

# Error detection and correction

1.5 hrs

Intended audience: yrs 7-9

## Key words

Error detecting codes, error correcting codes, parity, ASCII, ISBN

## Description

In this day and age we are constantly sending and receiving information from people all around the world. However, in transmission and storage, sometimes errors occur and the data is changed. This can come from background noise, network faults, even cosmic rays! Fortunately, there are ways of encoding messages so that errors can be detected and even corrected.

This session uses a 'mathemagic' trick and the binary telephone game to introduce error correction and detection using a parity digit. It finishes with a worksheet exploring the error detection codes used in ISBNs.

## Resources

1. 36 two-sided cards (with a clear face and back). Magnetic options are great for demonstrating on a white board.
2. One set of 36 two-sided cards per 2 students (printable template provided)
3. One ASCII table sheet per student
4. White board marker and white board (for instructor)
5. One binary telephone worksheet per student
6. One laminated binary telephone grid per student
7. One white-board marker and eraser per student
8. One pen or pencil per student
9. One ISBN worksheet per student
10. Many books with 13 digit ISBN (optional - exercise can be left for homework).

## Further Reading

The mathemagic trick came from Computer Science Unplugged. Find more instructions and details here:

<https://classic.csunplugged.org/error-detection/>

For more use cases and descriptions of modern and robust error correction and detection codes, see

<https://plus.maths.org/content/error-correcting-codes>

To learn more about the ASD-ANU Co-Lab, head to

<https://www.asd.gov.au/about/asd-anu-co-lab>

or contact us at [Co-Lab@anu.edu.au](mailto:Co-Lab@anu.edu.au)

## Session Plan

Time	Content	Activity	Resources
20 mins	Mathemagic trick demonstration.	<ol style="list-style-type: none"> <li>1. Have a student randomly lay out 25 of the large cards in a 5x5 square.</li> <li>2. Add another row and column 'to make it harder'. Lay these so that each row and column has an even number of cards 'face up'.</li> <li>3. Cover your eyes, and have a student flip one of the cards.</li> <li>4. Identify the flipped card by finding the row and column that now has an odd number of 'face up' cards.</li> <li>5. Ask the students how they think the trick was done. Repeat steps 3&amp;4 as necessary (don't forget to flip the card back each time!). Prompting questions include "how many are face up in this row?" and "what do you think I was doing when I added the extra row and column?"</li> <li>6. Teach the students the trick. Explain the extra card is called a <i>parity</i> card, and that each row and column has <i>even parity</i>.</li> </ol>	36 two-sided cards.
20 mins	Mathemagic trick-students	<ol style="list-style-type: none"> <li>1. Distribute the packs of small cards, one per pair of students.</li> <li>2. Give the students time to practise the trick on their partners.</li> <li>3. Once they have mastered the trick, ask them to explore whether it would work for any size square (yes), for rectangle layout (yes), if they could use odd parity (sometimes, as long as the number of rows and columns are either both even or both odd).</li> </ol>	Sets of 36 two-sided cards, one set per pair of students.
10 mins	ASCII	<ol style="list-style-type: none"> <li>1. Explain to the students that computers transmit and store</li> </ol>	ASCII table sheet, 1 per student

		<p>information as 1s and 0s (binary). Sometimes errors can creep in and change a 0 to a 1 or vice-versa (bit flip), just like flipping the card in the trick. Parity checking is one way of detecting such errors.</p> <ol style="list-style-type: none"> <li>Hand out an ASCII table to each student. Explain that ASCII is a commonly used code that converts text to binary.</li> <li>Demonstrate how a 7 character message can be encoded in ASCII, writing in a grid with one character per line. For example "<code>&lt;math&gt;I&lt;/math&gt;</code>" becomes             <pre>I 1001001 &lt; 0111100 3 0110011 m 1101101 a 1100001 t 1110100 h 1101000</pre> </li> <li>Add a parity bit to each row and column, and draw the parallels with the mathematic trick exercise.</li> </ol>	<p>White-board marker &amp; white board.</p>
<p>30 mins</p>	<p>Binary Telephone</p>	<ol style="list-style-type: none"> <li>Distribute a binary telephone worksheet, a laminated binary telephone grid, a white-board marker and eraser, and a pen or pencil to each student</li> <li>Instruct each student to write a 7-character message in the table on the worksheet, convert to binary using the ASCII table, and add a parity bit, as per your example.</li> <li>Now have the students copy the table <i>without the original message</i> to the laminated sheet.</li> <li>Working in groups of three, each student passes their laminated sheet to the student on their right. Each student changes exactly one digit on the sheet they have received. They then pass it to their right</li> </ol>	<p>All one per student:</p> <p>Binary telephone worksheet</p> <p>Laminated binary telephone grid</p> <p>White-board marker</p> <p>White-board eraser</p> <p>Pen or pencil</p>

		<p>again. Finally, they try to detect the error and decode the message.</p> <p>5. Allow the students to play multiple times. Can they detect and/or correct more than one error? How many? Does it make a difference where the errors occur?</p>	
10 mins	ISBNs	<ol style="list-style-type: none"> <li>1. Explain that error correcting codes are used in many different places, not just communications. Examples include credit cards and International Standard Book Numbers (ISBNs)</li> <li>2. Demonstrate calculating the formula for ISBNs either using the example on the worksheets or another book.</li> <li>3. Distribute the worksheets and instruct the students to attempt the exercise with other books. This could be left as homework.</li> </ol>	<p>ISBN worksheets</p> <p>Books with 13-digit ISBNs</p>