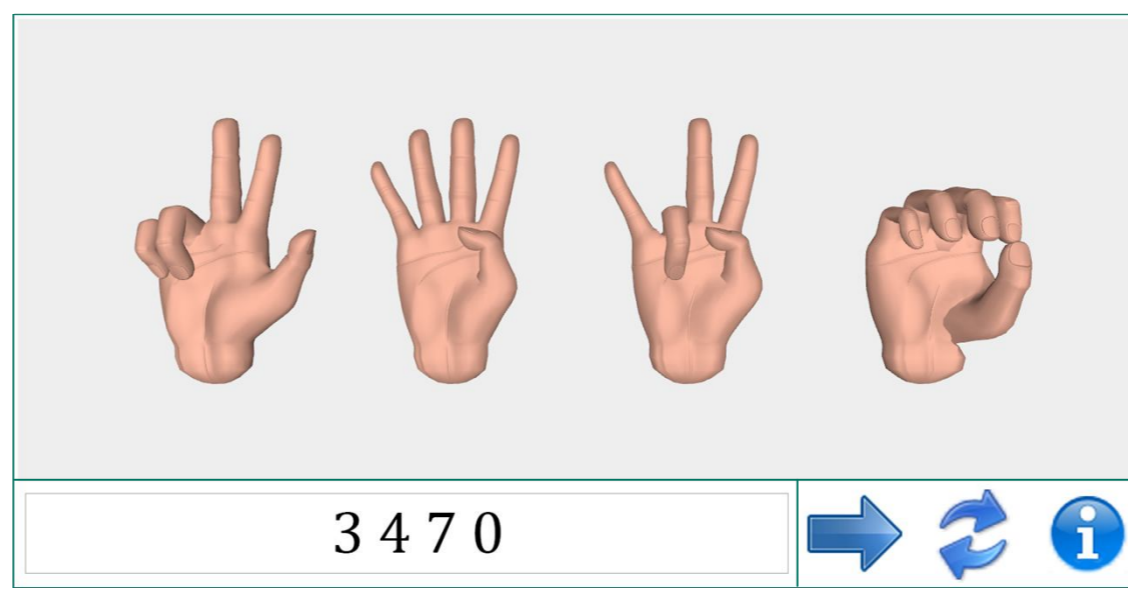


## CAPTCHA – Test for Humanity



## New Challenge for Spam Bots



- **Increased complexity for bots** – gestural CAPTCHA combines text, shaped and animated approaches.
- **Easy to use** – developed using HTML5 technologies, JavaScript programming language and cross-browser library/API THREE.js.
- **The ability to use clues** – schematic gesture notations easily understood by people and useless for spam bots.

## Reliable Defender Against Spam

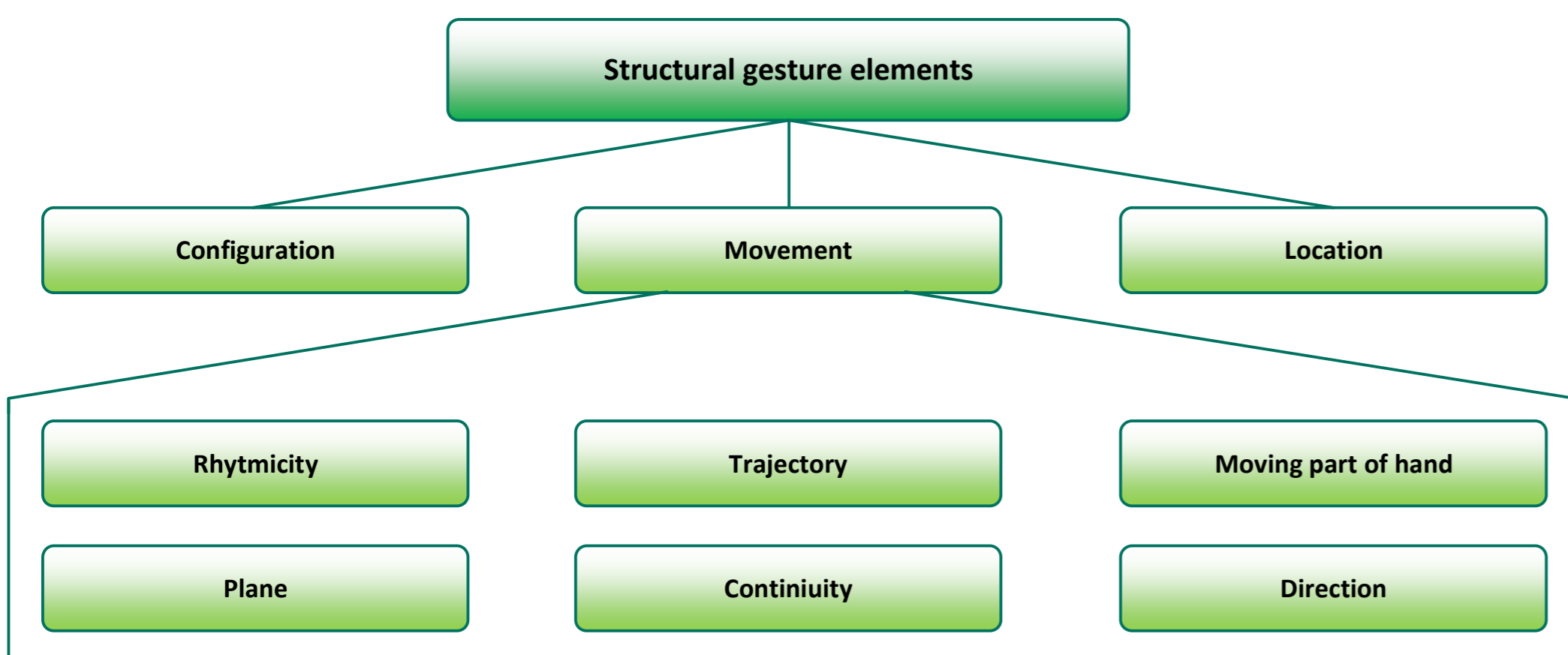
Akismet system catches more than **18 million spam comments per day** with their popular antispam WordPress plug-in.



Mollom system estimates that more than **90% of the comments contain spam**.



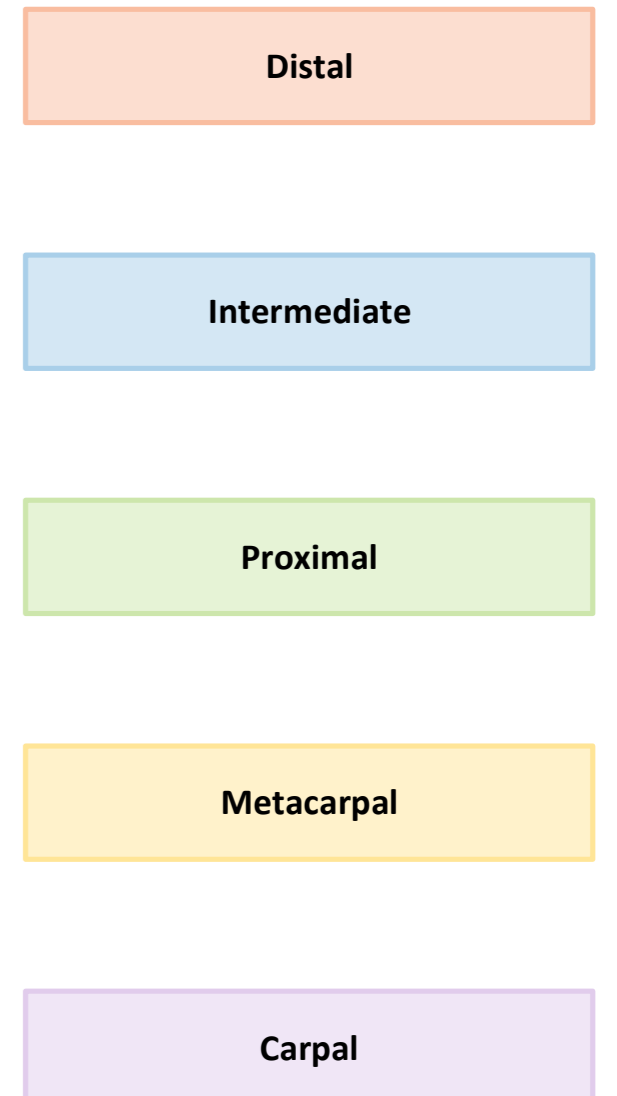
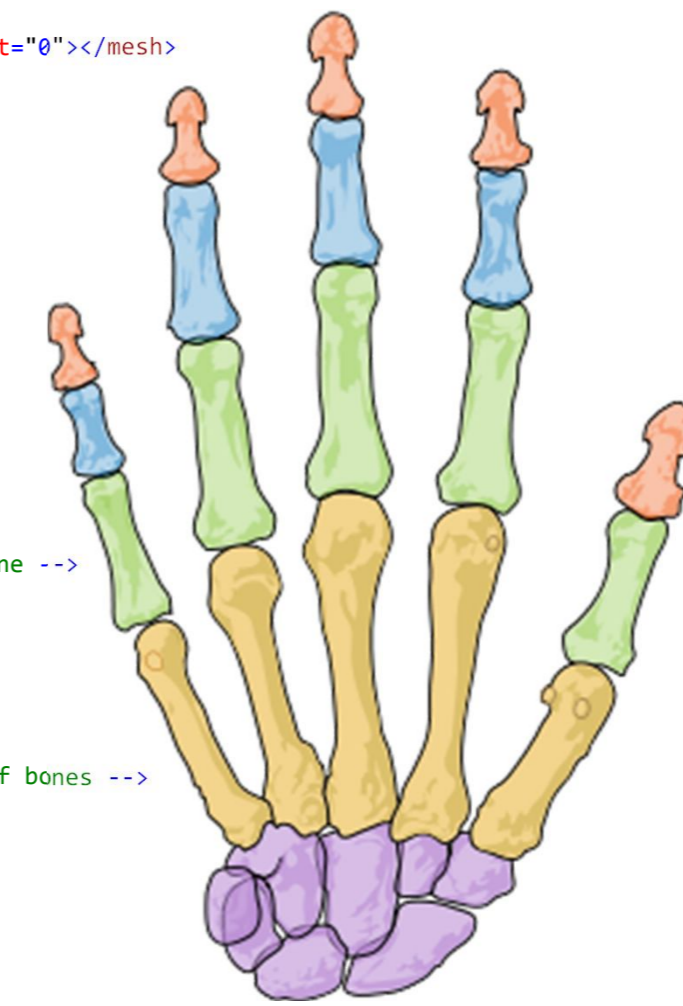
## Symbolic Gesture Language (Alexandrova A., 2007-2009)



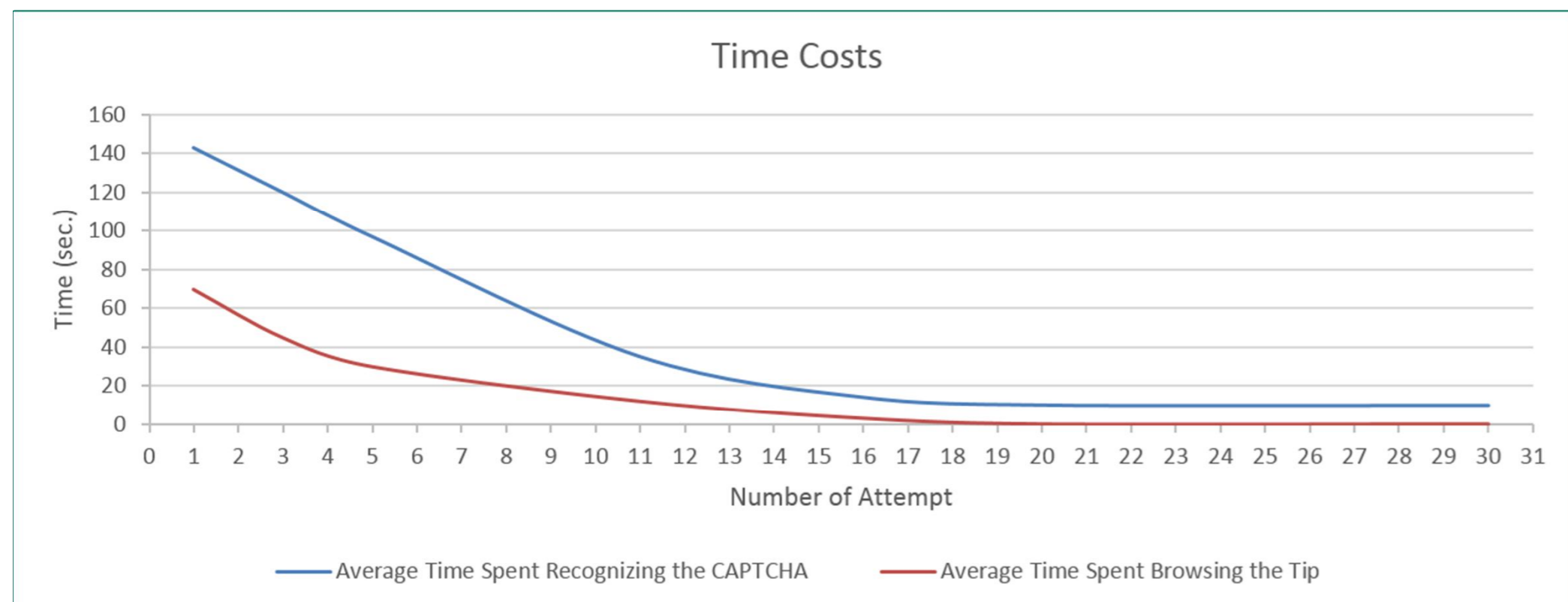
## Gesture Description

```

<pose>
<!-- Hand position and rotation -->
<mesh xPos="0" yPos="0" zPos="0" xRot="0" yRot="0" zRot="0"/></mesh>
<!-- Rotation of each bone in the hand -->
<finger>Index
  <bone pitch="0" yaw="0">Proximal</bone>
  <bone pitch="0">Intermediate</bone>
  <bone pitch="0">Distal</bone>
</finger>
<finger>Middle
  <bone pitch="0" yaw="0">Proximal</bone>
  <bone pitch="0">Intermediate</bone>
  <bone pitch="0">Distal</bone>
</finger>
<finger>Ring
  <bone pitch="0" yaw="0">Proximal</bone>
  <bone pitch="0">Intermediate</bone>
  <bone pitch="0">Distal</bone>
</finger>
<!-- Pinky finger allows to control it's metacarpal bone -->
<pinky>Pinky
  <bone pitch="0">Metacarpal</bone>
  <bone pitch="0" yaw="0">Proximal</bone>
  <bone pitch="0">Intermediate</bone>
  <bone pitch="0">Distal</bone>
</pinky>
<!-- Thumb has special axis settings and unusual set of bones -->
<thumb>
  <axle x="0" y="0" z="0">Pitch</axle>
  <axle x="0" y="0" z="0">Yaw</axle>
  <bone pitch="0" yaw="0">Metacarpal</bone>
  <bone pitch="0" yaw="0">Proximal</bone>
  <bone pitch="0">Intermediate</bone>
</thumb>
</pose>
  
```

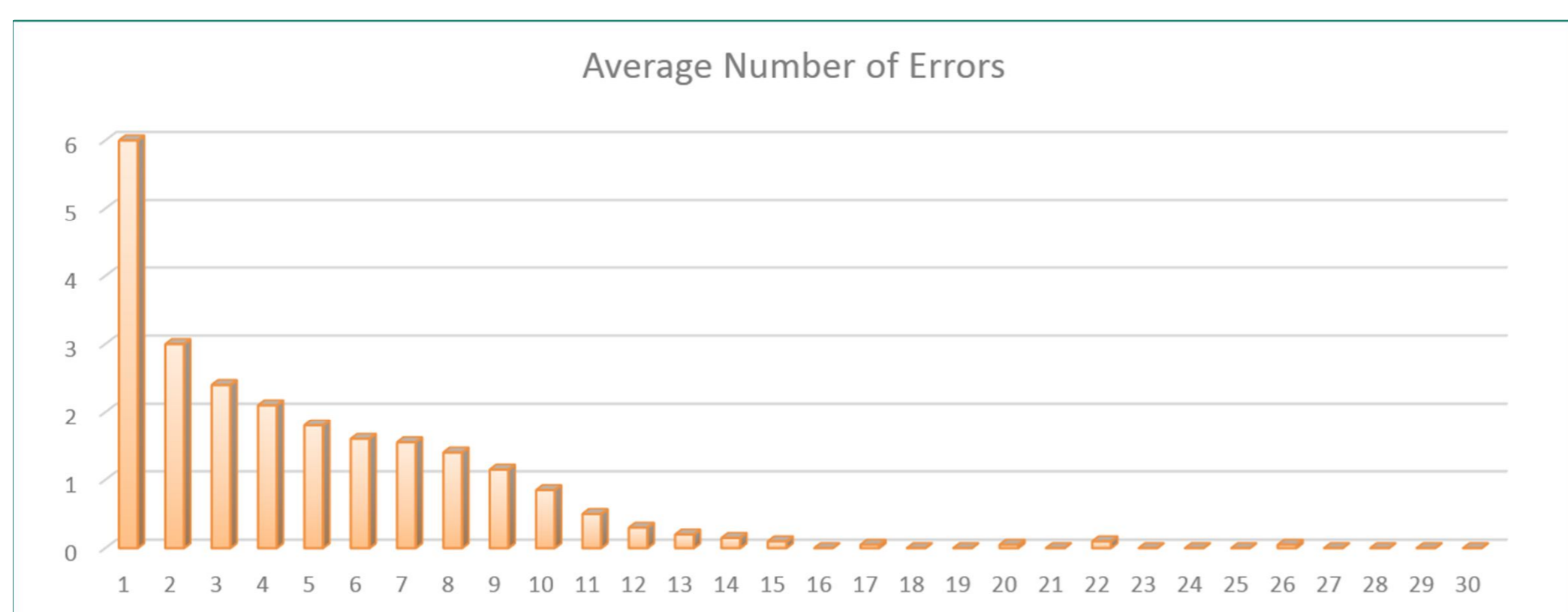


## Study of Human Reaction to the Gestural CAPTCHA



Textual CAPTCHA recognition usually takes **8 to 13 seconds**.

reCaptcha.ru

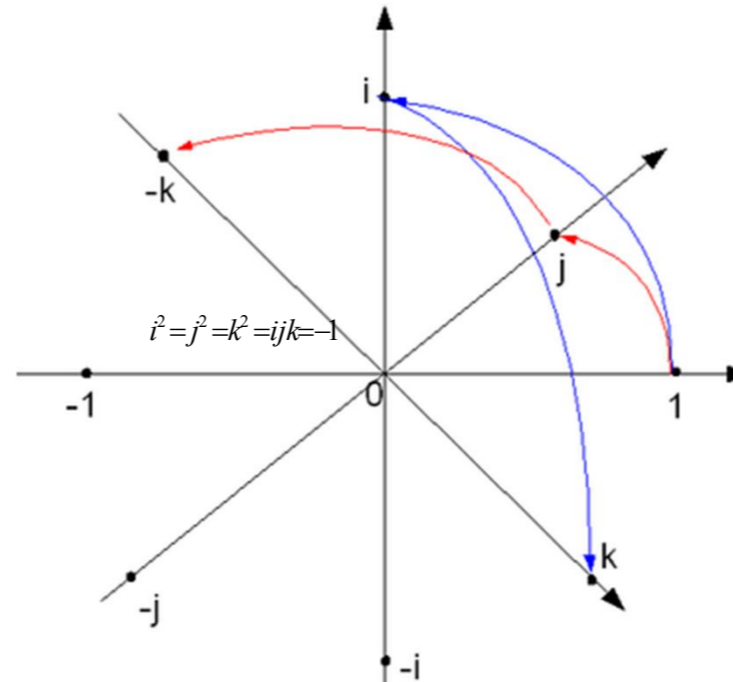


## Hand Modelling and Moving

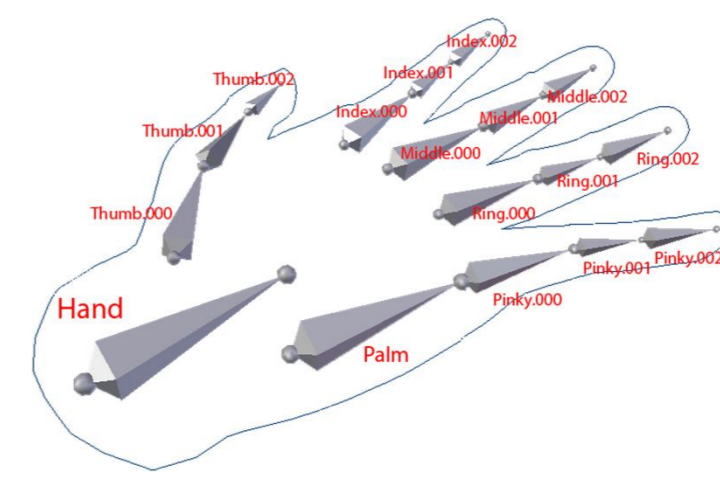
### Polygon model



Graphical representation of quaternion units product as 90° rotation in 4D-space



### Skeleton model



$$Q = a + bi + cj + dk$$

$$i^2 = j^2 = k^2 = ijk = -1$$

$$ij = -ji = k$$

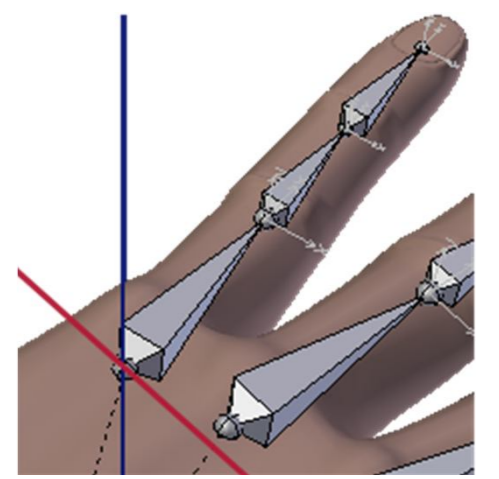
$$jk = -kj = i$$

$$ki = -ik = j$$

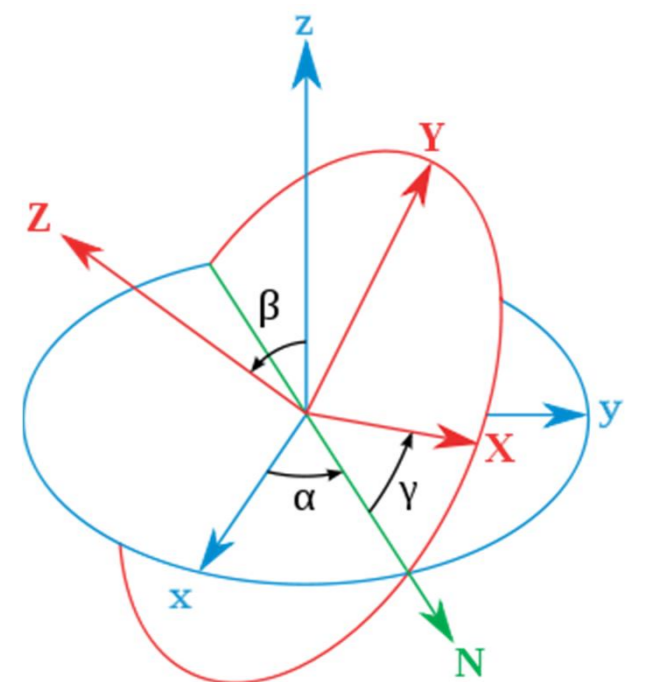
$$Q(\alpha, x, y, z) = \cos \frac{\alpha}{2} + i * x * \sin \frac{\alpha}{2} + j * y * \sin \frac{\alpha}{2} + k * z * \sin \frac{\alpha}{2}$$

$$Q = \begin{bmatrix} z & w \\ -w & z \end{bmatrix} = \begin{bmatrix} a + ib & c + id \\ -c + id & a - ib \end{bmatrix}$$

### Rotation axis



Conversion between quaternions and euler angles



## Social Significance

In many countries sign (gesture) language has the status of a state language.



"Some researchers believe that sign language should be recognized not only as a way to communicate the hearing impaired, but also as a complete way of communicating..."  
[Sarah C. E. Batterbury. 2012. *Language Policy*]

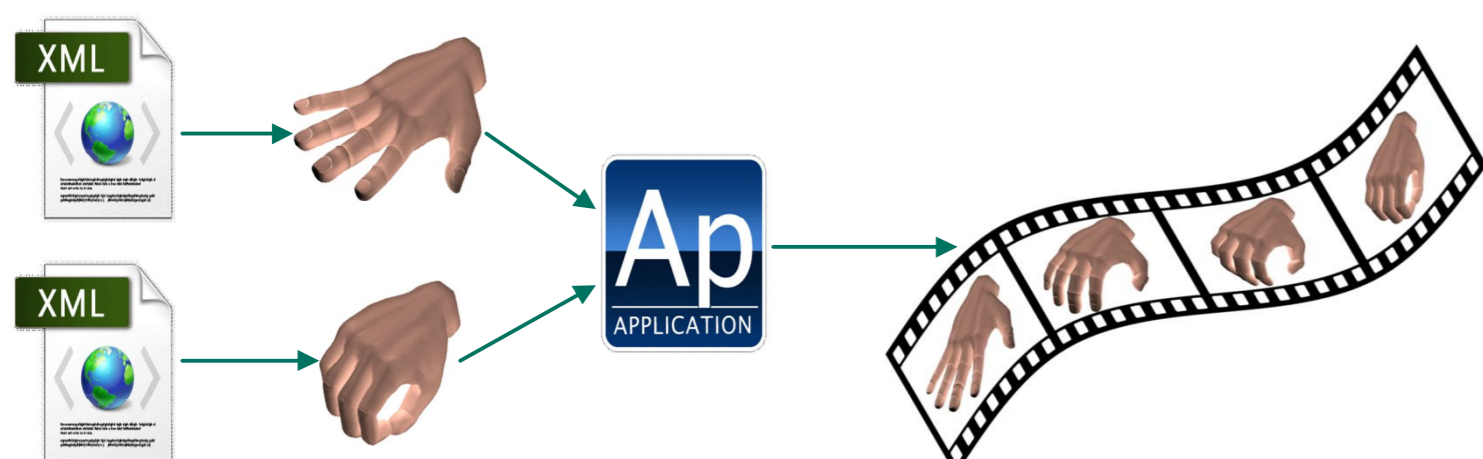
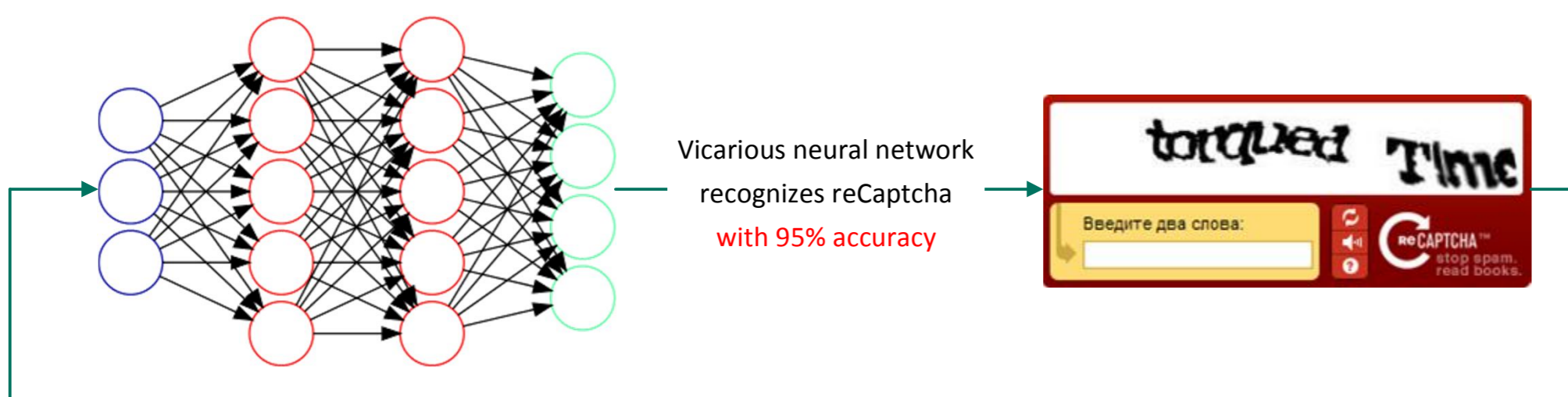


According to the Vision Council of America, approximately **75% of adults use some sort of vision correction**.



According to the National Center for Health Statistics of America, about **7% of people are hard of hearing**.

## Stability Against Hacking



- Automatic recognition can be further complicated by:
- changing textures;
  - rotating the model;
  - making distortions.

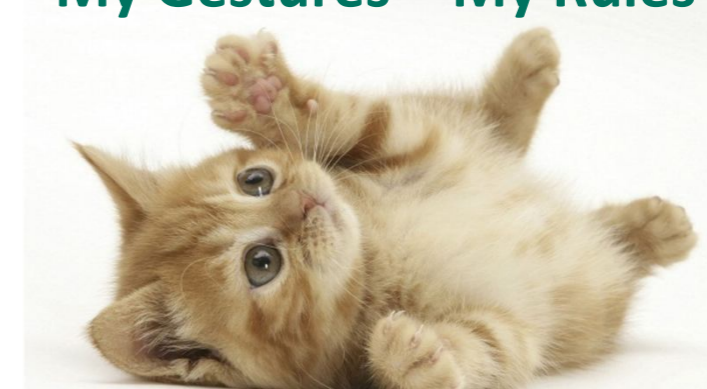
Complexity of neural network and time for training are growing rapidly while recognizing 3D gestures.



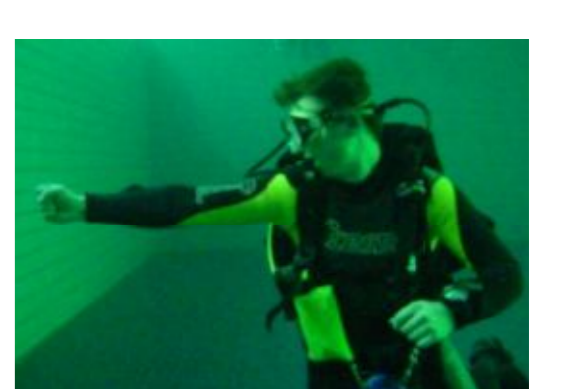
## My Gestures – My Rules



Order to line up in a row



"Play with me"



Danger in the specified direction



Signal to launch the catapult



"I'm all right"