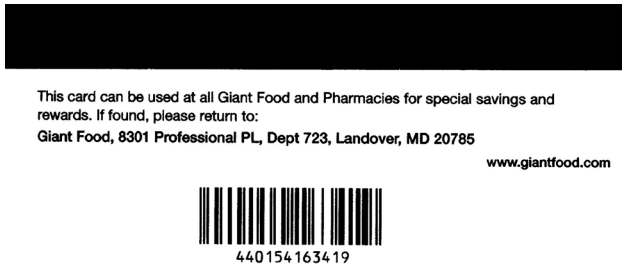
Barcodes Demystified

(Almost) Everything About Them









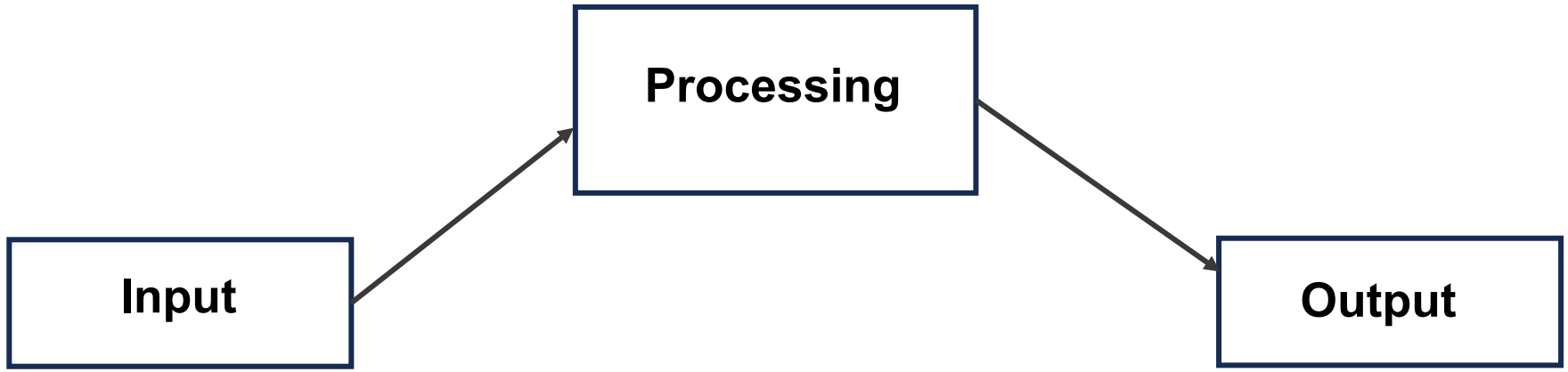
Riderwood Computer Club, April 15, 2024 – Income tax day!

Why Computers Became So Important

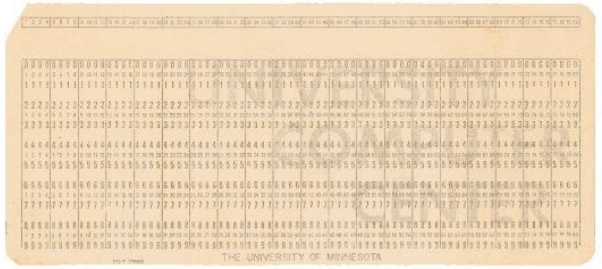
- As the economy ballooned after World War II, organizations started to become overwhelmed by paperwork
- Two considerations became imperative:
  - Tasks had to be done faster
  - Work had to be done with fewer errors
- Industries looked to the models that had previously been instituted by the U.S. Government for these same reasons
- The initial computer systems did batch processing, with each task accomplished in a separate job, or “run”

Back to Data Processing 101

Whether it's **batch processing** (the workhorse of computing in the mid-20th century) or **transaction processing** (the basis for interactive, web-based computing as we know it today), all computer applications have three basic components:



Remember this?





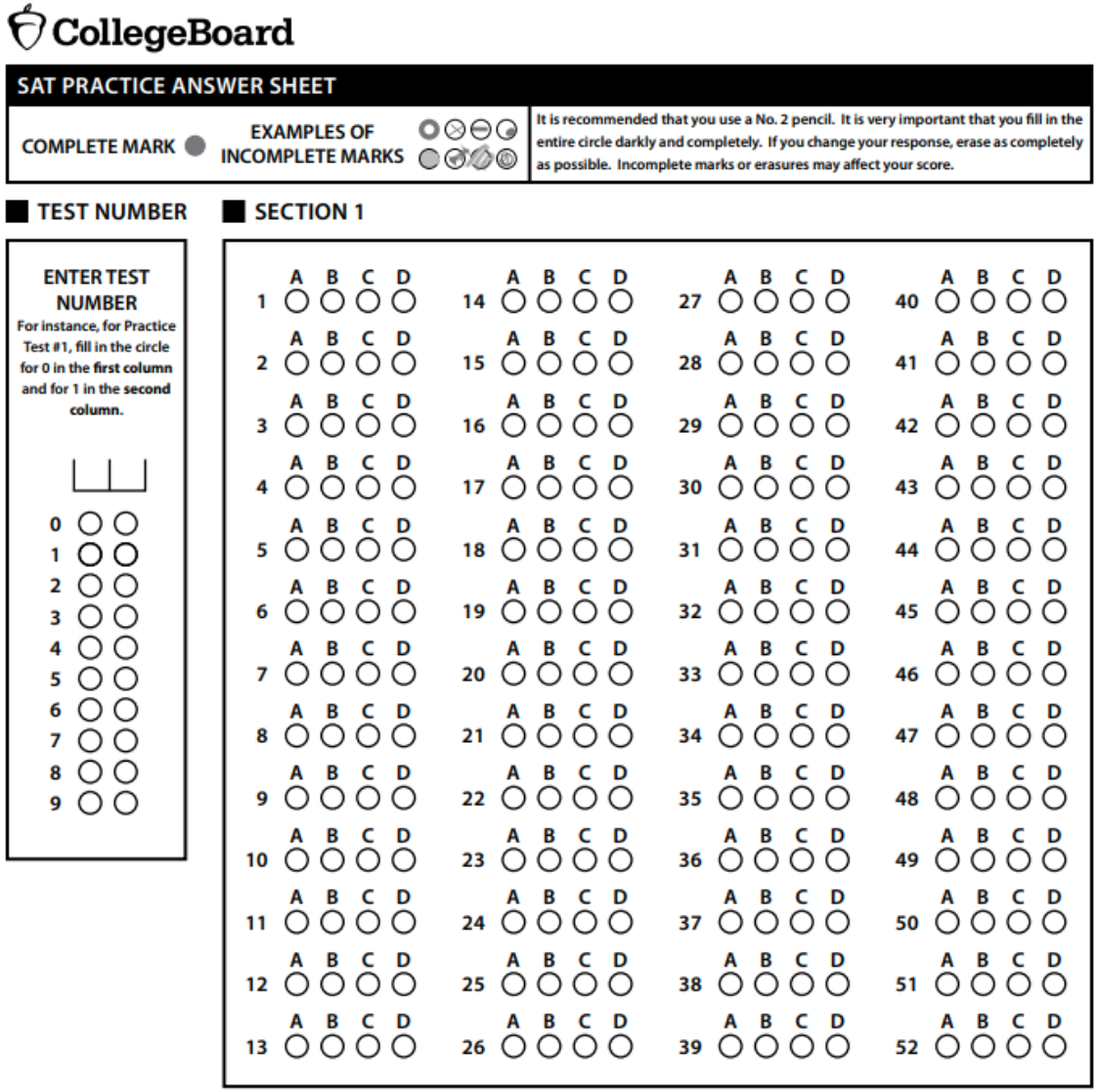


Input, in the form of punched cards…

…was **processed** by a mainframe computer…

…and the **output** was usually a printed listing.

Another Familiar Example



CollegeBoard

SAT PRACTICE ANSWER SHEET

COMPLETE MARK ● EXAMPLES OF INCOMPLETE MARKS ⊘ ⊖ ◔ ◑ ◕

It is recommended that you use a No. 2 pencil. It is very important that you fill in the entire circle darkly and completely. If you change your response, erase as completely as possible. Incomplete marks or erasures may affect your score.

TEST NUMBER

ENTER TEST NUMBER

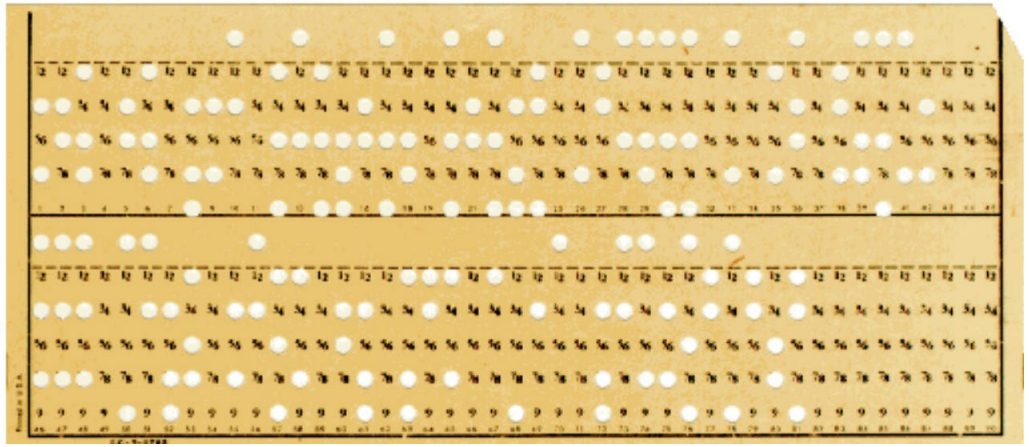
For instance, for Practice Test #1, fill in the circle for 0 in the first column and for 1 in the second column.

0 0
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9

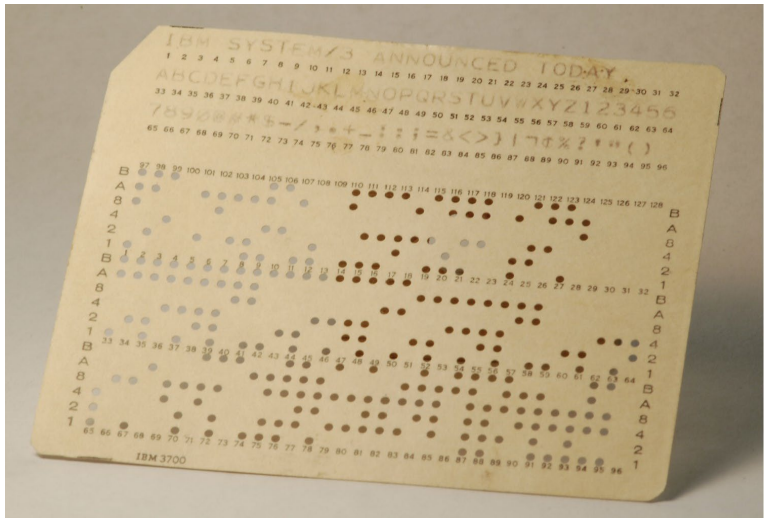
SECTION 1

1	A B C D	14	A B C D	27	A B C D	40	A B C D
2	A B C D	15	A B C D	28	A B C D	41	A B C D
3	A B C D	16	A B C D	29	A B C D	42	A B C D
4	A B C D	17	A B C D	30	A B C D	43	A B C D
5	A B C D	18	A B C D	31	A B C D	44	A B C D
6	A B C D	19	A B C D	32	A B C D	45	A B C D
7	A B C D	20	A B C D	33	A B C D	46	A B C D
8	A B C D	21	A B C D	34	A B C D	47	A B C D
9	A B C D	22	A B C D	35	A B C D	48	A B C D
10	A B C D	23	A B C D	36	A B C D	49	A B C D
11	A B C D	24	A B C D	37	A B C D	50	A B C D
12	A B C D	25	A B C D	38	A B C D	51	A B C D
13	A B C D	26	A B C D	39	A B C D	52	A B C D

But there were other card formats as well



Univac 90-column card



IBM System/3 96-column card

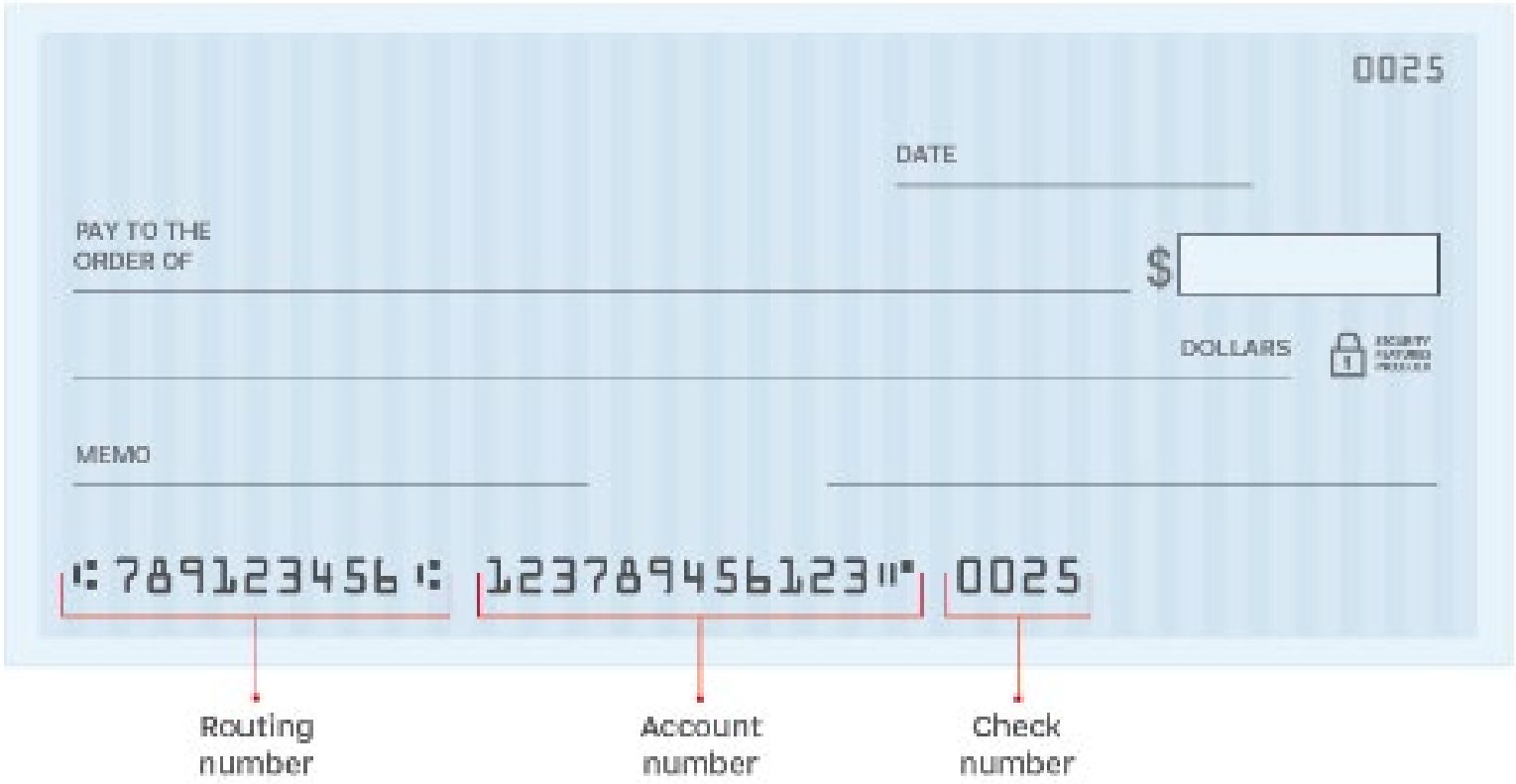
Back in the mid-20th century, it would have been impossible to imagine the number and variety of input sources or processing modes we have today

What about standardization?

- As long as computer programs were run within a single organization, standards were irrelevant
- When multiple organizations needed to exchange data, the importance of standards became obvious
- Information such as the specifics for data encoding became standardized through organizations like NIST (National Institute for Standards and Technology) and ISO (the International Standards Organization)

An Early Example of a Standard

The banking industry adopted Magnetic Ink Character Recognition (MICR) in the late 1950's to allow more accurate and efficient processing of paper checks



Evolution of Input Media

- Each type of input requires specialized hardware to “read” it
  - Punch-card readers
  - Document scanners
  - MICR reader-sorters
- We’re going to look at technologies that identify **things**
- The use of fingerprints, iris scans, facial recognition and other ways to identify **people** is a whole different topic
- Nevertheless, they’re all examples of the traditional model:



How Did Barcodes Come About?

- Norman Joseph Woodland, a Morse Code aficionado, was on a beach and scribbling dots and dashes in the sand, when he had a “Eureka” moment. He changed the dashes into vertical bars and that was that.
- He worked with Bernard Silver, a college classmate, to develop a final version of the code. They received U.S. patent number 2,612,994 for it in 1949, but it took more than a dozen years for it to find a practical application.

“Linear” Barcodes

Because these first codes were linear arrangements of vertical lines, or “bars,” they were called “barcodes.” Several early versions were

- UPC/EAN (for retail items and price tags)
- ISBN (for books)
- 2-of-5 (a general-purpose coding scheme with checksums)
- PostNet (a variant of 2-of-5, used for ZIP code information on envelopes)

More information can be found at

https://www.barcodelookup.com/symbology

What All Barcodes Have in Common

- Specialized scanning device needed to “read” the bar code
- The device must connect to a computer application to interpret the code
- The application then decides what to do next
  - Look up item in a database and determine price (grocery store)
  - Add item to inventory (library or bookstore)
  - Send item to next destination (baggage tag)
  - Take you to website (QR code)
- Back to **Input > Processing > Output**!



The Universal Product Code debuts

- The UPC barcode was developed by the grocery industry and product manufacturers to reduce costs involved in manually marking prices on items and keying in prices at checkout
- It was first used in the mid-1970's but faced resistance
  - Grocery store owners balked at the expense of installing the required hardware
  - Customers still wanted to see the prices on individual items
- Today, UPC labels are used by more than a million companies in more than 100 countries



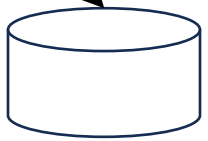
So, How Does it Work?





Bar code on product is passed over scanner
(if scan fails, the digits can be keyed in manually)

Scan data is sent to a constantly running program on store's computer system which looks up the item in a database



- Item's price is sent back to store
- Beep noise sounds
- Inventory is updated
- Other custom features

Next Step: Point-of-Sale Systems

- Other retail establishments adopt barcodes on price tags
- Systems expand, adding hardware and software elements to provide an end-to-end solution
- A few of the new features:
  - Inventory control
  - Reports to store managers and vendors
  - Customer payment via credit or debit card
  - Receipts in paper form or via text message or email
  - Capture of customer data allows “frequent shopper/flyer/user” programs to be established

Other Specialized Barcodes

- Airlines use barcodes to route and track checked baggage
- UPS, FedEx, and others use barcodes on shipping labels
- The purpose is to speed the process and eliminate errors





The USPS: A Unique Example

- The U.S. Postal Service has had multiple challenges to its mission of delivering mail within a realistic budget
- Various types of automation were essential to meeting this challenge
- Many of them involved developing specialized bar codes
  - “PostNet” for ZIP codes
  - “Service Type Identifier” to indicate special contract arrangements
- Bulk mailers receive discounts on their postal bills if they follow the USPS guidelines for envelope size and bar code use

A Prime Example: Election Mailings

The Montgomery County Board of Elections provides this envelope:

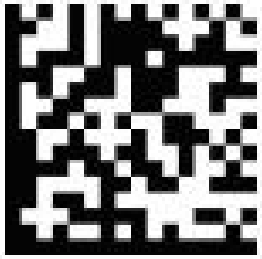


PostNet bar code of addressee

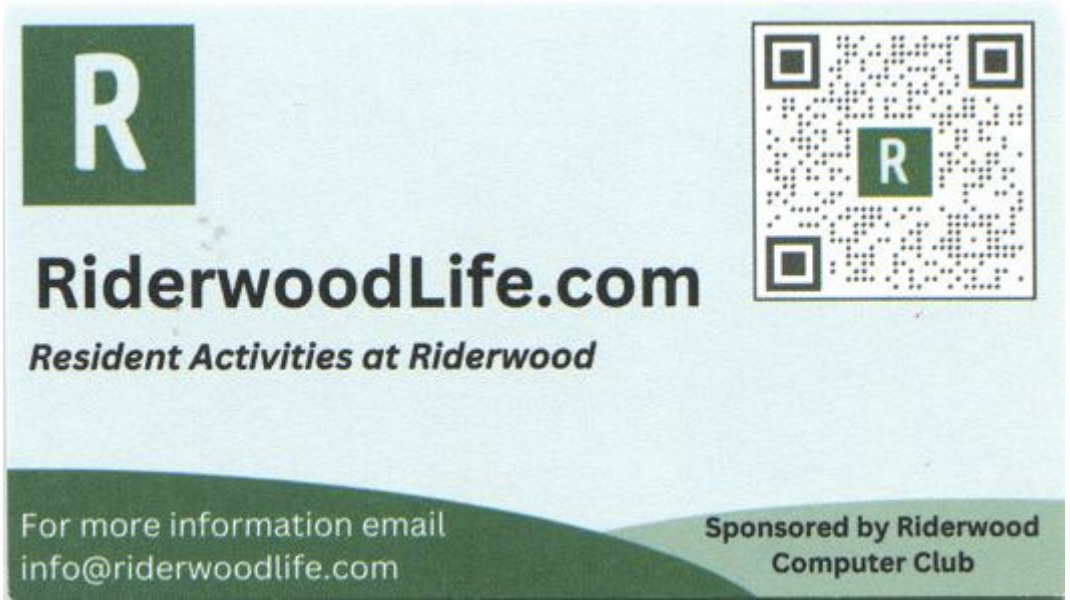
Codes to indicate type of mailing (Postage-paid return envelope; election-related)

Evolution:
Two-Dimensional or “Matrix” Barcodes

- Linear barcodes have limits on what they can represent
- In order to encode more data, two dimensions are required



GS1 DataMatrix Barcode containing GS1 element string
(01) 80614141123458 (21) 6789



Data Matrix Codes and QR Codes

Data Matrix



- Maximum encoding of 2335 characters
- Used in the manufacturing and food industries
- Must conform to ISO/IEC 16022 standard, making it easier to scan and ship internationally

QR ("Quick Response")



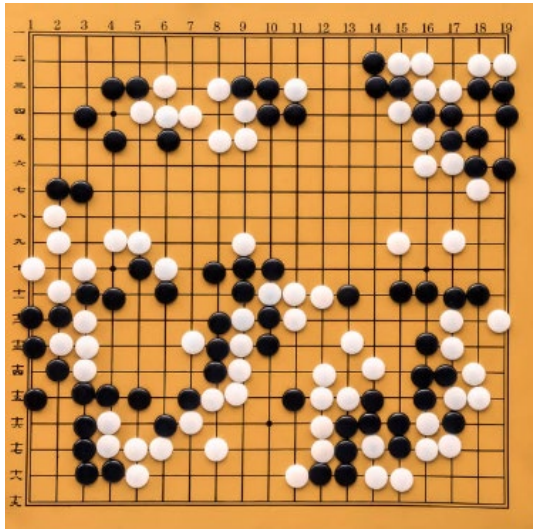
- Greater capacity
- Easy to create
- More versatile (no size limit)
- Can be *static* (as in an event ticket) or *dynamic* (as in linking to a URL where the user can then provide feedback)



- Can be read by cell phone cameras!

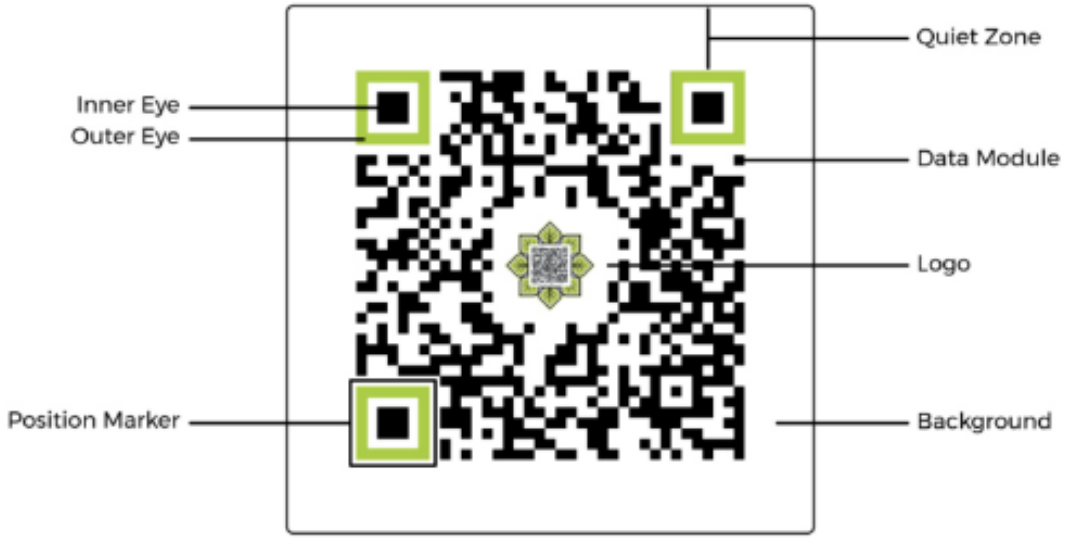
How QR Codes Came About

- Denso Wave, a Japanese automotive company, had been tracking components with multiple linear bar codes when an employee realized that a single two-dimensional barcode might be able to contain all the required information
- His inspiration came from the 19x19 grid of a GO game board



Recognizing the dot pattern as a code

- The QR code developers needed to come up with a standard that would let scanning devices recognize the pattern as a barcode, not just an image
- This is the QR code standard (ISO 18004:2015):

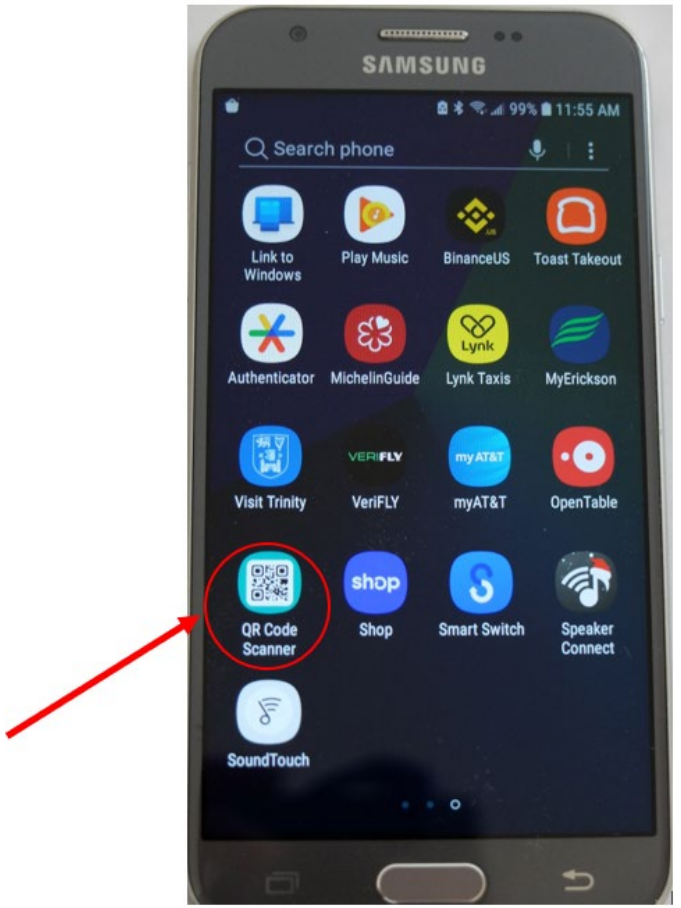


A Watershed Moment

- In the early 1990's, the internet became widely available
- Before this, the scanning applications had to be contained within a single organization's infrastructure
- With internet access, the potential for individuals and organizations to reach external resources became unlimited
- **Standards** became even more important for successful information interchange

Using Your Cell Phone to Scan a QR Code – Part 1

- If individuals are to be given access to the internet, why not do this via cell phone?
- Cell phones could also be used as specialized input device to “read” QR codes and then go to a website for the "processing” step
- The first apps to read QR codes were developed in 2001



Using Your Cell Phone to Scan a QR Code – Part 2

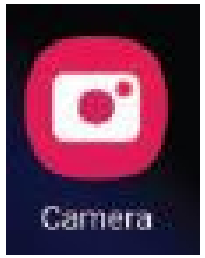
- Beginning in 2017, QR-code-reading was included in smartphone camera software
  - iOS version 11
  - Google Android version 8.0
- Today, all iPhones and Android devices have both options to read QR codes
  - Camera settings (for current versions of Android and iOS)
  - An app, such as QRbot (for all iPhones and Android phones)

Disclaimer

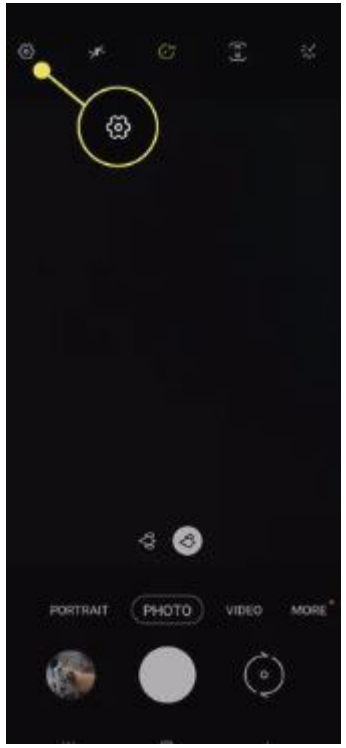
- The exact screen layouts in all devices differ by operating system version
- The following steps are shown for the most recent versions of iOS and Google Android, but the general procedure is the same for all supported versions
- Different QR-code-reading apps work slightly differently
- Don’t be frustrated if your phone’s screens don’t exactly match the ones shown here!

Enable Barcode Scanning with the Camera on an Android Phone

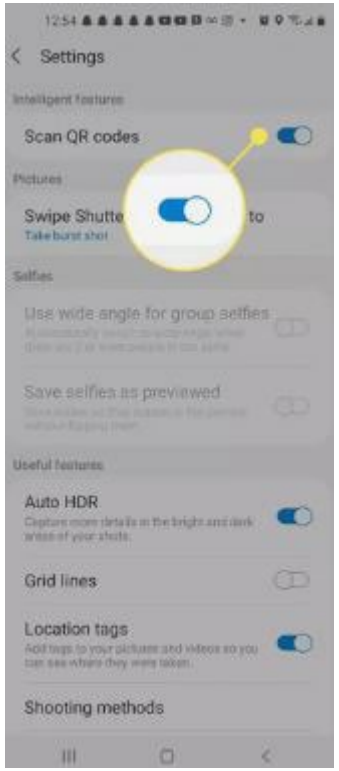
Click the Camera icon



Click the *Settings* icon on the Camera screen

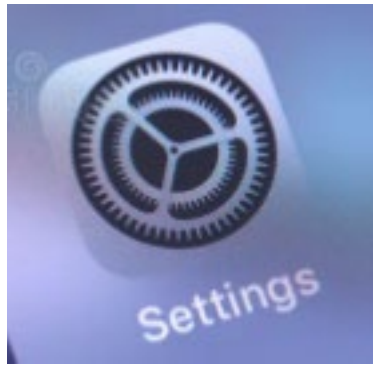


Enable the *Scan QR Code* Setting

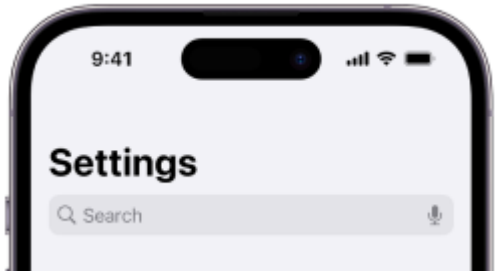


Enable Barcode Scanning with the Camera on an iPhone

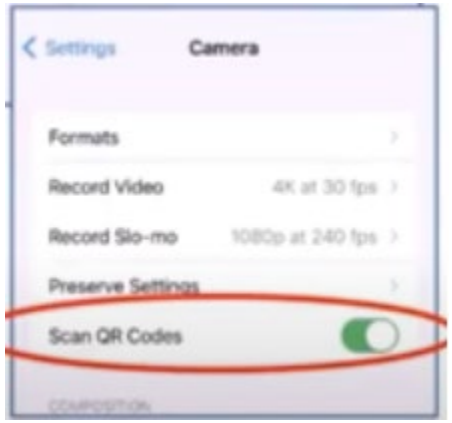
Click the **Settings** icon



On the **Settings** screen, search for **Camera**



On the **Camera** screen, enable **Scan QR Codes**

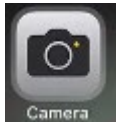


The “App” Option

- For older phones without the ability to enable QR scanning via the camera, the same thing can be accomplished by downloading an app
- This can also be done with newer phones
- One example is **QRbot**, which can be downloaded from the Apple Store or the Google Play Store



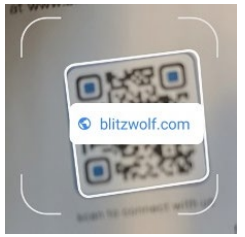
Scanning a QR Code on an iPhone

- Have the document with the QR code in front of you
- Open the Camera 

or the QR app  on your phone
- Point the camera at the QR code
- A set of four corners defining a square will appear
- Move the camera up and down until the QR code comes into focus and fits nicely within the four corners
- Depending on your phone's configuration, you may be taken directly to the website or you may have to click the URL that appears

Scanning a QR Code on an Android Phone

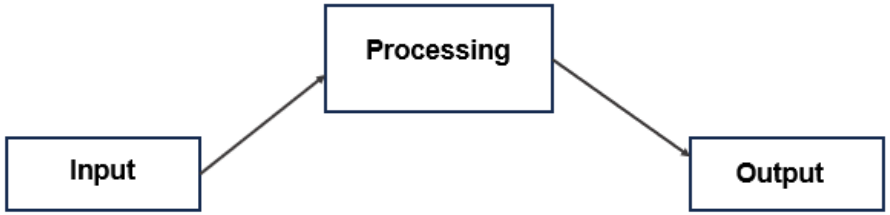
- Have the document with the QR code in front of you
- Open the Camera  or the QR app  on your phone
- Point the camera at the QR code
- A set of four corners defining a square will appear



- Move the camera up and down until the QR code comes into focus and fits nicely within the four corners
- Depending on your phone's configuration, you may be taken directly to the website or you may have to click the URL that appears

What Happens After You Click the QR Code

- Remember the original model?



- Your phone, which is always connected to the internet, is the INPUT device, scanning the barcode and using it to access the website that it represents
- The QR is just a shortcut that takes you to the associated webpage and keeps you from needing to type the URL manually
- The OUTPUT in this case is the content of the associated webpage displayed on your phone
- The QR code provides
  - Faster access to the intended webpage
  - A way to prevent errors in keying the webpage's address

One Example of a QR Code



In this example, the snail-mail card from the committee supporting the re-election of sitting judges in the Montgomery County Circuit Court encourages you to scan the QR code or go to the website https://www.electsittingjudgesmcs.com/ to learn more about the judges

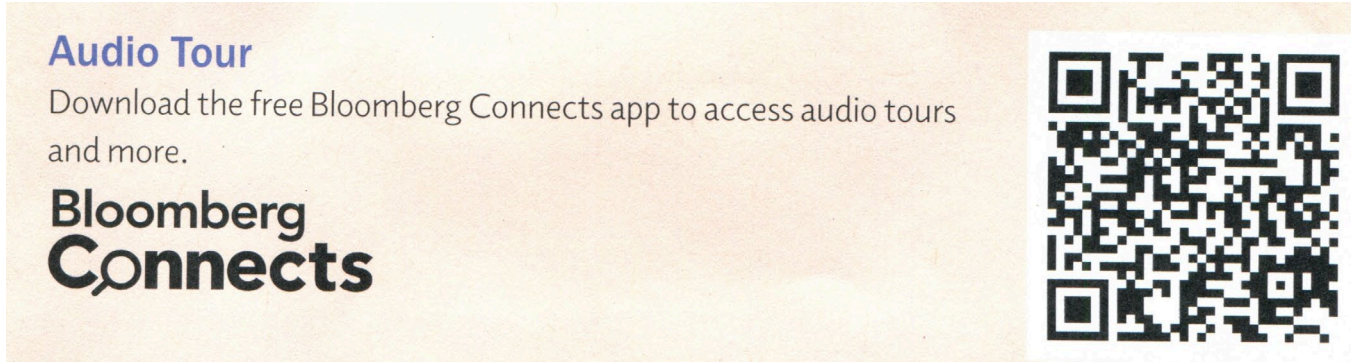
Another Example of a QR Code



This QR code takes you to the webpage
https://myerickson.erickson.com/myericksonV1/site/erickson/residentapps/mobile/desktopExternalLoginCallback/#/module/menus/4102155?active=true

A QR Code that takes you to a QR Code Reader

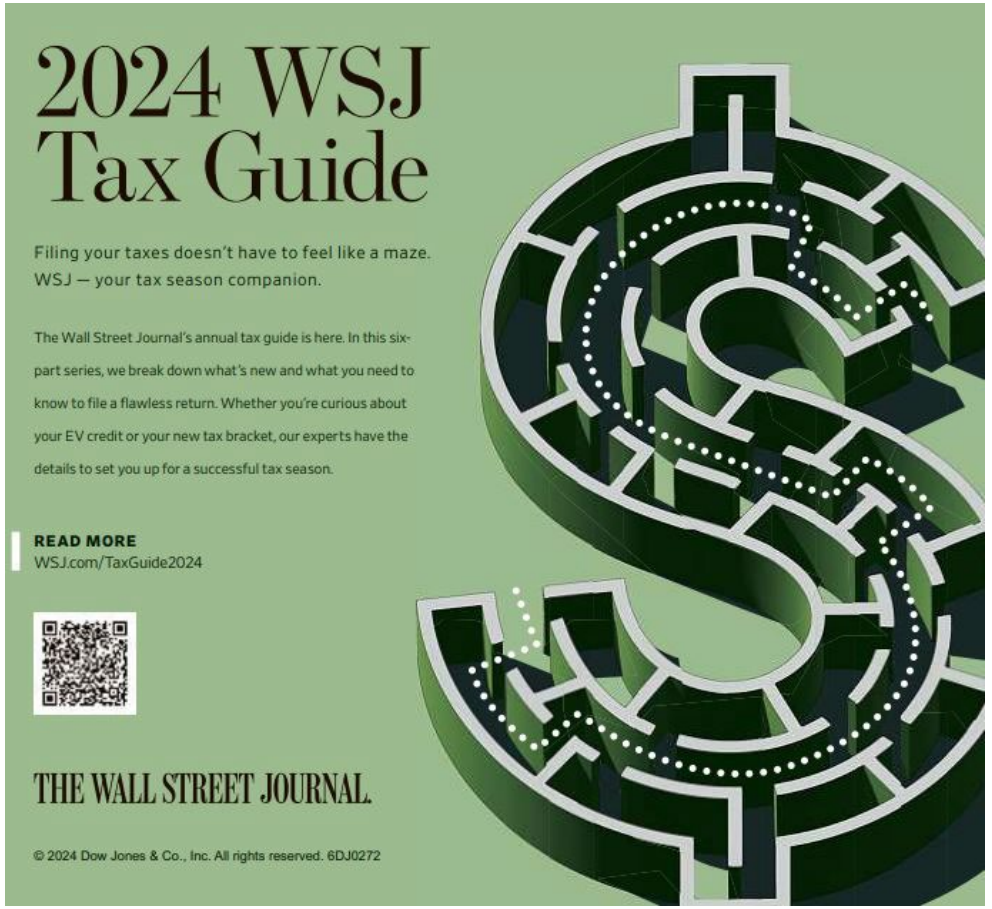
At the Phillips Collection museum in D.C., the brochure for their current exhibition contains a QR code that you can use to download an app



Once you have downloaded the app, you can use it to click on ADDITIONAL QR codes next to some of the works on display to learn more about them

More Examples of QR Codes



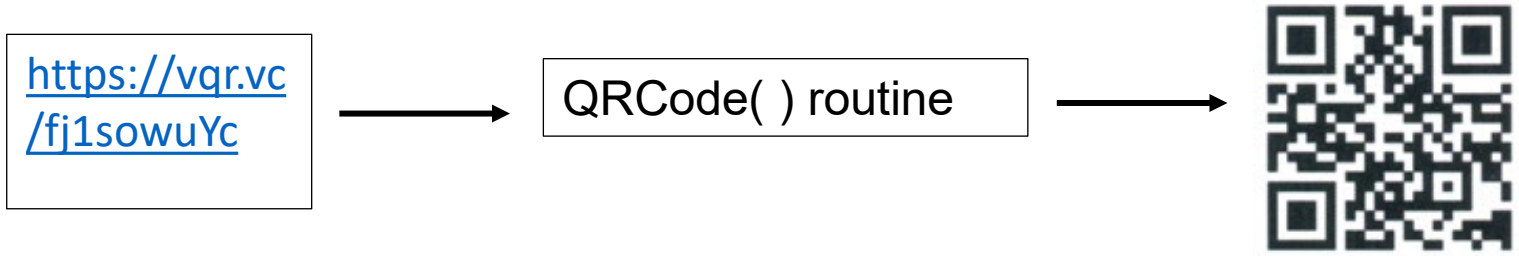


Yet Another QR Code example



Want to Create Your Own QR Code?

- Software tools and free services can be used to generate a QR code from a string of data that contains the web address
- Companies like https://www.onbarcode.com/ sell Software Developer Kits for organizations that want to generate their own codes using Visual Basic, Java, C#, or other widely used tools
- QR code generators are also available online



Summary – Part 1

- Remember just three basic things:
  - Organizations these days have many concerns, among which are:
    - Getting tasks done faster
    - Reducing errors
  - Every computer operation requires three components:
    - Input (a QR code is one example)
    - Processing (in the 21st century, almost always done via the internet)
    - Output (usually the display of a webpage)
  - Accomplishing the organization's goals requires creative approaches to acquiring the ***input data*** more efficiently in the first place and ***processing*** it more efficiently after that. You can see all around you that QR codes are a key component in that process.

Summary – Part 2

- QR codes are in the class of “two-dimensional” barcodes that allow for more information than could be encoded in “linear” codes
- The ability for smart phones to scan and interpret QR codes greatly expanded the ability of these coding systems to be useful for the general population
- So, basically, QR codes are just shortcuts to websites!
  - They contain actual links to the websites so they eliminate typing errors
  - They can be “static”, where they link to one-time information about things like a ticket, or “dynamic”, where they link to websites that allow the user to perform additional tasks such as submitting feedback or continuing to follow-on websites where other options can be selected

Acknowledgement

I was inspired to do this presentation when watching a YouTube video on this topic from the APCUG (Association of Personal Computer Users) speakers' bureau. It was shown on the website of the Maris Grove Computer Club last summer. Here is the link to the video:

https://www.youtube.com/watch?v=8FskI_RIh-w&t=2667s