

# Fundamental Artificial Intelligence

## *Machine Performance in Practical Turing Tests*

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Abstract: Fundamental artificial intelligence is founded on Turing's imitation game. This can be implemented in two different ways: a *simultaneous comparison* 3-participant test, and a 2-participant *viva voce* test. In the former, the human interrogator questions two hidden interlocutors in parallel deciding which is the human and which is the machine. In the latter test, the judge interrogates one hidden entity and decides whether it is a human or a machine. The results from an original experiment conducted at Bletchley Park in June 2012 implementing both tests side-by-side showed the *simultaneous comparison* was a stronger test for artificial intelligence.

## 1 INTRODUCTION

Turing's imitation game (Turing, 1950) can be implemented in two formats. A 3-participant *simultaneous comparison* test features a judge blind-reviewing two hidden interlocutors in parallel – one a machine the other a human (Shah, 2011; Shah, 2013). A *viva voce* version involves two participants: a judge interrogating a machine (ibid). As part of the Alan Turing Centenary Year celebrations an original experiment was conducted at Bletchley Park on the 100<sup>th</sup> anniversary of Turing's birth: 23 June 2012 (Warwick & Shah, forthcoming). Both the *simultaneous comparison* and the *viva voce* tests were staged side-by-side for 5-minute duration (Turing, 1950). A total of 180 tests were conducted: 120 *simultaneous* and 60 *viva voce* set ups. Among these were 90 control tests featuring 2machines, 2humans and a hidden human-*viva voce*. In this paper we report on the 90 tests involving one machine. The results showed when the machine was interrogated in parallel with a hidden human in a *simultaneous comparison test* it had a tougher time deceiving a human judge. In this case the judge's attention is divided over the 5 minutes, whereas in the *viva voce* it is concentrated on one interlocutor.

A further experiment is planned for June 2014 to answer questions raised here. In the next section, we trace the origins of Turing's two tests and then detail the experiment.

## 2 IMITATION GAME

The ideas for Turing's imitation game flowed from his work (see Turing, 1947, 1948, 1950 1951ab and 1952). It involves a human interrogator acting as *judge* using typewritten interaction only to decide whether he or she is interacting with a human or a machine. The rules of Turing's *dramatic game* (Hodges, 2010) stipulate the judge must sit in a separate room from the hidden interlocutors. This was Turing's sense of fair play to the machine [ibid], so that the machine was not judged on beauty or tone of voice (Turing, 1947).

Turing's imitation game progressed from chess to language (Shah, 2011; Shah, 2013). Turing believed the learning of languages was one of the most impressive and most human of a number of activities (Turing, 1948). He felt the question-answer method was "suitable for introducing almost any one of the fields of human endeavour that we wish to include" (Turing, 1950).

### 2.1 Simultaneous Comparison Test

Turing introduced the 3-participant interrogator-machine-human test (see Figure 1) from the man-woman game replacing one of the human participants with a digital computer (Shah, 2011; Shah, 2013).

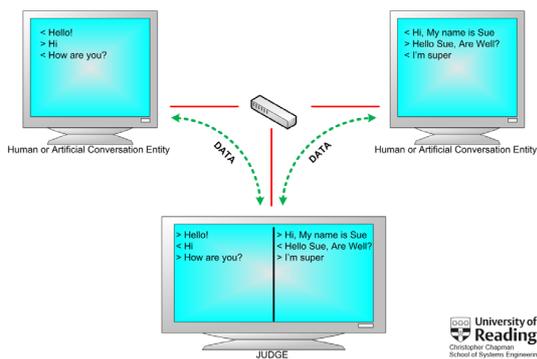


Figure 1: Turing’s Simultaneous comparison test.

## 2.2 Viva Voce Test

In Turing’s 1950 *Mind* paper, in his rebuttal of *The Argument from Consciousness*, Turing explicitly imagines a *viva voce* scenario for his imitation game (p. 445). This sees an interrogator directly questioning a machine ‘witness’ *one-to-one* (see Figure 2). Turing wrote, “accept the imitation game as a test... the game (with the player B omitted) is frequently used in practise under the name of *viva voce* to discover whether some one really understands something or has ‘learnt it parrot fashion’ ” (1950).

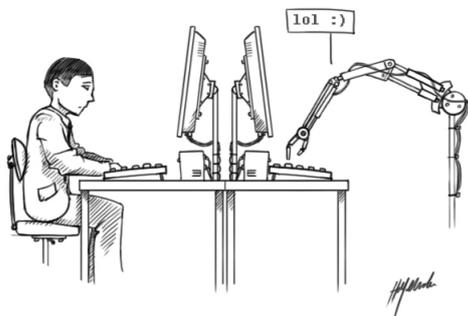


Figure 2: Turing’s Viva Voce Test.

Until now no experiment had been performed staging both scenarios to find which one was the best to examine machine dialogue and the harder test for the machine. The next section presents the method and results from the experiment implementing *simultaneous comparison* and *viva voce* tests side-by-side.

## 3 MACHINE PERFORMANCE

We describe 90, of the 180 tests conducted in total that involved at least one machine. The remaining 90

trials were control tests: 30 *viva voce* between human interrogator and hidden human; and 60 *simultaneous comparisons*: 30 tests with 2human and 30 with 2machine (see Warwick and Shah, 2013; Warwick and Shah, forthcoming).

The 90 tests reported here are 30 *viva voce* tests examining a machine (see Figure 2). These were embedded among 60 *simultaneous comparison* tests involving a machine and a hidden human comparator (see Figure 1). All tests were distributed among five sessions spread across a whole day of *Imitation Games* carried out on 23 June 2012.

### 3.1 Hypothesis

The simultaneous comparison is a tougher test for the machine. This is because the human interrogator has access to two responses in parallel and can subjectively decide which is human.

### 3.2 Method

Six computer terminals were set up in the judge area in the Billiard Room at Bletchley Park. This was the public area; here the interrogator-judges sat engaging the hidden interlocutors, who were located in another room (see Warwick & Shah, forthcoming). The judges’ terminals were connected to another series of computer terminals hidden from view and hearing in the Ballroom in Bletchley Park. Five sessions were administered with each session consisting of six rounds, a total of thirty tests in each session. In each round there were two set ups of human interrogator-machine with human foil *simultaneous comparison* tests and one *viva voce* interrogator-machine witness test. It is these three tests in the 30 rounds of the experiment that we focus on here.

#### 3.2.1 Participants

Human participants came from members of the public, journalists and experts in the field of computer science and philosophy (Warwick and Shah, 2013; Warwick and Shah, forthcoming). Elite developers were invited based on their machine’s performance in previous Turing tests (Shah and Warwick, 2010ab). Thus, three types of participants were involved in this experiment:

- Human interrogators
- Elite machines
- Human comparators for the machines.

30 human interrogator judges, and 30 hidden entities (5 elite machines and 25 human foils), each had a

unique experiment identity (e.g. J1, E1, E15). Human interrogators and foils were made up of teenagers and adults, males and females and people who had English as their first or only language (native) as well speakers of English as an additional language (non-Native English speakers).

### 3.3 Procedure

Each human participant was given specific information about their role: judges had to uncover the machines and recognise humans. Hidden humans were asked to ‘be themselves’ (Warwick and Shah, forthcoming). There were asked not make it easy for the machines by appearing *machinelike* (ibid). They were given the following example of a machine response in a practical Turing test (Chip Vivant, 2012):

*I can't deal with that syntactic variant yet.*

The objective of the machines was to convince the judges that they were human. Each judge and each human foil participated in one session of six rounds (Warwick and Shah, 2013; Warwick and Shah, forthcoming).

Rounds timed to last 5 minutes were terminated by disabling the graphic user interface via an especially written communications protocol (MATT). The protocol would perform an automatic switch presenting the interrogator judge with the next interlocutor(s) for the following round. This was repeated until the session’s six rounds were completed.

At the end of every round each interrogator completed a paper score sheet giving their judgment on the interlocutors(s). Judges’ feedback included:

- Scoring a machine for conversational ability from 0-100, where 0=machinelike and 100=humanlike,
- Assessment of human: male or female; adult, teenager or a child; native English speaker or non-native English speaker,
- Score of ‘unsure’ was allowed. This was in the case when the interrogator could not say whether they had interacted with a human or a machine.

### 3.4 Results

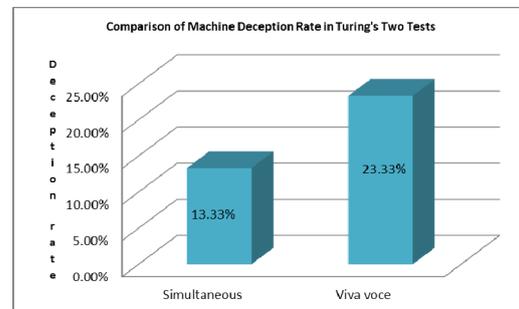
As hypothesised, *simultaneous comparison* was the stronger test for machines. However, it was also the more difficult for the judges, because they had to attend to two linguistic outputs in parallel to each input. In the 30 *viva voce* tests, in which a machine had twice as long (full 5 minutes) interaction time with a judge, the machines collectively deceived a human judge into attributing a human score at a rate

of 16.67%. If we include the two *viva voce* tests in which a judge was unsure whether they were speaking to a human or a machine, then the inaccurate identification of machines in the *viva voce* tests was 23.33% (see Table 1).

Table 1: Strength-comparison of Turing’s Two Tests.

Strength of Turing’s two tests	Turing’s Imitation Game	
	<i>Viva voce one-to-one direct tests</i>	<i>Simultaneous comparison Machine-human tests</i>
Number of tests	30	60
Number of deceptions	5	8
Total inaccurate classification	7 (twice machine classified as Unsure)	8
Type of error	Eliza effect	4 tests: both human 4 tests: machine considered human & human considered machine
% inaccurate classification	23.33%	13.33%

The results showed the *simultaneous* test, in which the machine shared 5minutes interrogation time with a human comparator, was almost twice as difficult for a machine to achieve misclassification as human, 13.33% given half the time as in the *viva voce* test (see Graph 1).



Graph 1: Machine deception rate in Turing’s Two Tests.

Judges were deceived at a rate of 13.33% in *simultaneous* tests compared to 23.33% in *viva voce* tests (Table 1; Graph 1). We present basic statistics here, because the qualitative data enlightens more about machine performance. Turing dismissed statistical surveys with a comment on Gallup poll (1950, p. 433); he preferred to examine whether a machine could sustain satisfactory responses as a significant performance measure. In the Discussion section we present transcripts from five of the tests. These highlight why the judges in the *simultaneous* tests were less likely to be deceived: they instantly

had two responses to their question, assertion or statement and could compare one with the other deciding what was an artificial reaction from a natural retort.

### 3.5 Discussion

Turing had noted the problem of subjectivity, writing “It is conceivable that the same machine might be regarded by one man as organised and by another as unorganised” (Turing, 1948). The authors are fully aware that some people are more susceptible to deception than others. To mitigate interrogator subjectivity the largest possible number of judges, with a broad extent of expertise level and wide age range, had been recruited for this experiment. In the five transcripts we present here a judge misclassified the machine for a human in the test, however, our focus is on how the time was used by the interrogator and machine. The exact time of the utterance in the test is shown each box, and in every case ‘Local’ is the interrogator judge, and ‘Remote’ is a hidden interlocutor.

In the *viva voce* tests (Transcripts 1, 2) the one-to-one transcripts between interrogator and machine tell us the judges (Local) were able to use most of the five minutes accorded to them.

Transcript 1: Judge J18 *viva voce* test session 1, round 1 Terminal E

[10:41:48] Local: Hello. How are you?  
 [10:41:53] Remote: Hey.  
 [10:42:16] Local: How do you like Bletchley [Park]?  
 [10:42:20] Remote: lol.  
 [10:42:39] Local: Are you from England?  
 [10:42:47] Remote: They have Wi-Fi here in the pub.  
 [10:43:31] Local: Which pub?  
 [10:43:38] Remote: I'm just down the pub.  
 [10:44:03] Local: Have you ever been in a Turing Test before?  
 [10:44:08] Remote: Will this be the 5 minute argument, or were you thinking of going for the full half hour.  
 [10:44:55] Local: Very funny. You sound suspiciously human. Do you like the Beatles?  
 [10:45:02] Remote: I'd like to get the next Dread the Fear tape.  
 [10:45:20] Local: What is Dread the Fear?  
 [10:45:24] Remote: Dread the fear has that Steve Henderson guy in it.  
 [10:46:08] Local: What sort of music is that? Or is it comedy?

Both the machines (marked as Remote) in the *viva voce* conversations were misclassified as human by interrogator judges J18 (Transcript 1) and J20 (Transcript 2).

Transcript 2: Judge J20 *viva voce* test session 3, round 2, Terminal D

[13:07:07] Local: Good morning, are you well?  
 [13:07:11] Remote: Yes. Are you?  
 [13:07:43] Local: Yes I'm very well. Are you happy that the sun is shining?  
 [13:07:50] Remote: Yes.  
 [13:08:07] Local: Have you been on holiday this year?  
 [13:08:12] Remote: No.  
 [13:08:24] Local: Do you hope to?  
 [13:08:32] Remote: Yes.  
 [13:08:58] Local: Would you like to spend your days on a beach or visit historic places?  
 [13:09:11] Remote: No.  
 [13:10:19] Local: What would you like to do then?  
 [13:10:28] Remote: I don't know.  
 [13:10:46] Local: Are you from the UK?  
 [13:10:52] Remote: No.  
 [13:11:12] Local: Where do you come from?  
 [13:11:16] Remote: Egypt

In contrast, in the *simultaneous* tests (Box 2, Box 3, and Box 4) the conversations show, though wrongly classed as human, the machines were more loquacious than the human foils in the same test (left Remote in Box 2; right in Box 3; right in Box 4).

Box 1: Judge J1 simultaneous test machine miscategorised as human.

J1 with machine	J1 with human foil
[12:23:19] Local: What is black and white and read all over? [12:23:32] Remote: I don't have true sense of color perception I am only able to see the RGB values. [12:24:08] Local: That's ok. Do you like jokes? [12:24:19] Remote: Please tell me your inclination to a good sense of humor first. [12:24:40] Local: A person who can laugh at one's self. [12:24:46] Remote: Would you like to hear a joke? [12:24:54] Local: Yes, please. [12:25:21] Remote: This joke has been making the rounds in robotic circles: A robot goes to the doctor and says: "My left arm is stuck. Give me a new arm." The doctor answers: "Your arm is fine. We'll have to replace the rest of you." [12:26:06] Local: Ha! Ha! Why did the chicken cross the road? [12:26:22] Remote: The chicken wandered into the road because it liked the shiny colors of the cars and trucks whizzing by. [12:27:39] Local: You're right. It didn't care if it got to the otherside. [12:27:50] Remote: By the way, did you ever actually see a chicken crossing the road? [12:28:03] Local: Only one that didn't make it.	[12:24:17] Local: Hi, how are you today? [12:24:53] Remote: Im excellent, how are you? What's your name. Im Buzz. I was named after a lawnmower [12:25:27] Local: You are the first person I ever knew named after a lawn mower. I'm Cathy. [12:26:07] Remote: Hello Cathy. Yes my parents were keen gardeners. We lived in a glass house... we weren't allowed to play football much [12:27:00] Local: There are always soft balls for football. I think your family has a great sense of humour! [12:27:56] Remote: Really? I think they are quite cruel, lawnmowers aren't great things to be named after.

In the simultaneous conversation in Box 2,

interrogator judge J1 (Local) returned an incorrect score of BOTH HUMAN for the two hidden interlocutors: one was a machine feeding responses to the left of the judge’s screen, the other a human sending messages to the right. The conversation shows J1 interacted more with the left entity, machine (between 12.23.19pm-12.28.03pm) than with the human (Box 2) feeding utterances to the right of the screen (12.24.17pm-12.27.56pm).

J1 exchanged three utterances with the right Remote (human) compared with seven shared with the left, machine (see Box 2).

Judge J2 made a double error in a *simultaneous test* by scoring the hidden human as a machine, and the machine as a human (Transcript in Box 3). Judge, J13 misclassified the machine as human in the *simultaneous test* (Box 4).

Box 2: Judge J2- Double Error

J2 with human foil	J2 with machine
[15:45:23] Local: Hi have you been on line long	[15:46:05] Local: My favourite music is contemporary Jazz,
[15:45:34] Remote: just a few seconds	what do you prefer
[15:46:28] Local: Have you been to see any good films recently	[15:46:14] Remote: To be short I'll only say that I HATE Britnie Spears. All other music is OK compared to her.
[15:47:08] Remote: went to see Avengers Assemble last weekend, and hoping to see Prometheus tomorrow	[15:47:06] Local: do you like to play any musical instruments
[15:47:28] Local: They seem a bit serious	[15:47:23] Remote: I'm tone-deaf, but my guinea pig likes to squeal Beethoven's "Ode to Joy" every morning. I suspect our neighbors want to cut his throat... Could you tell me about your job, by the way?
[15:47:54] Remote: Wouldn't say that about Avengers Assemble, just a bit of fun	[15:48:02] Local: Guine pig/ are you an animal lover
[15:48:29] Local: do you drive?	[15:48:08] Remote: Yeah. A nice little guinea pig. Not some annoying chatter bot.
[15:48:39] Remote: when I have too	[15:48:50] Local: do you live with anyone else?
[15:49:08] Local: I prefer the bike myself	[15:48:59] Remote: Yes I do. But better ask something else.
[15:49:30] Remote: train for me, although bike is good for recreation	And I forgot to ask you where you are from...
	[15:49:39] Local: Ireland? geen patures and too much rain!
	How about you

The judge-interrogator J13 shared more utterances (six) and more of the allowed five minutes with the right remote entity (hidden machine) than with hidden entity at remote left: four utterances with the

hidden human (Transcript in Box 4). This may demonstrate that if a judge feels interested in one conversation in a *simultaneous test* they may not pay enough attention to the other hidden interlocutor they are meant to be questioning in parallel.

The results from the experiment, and the content of the conversations were intriguing and raised questions, including: does being presented with a hidden human first, rather than a machine, affect interrogator accuracy in *viva voce tests*? Should the *simultaneous tests* allow for a fixed number of questions, rather than fixed time? Should the duration of the *simultaneous tests* be twice as long as the *viva voce tests*?

Box 3: Judge J13 simultaneous test machine miscategorised as human

J13 with human foil	J13 with machine
[16:06:30] Local: Hi there, do you prefer to wear a dress or trousers to work?	[16:06:31] Local: Hi there, do you prefer to wear a dress or trousers to work?
[16:06:49] Remote: that really would be telling	[16:06:37] Remote: I am a scholar. I'm too young to make money.
[16:07:31] Local: What was the last film you saw at the cinema?	[16:07:32] Local: What was the last film you saw at the cinema?
[16:07:40] Remote: Avengers Assemble	[16:07:38] Remote: Huh? Could you tell me what are you? I mean your profession.
[16:08:44] Local: cool, what was your favourite game as a child?	[16:08:11] Local: I am an IT manager and you?
[16:09:08] Remote: Don't Miss the Boat	[16:08:16] Remote: manager? So how is it to work as manager?
[16:09:28] Local: tell me more about that	[16:09:13] Local: Hard work but rewarding, what do you do?
[16:09:57] Remote: It's like Ludo, but the end bits keep moving around	[16:09:18] Remote: I am only 13, so I'm attending school so far.
	[16:09:51] Local: Have you seen teleubbies?
	[16:10:04] Remote: No, I haven't seen it, unfortunately. But I hope it is better than these crappy Star Wars. And I forgot to ask you where you are from...
	[16:10:15] Local: Brighton, and you? Box 6: Judge J13 simultaneous test machine miscategorised as human

## 4 CONCLUSIONS

Our purpose for implementing Turing’s own two tests (Shah, 2010), was to find which is more difficult for the machine in the same duration to achieve deception: is being interrogated alongside a human for immediate comparison harder for the machine imitating humanness, or being directly

questioned relying on the judge's subjective opinion? In our experiment the *simultaneous comparison* trials were shown to be a more difficult test for the machine than the *viva voce* tests. The *simultaneous* test was also arduous for the interrogator, because their focus was on two dialogues in parallel.

Further experiments are planned to answer questions raised here. Future tests are being organised at The Royal Society in London, 7 June 2014. The authors encourage ICAART 2014 delegates to participate as judges or hidden humans and try a practical Turing test to determine human for machine themselves.

## REFERENCES

- Chip Vivant. 2012. Accessed 8.11.13 here: <http://people.exeter.ac.uk/km314/loebner/index.php>.
- Copeland, B. J., 2004. "The Essential Turing: The ideas that gave birth to the Computer Age", Oxford: Clarendon.
- Hodges, A., 2010. "Fair Play for Machines", *Kybernetes*, Vol. 38, No. 3, pp. 441-448.
- Shah, H., 2010. "Deception-detection and Machine Intelligence in Practical Turing tests", PhD Thesis, University of Reading, October 2010.
- Shah, H., 2011. "Turing's Misunderstood Imitation Game and IBM's Watson Success", 2<sup>nd</sup> Towards a Comprehensive Intelligence Test, AISB Convention, University of York, 5 May, pp. 1-5.
- Shah, H., 2013. "Conversation, Deception and Intelligence", in S. B. Cooper and J. van Leeuwen (Eds), *Alan Turing – His Work and Impact*, Elsevier.
- Shah, H., and Warwick, K., 2010b. "Hidden Interlocutor Misidentification in Practical Turing tests", *Minds and Machines*, Vol. 20, issue 3, pp. 441-454.
- Shah, H., and Warwick, K., 2010a. "Testing Turing's Five Minutes Parallel-paired Imitation Game", *Kybernetes*, Vol. 39, No. 3, pp. 449-465.
- Turing, A.M., 1947. "Lecture on Automatic Computing Engine", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp. 378-394, 2004.
- Turing, A.M., 1948. "Intelligent Machinery", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp.410-432, 2004.
- Turing, A.M., 1950. "Computing machinery and intelligence", *Mind*, Vol. 59, No. 236, pp. 433-460.
- Turing, A.M., 1951a. "Intelligent Machinery, A Heretical Theory", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp. 472-475, 2004.
- Turing, A.M., 1951b. "Can Digital Computers Think?", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp. 482-486, 2004.
- Turing, A.M., Braithwaite, R., Jefferson, G., and Newman, M., 1952. "Can Automatic Calculating Machines Be Said To Think?", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp. 494-506, 2004.
- Turing, A.M., 1953. "Chess", in B.J. Copeland, *The Essential Turing*. Oxford: Clarendon, pp. 569-575, 2004.
- Warwick, K., and Shah, H., 2013. "Good machine performance in practical Turing tests", *IEEE Transactions on Computational Intelligence and AI in Games*. DOI: 10.1109/TCIAIG.2013.2283538.
- Warwick, K., and Shah, H., (forthcoming) "Applying Turing's Imitation Game", in J.P. Bowen, B.J. Copeland, R. Whitty and R.J. Wilson, *The Turing Guide*, Oxford: OUP.