Digital Information (Part 2)
Lesson Plan: Class 04 / PS / 15

CS pathshala
Bringing computational thinking to schools

Overall goal of the lesson	**Students learn more details about Digital Information, beyond Part 1 of this class, what are the rules for digitizing text, images, audio and Video such as ASCII, RGB and others.**
Prior knowledge required	Digital Information (Part 1) 04-PS-14

MODULE 1: **Module time:** 35 minutes

Goal:	Advanced concepts and details about Digital Information
Description:	The objective of this class (Part 2) is to reinforce the concept of Digital Information learnt in Part 1, explain the importance of digital information, types of digital information, how each type of information is digitized the rules for the same.
Material required:	**Physical: Projector to display the presentation titled Class 4 - P15 - DigitalRep (Part 2) - PPT.pptx** **Electronic: Computer / Laptop with Internet connection in order to show visuals and videos linked to the presentation. It is a MUST to have internet connection otherwise several important concepts in this lesson cannot be interned by students very easily.**
Procedure Details:	**Pre-requisite:** Please cursorily review the previous part of this topic (04-PS-15 x before you begin teaching the class 04-PS-15 and go over this lesson plan. This lesson plan describes the slides in detail and how information in these slides can be shared with students. Procedure details: ----------------------- 1.) In this class, we will go over the concept of Digital Representation. It was introduced in previous class Class 4 - P15 - DigitalRep (Part 1) - PPT.pptx. In previous classes, students were already introduced to Binary in previous classes and now in Part 2 we will build upon all those concepts. **Before you begin the class**, get the **student's attention** and **make them wear 'thinking hats'** by asking them a GK question. Ask them what are the two meanings of the word 'Digit'. First: Digit refers any of the numerals from 0 to 9. Second: Digit also refers to a finger, thumb, or toe. 2.) Begin the class with Slide #2 titled "Digital Representation". Refresh student's memory about Digital Representation and ask them if they remember Part 1 where Digital Representation term was introduced. Ask them if they remember why we need digital representation in today's world. Answer: Technology is touching almost all walks of life - be it office, home, school. Computers are used in all aspects of life. They understand only digital whereas humans use language to communicate. To share information with computers and to get work done - we need to use digital format and therefore digital representation is important to understand. Let the students know that besides recap of previous class (Part 1), in this class we will learn some advanced concepts such as rules to digitize different types of information. And of course there will be fun activities interspersed along the way!

	3.) Slide #3: This slide is a recap of digital representation concepts. It makes the student think about the different 'kinds' of information we see around us. Information comes to 'us' from natural as well as man made things. For example - sky, trees, birds give us information. Say the blue sky or cloud covered gray sky tells us whether it is clear or we need to carry our umbrella, the quiet leaves on trees or bustling leaves tell us whether there is no wind, gentle wind or an approaching storm, birds flying or chirping - all these natural sights and sounds are information). Besides these there are other things - man made - that give us information such as clocks, phones, computer. Humans receive and share information through sound or visual means, or through other sense organs. Information is of different types. Each type could be either digital or nondigital. Sources of non-digital information are called analog instruments such as manual clock, guitar, landline telephone (not cell phone) . Sources of digital information are digital clocks, computers, cell phones, various 'apps' and software. 4.) Slide #4 Digital Representation: This slide depicts different ways of representing the same piece of information. Let's say we want to share 3 information pieces: first - numeral '1', second - 'an asterisk or star on the keyboard' and third - 'the switch is on (or off)'. This information can be shared via English language or via pictures or via digital representation. Take a look at the slide. We all know how to represent these 3 pieces of data via English/other language or via pictures. But how do computers share this information - answer - via digital representation. It could be Decimal, Binary, ASCII or other format. Ask children if they remember what is Binary? Read out aloud with kids - English 'One' is same as Pictorial '1' and is same as Decimal 49, Binary 00110001. There are rules to convert information from one type to another. Binary, ASCII are some of the rules. 5.) Before you turn to Slide #5, ask the students if they know why we need Digital Representation. Simply ask them to raise hands if they know - don't actually ask them to answer :-). Then bring on Slide #5. Ask the students to see the cartoon carefully and answer in either yes or no - "Is the human able to understand the information that the computer is sharing"? Answer: No. Now read out contents of slide #5. It answers why digital representation is needed. The last bullet of the slide asks a question - why computers understand only digital? The answer is based on Part 1 of this class- we showed the internals of a computer and explained that it is made up of electronic parts which resemble a switch. A switch can only give two pieces of information - whether it is on or off. Computers are made of millions of switches and they can only be on/off. Hence they can only understand digital / Binary / ASCII. 6.) Slide #6 Recap of Binary Data: Begin this slide by asking children how they store their homework, classwork or whatever instructions the teacher gives them in class? Answer : Memory, Notebooks, files and folders. Highlight the picture on the slide. Ask the students if they can name the 'creature' in the cartoon. It is a 'Minion'. Tell the students that the drawing is made using a paper and pen but it looks three dimensional. By using some artistic techniques and rules, the artist has represented the minion on a two dimensional paper to look like a 3D object. The information is stored on the notebook by an artist. How do computers store information? How are you able to read mails and messages on a computer? Computers don't store pictures and numbers like we do on a notebook. They need to binary/digital representation in order to store images, sound and other kinds of

	information. Now there can be so many combination of 0s and 1s. How do we know which combination means what? This is where rules come into the picture - they helps us encode and decode information from one form to another. So when we store 'numeric' information, we need ASCII code to convert it into a form that computer can understand and store. If we need to store a picture - there are other kinds of rules to convert a picture into digital format. Can anyone tell the name of that rule? we learnt that in previous class. ANswer - RGB. 7.) Slide #7 is a fun exercise. This exercise helps to refresh binary codes. Each exercise gives the rules for binary encoding showing what means a 0 and what means a 1. Refer to the presentation notes section on this slide for answers to the exercise. Repeating those here for easy access: Answer: LHS 01001, 101, 00000,10 RHS 1010 1101 10001 10100 11111 8.) Slide #8 brings in the concept of rules. Digital Representation of information needs rules, but why? Make the students think about the consequences in day to day life if there were no traffic rules, what will happen? Will people be safe in traffic? How will one traveller know when to stop and when to cross a road or a junction? If the traffic rules were in local language then would people from different states understand what traffic rule they need to follow? People across the globe are able to understand how to cross a road because of rules. If you travel to any country - they see a red light on the crossing and know that they need to stop. The traffic rules are 'encoded' in lights - Red means stop and Green means go anywhere in the developed world. Just like traffic rules help people from different backgrounds and different parts of the country or the world to travel safely and cross roads safely by understanding information correctly, without confusion, similarly rules help the computers to receive and share information correctly without causing confusion or miscommunication. 9.) Slide #9: Gives a brief recap into the process of converting information from one form into another - say from English to another language or from English to digital format. When we apply a rule to convert say English to digital information - the process is called Encoding information. When we do the reverse - converting digital information back into English, the process is called Decoding Information. Remind children what they did in previous exercise in Slide #7. It had rules which indicated what is supposed to mean a 0 and what is supposed to mean a 1. They used those rules to convert pictorial information into binary information. That process is called encoding. If they did the reverse -converted digital information back into pictures - that would be called decoding. Ask the children if the rules were enough for encoding/decoding in the exercise. Answer: Yes. But for each exercise, rules were different. If you mix these rules then decoding may be incorrect. For e.g., if rule says uparrow is 1 and downarrow is 0 for one exercise then the same rule needs to be applied to decode. Else if a different rule is used to decode (say thumbs up is 1 and thumbs down is 0), then the result would not be

	same. Now the last bullet in the slide can be answered / understood easily. The actual answer is in the notes section of the same slide. 10.) Slide #10 highlights the fact that there are many kinds of rules to convert information into digital representation. Why are there so many rules - it is because there is different kinds of information. We need different rules to store text and a different set of rules to convert pictures or other kinds of information.The table represents different kinds of rules for various kinds of information. Ask children what will happen if we use text encoding rules to encode text and say image encoding rules to decode the digital representation? Remind them that same set of rules that were used to encode MUST be used to decode otherwise we will not get back the same information that we started with. 11.) Slide #11 What is ASCII? We know it is a set of rules for digital representation of information. What kind of information? Answer: Text. Do you know that ASCII is an acronym - a short-form. It stands for 'American Standard Code for Information Interchange'. Refer to the table to show how some of the letters of English alphabet are represented in BInary and what the ASCII code for each alphabet is. Using ASCII computers across the world can share information. Each computer understands ASCII in the exact same way - just like all educated people understand traffic signals and the codes - Red means stop and Green means Go. At this juncture, ask the students to observe the first digit in each alphabet ASCII code. Ask them if they notice anything special. It will be needed in next slide. The answer is: each ASCII code has a '0' at the '8th' bit position. So only 7 bits are needed to encode all the English textual characters and numerals. 12.) Slide #12 introduces the concept of Advanced ASCII. The figure shows that there 8 bits in each ASCII code and as noted in previous slide, the digit on '8th' bit is always 0. This is because out of total 8 bits in a byte, standard ASCII uses only 7 bits for encoding 128 combinations of 0 and 1 to digitally represent text and numbers. English is not the only language in the world. To digitally represent other languages and other special characters we need to use more than 7 bits. With 8 bits, total of 256 characters (More than 128 when using 7 bits) can be represented. When 8 bits are used, the 8th bit in ASCII code is '1'. Such ASCII codes are called 'Extended ASCII' as they extend the basic ASCII rules to cover more characters. 13.) Slide #13 ASCII Fun is meant as a fun activity. Ask children to see the chart carefully and then try to encode their class in ASCII. Example 'hello' is shown encoded in the slide. Write down the correct ASCII code for the class say IV-B once some student has solved it correctly. Then ask the student to encode their full name into ASCII. 14.) Before you begin Slide #14, do a quick recap. We learnt about how text (Numbers and alphabets, literals) are converted to digital representation via rules such as binary, ASCII. Ask children whether these rules can help to digitally represent pictures or images? Answer: No. Reason: images are not made of text. Ask Children what is an image made up of? Answer: Color, lines, shapes and more. So how can we convert a picture or image into digital representation? We need a new set of rules - and it is called RGB. RGB stands for Red, Green and Blue - the primary colors. Ask children if they know what are secondary colors? Answer: Colors that are created by mixing primary colors. Now to convert each image to digital format so a computer can understand and store it, we need to first think of a graph paper.

	Imagine the picture is created on a graph paper. A graph paper has very small squares. Now you can observe the color of each small square and digitize the color. This way if you store the color of all the squares in the graph paper containing the image, you can digitize the image. In real life, if we use graph paper, the picture will not be very sharp. So we need a much smaller unit. It is called a pixel. It is same as the point or tip of a needle. Imagine a picture to be made up millions of small pixels. If you note each pixel's position and color, then you can convert it into digital format. Computer stores a picture bitmap which is similar to a graph paper but with each small square replaced by a very small pixel. The color of each pixel is noted in RGB levels and then the computer stores this information. When you ask the computer to use this digital representation and show you a picture on the screen, it decodes the digital format, reads what is the color and then displays that color on the particular position in bitmap. This way we can see the actual picture on the screen. THe pictures on the right show this very same concept. If you notice an apple and superimpose a grid or graph paper on it, you get the picture on the right, apple with little color squares. If we use pinpoint pixels, then the image will not look hazy and you can't see squares. Similarly, for the pine tree, you can see that corresponding to each square a number is stored which represents the color of that pixel or the position of black line. This collection of pixels, the RGB color value for each and the complete set (complete graph paper) for entire picture is called a bitmap. 15.) In Slide #15, the same pixel and bitmap concept is explained through a TV screen. The top right corner shows one single pixel - it is made up of RGB. Using differet levels of red blue and green the exact color of each pixel is represented. In the next slides we will learn how different values of RGB can result in different colors. Lots of colored dots put together can create a sophisticated image. 16.) Slide #16 Before you begin this slide, ensure that children don't confuse the RGB color mixing with pigment color mixing. Children are familiar with mixing water colors or poster colors. Ask them what happens if they mix blue and yellow water colors - it results in green. The same is not true in RGB because this is mixing of light of different colors and not water or pigment colors. When we mix red, blue and green water colors, we get a black water color pigment. However, when we mix red blue and green light, we get white light. Sunlight is white in color, when it passes through a prism (for e.g., rain droplets), it gets split into 7 colors of the rainbow. So mixing of lights of different colors is very very different from water color mixing. Computers work by mixing different color lights for each pixel in the bitmap of the image. In this slide, we have shown some examples. Ask children to read out aloud and notice how black color in computer images is made - notice the R,G,B color levels (values) that create different color light. To summarize, computers use RGB rule to convert images into digital format. They do this by noting the position and RGB value for each pixel in the bitmap. A bitmap consists of all the pixels that make up an image. So far we have learnt how text and images are converted into digital format. Next, we will learn about image compression. 17.) Slide #17 is about Image Compression. Before we begin to wonder what is Image compression, guide children's attention to the fact that it takes a few 0s and 1s to digitally represent text. However, each image is made up of millions of pixels and we need to digitally store RGB value for each pixel. This results in lots of 0s and 1s and the computer needs to store a huge amount of data in order to store an image.

	Ask children if their parents ever scold them over too much internet/cellphone data usage. Sensitize them to the fact that if they share lots of pictures on phone or videos (digital representation of video takes a lot more 0s and 1s than even single image) then they use up a lot of data as data is made up of 0s and 1s. So how do we solve this problem of too many 0s and 1s? Lets take another example to solve this - if you have a lot of cardboad boxes at home, how do you store them in limited storeroom space? Have you seen your parents open the boxes or press them flat and then store them one over another? This is called ‘compression’. Whenever we need to use the folded and compressed box, we can open it, put staples or tape and then bring it back into 3D shaped box again. But during storage, we open the hinges, press it flat and store it so that it takes less space. We do the same for say balloons. When we need them, we blow air and use them inflated. To store, we remove the filled air and then they take less space and we can save lots of balloons in a small bag. We do exactly the same for images. We compress the 0s and 1s that make up an image using rules such as JPG, GIF etc. There are many rules and algorithms used to compress images. The names of some of these rules are JPEG,GIF, PNG. You must have seen that image files have .jpg or .gif or .png towards the end of their name, called ‘file extension’. It indicates what kind of rule was used to digitally represent that image. Can you figure out which rule provides best quality image? Answer is on the slide. Ask the children to look carefully at the slide and answer. Before you move on to the next slide, Slide #18, ask children what are the two types of digital information that we have covered so far in digital representation? Answer: Text and Images. Now we will see how sound is stored in digital format - or how sound is converted into digital representation for the computer and then stored / used. 18.) In this slide, we will cover the topic of digital representation of audio or sound. So far we have covered text and images. Ask children to raise their hands if they have listened to recorded music, either on a digital disk or via a computer or while playing a video game or on a cellphone. Ask one of the children who raises his/her hand to think and tell if audio or sound can be stored as 0s and 1s. The answer is yes. How is it done? Sound is recorded using a microphone. The microphone converts audio signals into electrical signals which are then converted into binary format using 0s and 1s that a computer can understand. Just as we have ASCII and RGB rules to encode text and images, there are rules to encode sound into digital representation. Some of these rules are MP3, WAV, M4P. Audio in digital format also contains lots of 0s and 1s, similar to images so it needs to be compressed as well. Now that we have seen how images and audio are converted to digital form, let us check out videos and how they are stored in digital format. 19.) Video is similar but not exactly same as images. When you bring up Slide #19, ask children if it is possible to make a video from a lot of still images? Answer is yes. A video comprises of audio and lots of images that are flipped quickly one after another or in succession. To convert a video into digital representation, we need to convert and store both audio and images as 0s and 1s. Video’s take a whole lot more 0s and 1s than either audio or image alone. Therefore when we use internet to watch / download you tube videos, we end up using a lot of internet bandwidth and at times parents ration you tube watching for kids. Ask children if they have experienced that at home. Explain to them that it is because videos require a lot more 0s and 1s to be downloaded onto their computer or cell phone and that results in expensive bandwidth usage. On the other hand, messages which contain

	only text do not require as many 0s and 1s. On the slide, there is a link to a fun activity. Children can visit the webpage and learn how to create a motion picture using a set of still images that they can draw / create themselves using Flip Video technique. 20.) In slide #20, we will continue to explain how video's are digitally converted. Earlier, we learnt about what a video is and that it too can be represented digitally. Here is how. Just like images use bitmap (give analogy of graph paper), video is made up of frames. Each frame comprises of one image. So a bunch of frames together is a video. Besides images, video also has this concept of number of frames played per second which impacts video quality. If there are more pixels in an image bitmap, the picture looks sharper. Similarly, if there are lots of frames that are played quickly one after another, the video looks smoother and better quality. SHare the link on this slide, let children see for themselves and experience how by playing different frames per second video quality can be different. Once they assimilate this information, let them know that 24 frames per second is usually the rate at which most cellphones and video cameras and players record/play videos. To show that number of pixels can impact the picture quality, show the link on slide 20 so children can relate to this concept better. Explain using day-to-day things such as TV - one with larger screen and more pixels has not only larger picture but better resolution and quality. If you simply have a large screen but have same number of pixels as in small screen, you will only see bigger image, but quality of image will become worse than small TV with same number of pixels. In the next slide, we will complete how videos can be digitally represented 21.) In Slide #21, we talk about rules used to digitally represent videos. Some of common rules are VHD, DVD, MPEG and HD. Explain what MPEG stands for and ask children to find out the full name of other video encoding rules as homework. Out of these rules, HD uses the maximum number of 0s and 1s to convert videos to digital format. As an example, 1 minute of HD quality video could use as many as 200000000 number of 0s and 1s!!!! As a fun activity, show the videos linked to this slide - these are educational explaining the principle of motion picture or video. For your convenience, both these videos are linked on the slide and teh actual links are mentioned in the notes section of this slide. This is the end of digital representation (Part 2). The following slide will recap what we learnt today. 22.) Slide #22 summarizes what we learnt today. Make sure to reiterate and repeat the second bullet "Digital representation is imporatnt for…" - that is the crux of digital representation lesson. Here is one more request for the teacher from CSPathshala content creating team - it would be really nice if you could ask children at the end of this class about which video they liked best and what would they like to try at home from among the fun activities mentioned in this class. Thank you.