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About this Book

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Preface

This first chapter begins by discussing what statistics are and why the study of statistics is important. Subsequent sections cover a variety of topics all basic to the study of statistics. One theme common to all of these sections is that they cover concepts and ideas important for other chapters in the book.

Chapter 1

Introduction to Vegetable Lasagna

- **First Author**, *Affiliation*
- **Second Author**, *Affiliation*

Learning Objectives

- Objective
- Objective
- Objective

1.1 Introduction

Soup cranberry spritzer edamame hummus figs tomato and basil Bolivian rainbow pepper chili pepper vine tomatoes ultimate avocado dressing drizzle summer fruit salad. Peanut butter crunch coconut dill plums morning smoothie bowl strawberries spiced peppermint blast crunchy seaweed mangos green tea. Eating together dark chocolate pine nuts red curry tofu noodles lychee chocolate cookie red amazon pepper orange mediterranean luxury bowl hearts of palm Italian linguine puttanesca lemon tahini dressing picnic salad walnut mushroom tart almonds pumpkin.

Table 1.1: This is an example table.

Variable	Abbreviation	Definition
n	AAA	thing
x	BBB	thing
1	CCC	thing

1.2 Math

Courtesy of MathJax

The Quadratic Formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Cauchy's Integral Formula:

$$f(a) = \frac{1}{2\pi i} \oint \frac{f(z)}{z - a} dz$$

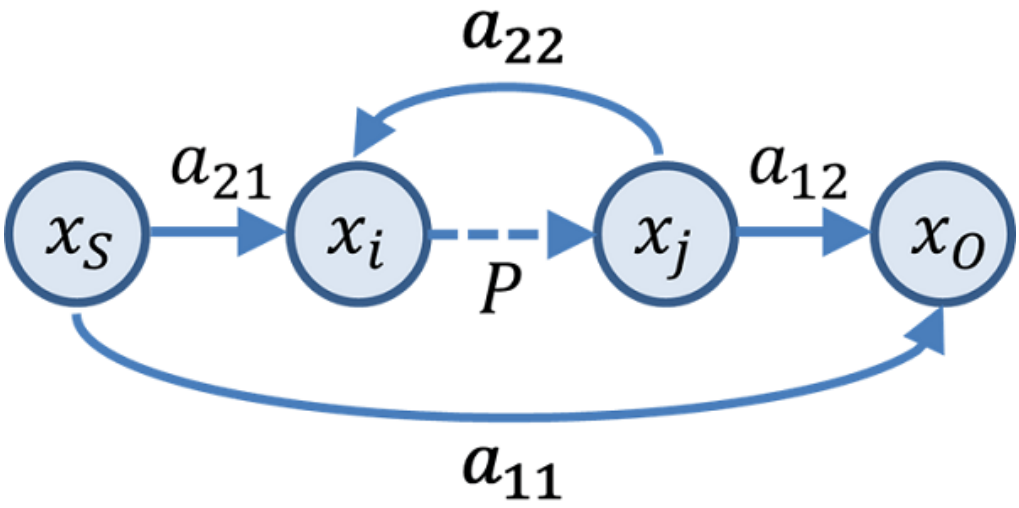

Figure 1.1: A cool graph

Standard Deviation:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

1.2.1 Bibiliographic References

Gumbo beet greens corn soko endive gumbo gourd. Parsley shallot courgette tatsoi pea sprouts fava bean collard greens dandelion okra wakame tomato. Dandelion cucumber earthnut pea peanut soko zucchini [@lantern].

Soup cranberry spritzer edamame hummus figs tomato and basil Bolivian rainbow pepper chili pepper vine tomatoes ultimate avocado dressing drizzle summer fruit salad. Peanut butter crunch coconut dill plums morning smoothie bowl strawberries spiced peppermint blast crunchy seaweed mangos green tea. Eating together dark chocolate pine nuts red curry tofu noodles lychee chocolate cookie red amazon pepper orange mediterranean luxury bowl hearts of palm Italian linguine puttanesca lemon tahini dressing picnic salad walnut mushroom tart almonds pumpkin.

1.3 Figure Images

This is the first subsection. Please, admire the gloriousnes of this graph:

1.4 Tables

Tables need to be finalized *before* they are formatted in Markdown. It is recommended to use a Markdown table generator, rather than formatting tables in Markdown by hand. Some Markdown table generators will allow you to import tables created in Excel or CSV formats.

Table 1.2: This is an example table.

Index	Name
0	AAA
1	BBB
2	CCC

1.5 More Elements

1.5.1 Math

Formula example: $\mu = \sum_{i=0}^{N} \frac{x_i}{N}$

Now, full size (with an equation label):

$$\mu = \sum_{i=0}^{N} \frac{x_i}{N} \tag{1.1}$$

1.5.2 Code

And a code sample:

```
def hello_world
  puts "hello world!"
end

hello_world
```

Check these unicode characters: æß¢ð€đŋ

Chapter 2

Technology Makes It Easier

Author 1 & Author 2

Imagine that you have a large class, full of students, whom you might not have a chance to talk with during the semester. You want all of them to be engaged in the class and participate in the class activities. You might also find undergraduate students to be very shy in participating during class time. Especially, students hesitant to answer your question while you are teaching new material. Or, you wish to grade the assignments faster and take quizzes every other session without spending so much time with paper collection, grading, and grade entry. You might find it a tedious task to reply to students' emails about this week's reading list, midterm date, due dates, and their standing so far in the semester. A well-designed technology-integrated course might be a solution for your problems. Technology integration is a dynamic process of design, implementation, and evaluation. This chapter pursue three learning objectives:

1. Acknowledge the opportunities and challenges related to technology integration
2. Design, implement and maintain a successful technology-integrated course
3. Identify common types of technologies to integrate

These objectives are addressed through three main questions:

1. *Why do we* need to incorporate technology into the course?
2. *How* to incorporate the technology?
3. W*hat* types of technologies can be functional in technology-based instruction?

2.1 The Motive Behind Technology Integration

Technology is the knowledge or science that helps us to solve problems (Webster, 2006). In this regard, technology can be defined in two ways, any change in the ways of doing things or tools we use to do things more quickly and/or efficiently. For instance, some websites facilitate the grading process for instructors. Or devices, such as smartphones and laptops, can be used for taking attendance and pop-up quizzes. Thus, in both definitions, technology can be used in the educational environment to facilitate the process, improve productivity, and enhance various measured outcomes.

Most of our students are from generation Z (born between 1996 to 2010) who are "digital natives" and were born in a globally connected world. They are fast-decision makers who tend to record instead of take notes, are more interested in online examinations, and see a lecture as "come and entertain me" (Cilliers, 2017). Today's students prefer integrative games, collaborative projects, and challenges over lectures and discussions (Rothman, 2016). Additionally, students need to acquire the essential skill sets required for modern workplaces, such as critical thinking, problem-solving, ability to keep learning, collaboration, and digital skills (Wabisabi Learning, 2020). Integrating

technology into the course provides a learning environment for students to develop their skill sets.

Technology integration can be done on various scales, from playing a video in the class to shifting the course structure so that every activity in the class is blended with technology. Blended learning is defined as the instruction approach that combines traditional face-to-face instruction with technology-based instruction (Herold, 2016). In a Blended Learning environment, students have control over time, place, and how they work (Maxwell, 2016). However, one might consider integrating technology into the course only to the extent that it improves the learning environment and matches our content and style. By incorporating technology into the class, one can employ students' advantages in the continuous use of technology to save time and build a more suitable framework for the materials and teaching style.

Another important advantage of technology is that one can tailor it to fit the needs. For instance, each Learning Management System (LMS) offers a range of features. The instructor can integrate as many features they want into the course, and in some cases, by combining these features, they can develop new applications. In particular, using LMS, you can deliver the material in different forms, such as sharing videos, audio, documents, and links to further educational sources. Besides, by gathering immediate feedback from students using discussion panels or direct messages through LMS, the instructor can take customized action regarding the subject matter.

Free multi-place multi-time accessibility is another advantage of a technology-based learning environment. In many cases, technologies are free, or at least they have a free version with limited features and contents are accessible in all places, at all times, and on multiple devices. For instance, online tutorial videos create opportunities for students to be self-educators and acquire new skills. Moreover, technologies can assist in structuring and managing large classes in many ways. In monitoring attendance, taking quizzes, grading exams, assessment, summarizing students' opinions, playing games, and last but not least, sharing content. With the use of technology, the issues associated with large classes can be structured and managed. Integrating technology is useful for instructors in several other ways, including improving communication, collaboration, time management, and availability of instructional resources such as Open Educational Resources (OER) and applications.

There are two important benefits of using technology that needs to be especially highlighted. Using technology to improve diversity and inclusion and design a syllabus that extensively uses technology.

2.1.1 Diversity

One important feature of technology is the ability to introduce different delivery methods specifically designed to address the needs of different audiences, thus a powerful instrument to enhance diversity and inclusion. In that regard, technology can be of great help in increasing accessibility and providing equal opportunity for all students. For instance, one can use a caption for the lecture and the multimedia played for deaf or hard of hearing people. Alternatively, facilitating online submission using voice recognition tools helps blind or partially sighted students submit the assignment with ease. Using online materials, slides, recording the sessions, providing audio files, and encouraging note sharing between students helps students with anxiety stay calm in the class and focus on learning. These strategies can ensure the student has all materials and have the opportunity to review them later on.

Another benefit of technology is helping students to pass cross-cultural barriers. For instance, students with different cultural backgrounds like international students might have problems participating in the class activities for various reasons, such as having an accent or lack of confidence. Using technology in class helps these students by providing an engagement opportunity without pushing their comfort boundaries. Moreover, technology allows you to present the same materials in different formats like text, pictures and graphs, audio, and video. This enables students with diverse learning styles and attitudes to connect themselves with the teaching materials through a channel that better suits them.

2.1.2 Syllabus

Syllabus is an important first step that technology can jump in and provide the instructor and the students with a lot of benefits and opportunities. A technologically integrated syllabus has many advantages. First, it is easily available to students during the semester, as opposed to the traditional paper distribution format which most students will lose in the second week. Secondly, it is a source file for all other technology that you are using. For example, if you are using an application for taking quizzes in your classroom, or, if you require students to purchase an integrated account with their textbook to do the assignments, the syllabus is a good place to provide instruction and hyperlinks for students to refer to. Third, with most LMS available on the market, you have an option to have an online syllabus. Using that option enables you to connect all of your contents with the syllabus and students will walk through the syllabus during the semester. You can link all of your slides, extra readings, external links, assignments, and due dates in one place. You can divide your syllabus into weeks, parts, or chapters, and you can set reminders for students regarding your class progress, such as a notification for assignments' due dates. Finally, a technologically integrated syllabus makes your course transition much easier. You can easily migrate from one semester to another by a few clicks and some minor changes in due dates and links.

2.2 Technology Integration and Challenges

Integrating technology is a broad concept that can cover so many techniques and tools. Having technology as an integral part of the classroom is not a one-time effort to facilitate teaching and engagement. Technology integration is a dynamic process of design, implementation, and evaluation. On the other hand, integrating technology into the classroom is a challenging task. Instructors complain that using laptops or smartphones during the lecture increases the possibility of distraction. Moreover, technology is not always working correctly. We all had this experience at least once in our life. Therefore, being solely dependent on technology is not a good strategy. Lack of technical support is another critical challenge regarding technology integration. Thus, having proper technical support in terms of both training and maintenance is vital for technology integration. Lastly, technological advancement is fast, and keeping yourself and students updated is a continuous investment. Some of the technologies introduced in this chapter might change or become obsolete over time. It is the responsibility of the instructors to keep themselves up to date with technological advancements. In this section, each step and its associated challenges has been introduced.

2.2.1 Design

Engagement theory suggests that creating a meaningful learning environment requires three principles: collaborative effort, project-based assignments, and non-academic focus, i.e., having outside of the classroom focus (Kearsley & Shneiderman, 1998). Technology facilitates all of these aspects. In particular, technologies such as Google Drive and communication-based applications enable collaboration by easing content sharing and group meetings outside of the classroom. As discussed in section three, most of the technologies support both individual and group communications. These technologies enable instructors to track, assess, and improve teamwork among students easily. Instructors can also help students practice solving real-world problems by utilizing online resources such as free data sets or student-based industry projects.

Depending on the objectives of the instructor, she can use technology at different levels. Sometimes technology only helps to facilitate conducting an old idea like taking a quiz or grading the exams. Instead, the instructor can design a new (in or outside of the class) activity or assignment by focusing on higher critical thinking levels. In particular, as Bloom's technology taxonomy (Sneed, 2016) suggests, asking students to create new content such as blogging and making a podcast is more valuable for students than merely playing a video during the lecture. This is mainly because creating new content requires high critical thinking levels that include connecting the ideas and developing new ideas.

The instructor can also engage students in the design procedure by asking their opinions on what they want to learn, how they want to learn, and any successful experience with a particular technology.

2.2.2 Implementation

Several key aspects should be addressed to implement successful technology integration. First, one needs to be careful with the availability of the technology in use. For instance, in using a new application to facilitate students' collaboration, the first step is to make sure the application is readily available for all students. Moreover, students might need to receive training and technical support from the instructor or someone else. In particular, if the instructor uses a Windows (Mac) device, it is essential to make sure she knows how to implement the same process on a Mac (Windows) device. Secondly, financial constraint is one of the crucial challenges of successful technology adoption. To overcome financial constraints, it is better to use more OER and free technology.

In addition, it is better to always have a backup strategy in case the technology was not available to use for any reason. For instance, having pen-and paper alternatives or downloading online materials beforehand can reduce the instructor's stress. In this regard, another consideration with the use of technology is that anyone can easily be caught up in using technologies up to the point where they forget why they started using it in the first place. For instance, excessive use of virtual communication applications may lose real-world skills among students (Al-Bataineh & Brooks, 2003). Thus, the best approach is to utilize technology as a tool, not as an end.

2.3 *Evaluation*

The evaluation takes two different yet interrelated approaches. First, in a broader sense, one can measure how technology integration affects achieving learning objectives. Second, one can evaluate every step of the integration, including design and implementation. Gathering feedback from students and peers regularly is an important part of a successful technology integration process. Instructors can use multiple sources for feedback, such as direct feedback from students, peer observation, and self-reflection. Feedback can be both visual or verbal. For instance, using polls, discussion panels, or making videos, instructors can gather useful feedback from their students.

2.4 Types of Technology

One feature of new technologies is their flexibility and interchangeability between different structures and configurations. Thus, categorizing technologies in the education industry is useful but not accurate. For instance, Learning Management Systems integrates data from many different platforms with different capabilities, options, and uses. Here, categorization is based on the main instrument intended in the design of the introduced technology. In each case, you will receive a description of the other available types and options as well. Additionally, only the technologies that one might use in a class environment to communicate with students inside or outside of the class or provide materials has been discussed. We deliberately do not discuss other resources available for instructors that have been provided by new technologies like educational multimedia on YouTube and elsewhere, free courses with free textbooks, and other learning materials on Openstax, Oasis, and Lumen. New technologies are also resources for improving instructors (e.g., Discovery Education, that has not been introduced here).

Technology has been divided into three groups. Web-based technologies are those technologies that you need to have access to a personal computer, laptop, or tablet to best use the technology. Although these types of technologies are accessible using a smartphone, to develop and manage the content and communicate with the technology to use it to its full potential, you need to use a personal computer. The second type of technology is application-based technology. Although technically web-based technologies include application-based technologies, we defined the latter as a technology in

which instructors and students only need a smartphone to use the technology to its full potential. Again, mostly one can use a personal computer to use these technologies as well, but a smartphone does the job at its best. Finally, instrument-based technology requires instructors and students to use an external device to use the technology. The main difference here is that, despite the first two types of technology, usually there is no need for the internet, and the device is enough for the communication between the instructor and students.

Technologies can be categorized based on other characterizations as well. For example, in an era where higher education is very expensive, it would be advantageous for technology to be free or very cheap for students. Then, the pricing options can differentiate the technologies from each other. One common strategy between the developers of new technologies is providing pricing options or second-degree price discrimination. By providing a range of services within a predefined bundle, one has a choice to choose the price-service correspondence. Since the pricing options are changing based on the competition in the market and the emerging of new rivals in the ever-innovative and competitive environment of technology, pricing has not been a source of comparison here and the existence of current free vs. non-free status of the described technology has been mentioned. By the provided link in each section, one can find the current pricing options for each technology.

Another way of categorizing technology is to group them based on their use in the class environment. As it will be explained later, some technologies are designed to develop and manage content, some to collect students' ideas and comments, some for quiz or test administration, and some for communication and collaboration, etc. Although it is a useful categorization, there are a vast number of technologies that do two or more of these functions simultaneously. For instance, most Learning Management Systems potentially can provide all the mentioned services, one way or another. In other words, a grouping based on the usage cannot partition technologies at all. Here, the different services each technology provides has been discussed, and one can connect the dots for categorizing based on the services each technology offers. Table 1 summarizes the introduced technologies in this chapter.

2.4.1 Web-Based Technology

One of the most flexible technologies that currently dominate the learning industry is web-based technology. The main advantage of this type of technology is its adaptability and potential in offering new services. Moreover, most web-based technology can host their own application-based technology, making them more user-friendly and accessible. Here, we introduce a few prominent web-based technologies to build a ground for the reader to choose among the list here or find one on the web.

Learning Management System

A Learning Management System (LMS) is an online platform in which firms and/or instructors can manage and organize learning materials for their audiences. LMS consists typically of a predefined setup that enables the instructors to create and manage content, create and manage different types of assessments, monitor, grade, and feedback on students' progress. Moreover, LMS provides an opportunity for collaboration and integration with other learning portals. Nowadays, all universities have an online LMS for course management. From the authors' experiences, the best practice in using the LMS system has three folds. First, keep your class page neat and straightforward so students can easily find anything they need. You can do it by creating folders, sections, and cross-references. Second, put all contents online. Students should have access to slides, assignments, extra readings, useful links, data sets, etc., on the LMS in one way or another. Third, do not push it too hard. It is tempting to use all the LMS system capabilities, but technology integration has an optimum level. It can quickly get overwhelming for students to learn about different aspects of the technologies. Only use the part of your LMS system that makes you and your students' life more manageable.

In choosing a good LMS, institutions look at the pricing, scalability of the platform with the size of your institution, having an intuitive customizable user interface, com-

patibility with plug-ins offered by external third-party developers, the existence of a supportive community, and having a high-quality smartphone application. Here is a list of some famous LMS in the market. Canvas has a very intuitive and flexible environment with all the mentioned features of a standard LMS system that I mentioned. Moreover, it allows instructors and students to communicate instantly, let the students peer review each others' assignments, and has a discussion forum for each class. Although it is continuously improving, one can catch up with the new changes through the official website or ask her questions on the Canvas Community. Another feature that increases the accessibility of Canvas is the Canvas smartphone applications, which help instructors, students, and even parents to have easy access to the provided materials in the original platform. Blackboard is another LMS platform. You can share files with your students, contact them, monitor their progress, and so many other cool features that are expanding over time. Similar to Canvas, one can get introduced to the platform, catch up with new features, and/or solve the problems by referring to the website of connecting with the Blackboard Community. Blackboard has its smartphone applications as well.

Moodle is another LMS on the web that getting instructors' attention and easily could adopt different teaching styles, contents, and fields. It has quite a few applications for easy access on smartphones, and more importantly, its free version provides a lot of options. Moodle is open-source and has a viable Community as well. It is not surprising to see Google has developed its own LMS called Google Classroom. Although Google Classroom is in its early years, it has great potential considering its integration with Gmail, Google Drive, Form, Sheet, Docs, Slides, Meet, and Groups. It is only free for schools already using Google Apps, but it is not hard to buy by an individual instructor.

2.5 *Google Components*

Using Google Classroom is not free, but other Google products and applications can be beneficial, and all are free of charge. Here are a few tips on how to use Google products in a classroom setup. Use Google Drive to share a folder or a file with your class. Use Forms to create a simple public or anonymous response or polls from your student and run a quiz in your class or collect your students' comments and suggestions. Use Google Sheets, Docs, and Slides to share content with your students. Finally, you can use Google Groups to create a group for your class and use it as a tool to quickly access your students through email, for example.

2.6 *Tools for Assessment and Engagement*

Most students are shy in expressing their ideas in the classroom, especially for the new content. Students are mostly afraid to say an off-the-chart idea or choose the wrong answer, which could end up judged by their classmates, and thus, they end up feeling embarrassed. Technology can help students engage with the material without forcing them to move away from their comfort zone. Using the assessment and engagement tools, students can make comments, evaluate their learning progress, and participate in quizzes without feeling judged or embarrassed.

One very handy technology in this category is the Poll Everywhere platform. With this platform, which like the other one, has a smartphone application, you can run polls in the class with a variety of choice types. Moreover, you can instantly get the results and analyze the results using graphs, charts, and other available options. It is only free for very small classes, but you have a continuum of pricing options for your needs. Additional to conducting quizzes, other websites help you to create content as well. Mentimeter and Padlet have pre-designed tests and content that make the instructors' life easier. ExamSoft provides a platform that enables the instructor to administer tests easily. More importantly, it provides a detailed assessment tool for the instructors to evaluate learning progress, quality of the exam questions, and even the curriculum. The same services exist for students to follow their progress and find the concepts that need more attention.

2.7 *Video Conferencing Tools*

We are writing this book in a time when COVID-19 forced us to stay at home. It has been three months now. Halfway through the Spring 2020 semester, almost all universities canceled all physical in-person classrooms and moved online. One significant help that enables them to do so was the video conferencing tools. With these technologies, you can experience a virtual classroom, present from your slides, use a blackboard, talk with your students. Most of these technologies need personal computers, with smartphone applications that can support the essential functions. Zoom, Skype, Slack, and Join Me are among the most used applications for these purposes.

2.8 *Add-on*

There are plenty of add-ons that can be combined with Google and Microsoft products that help you to conduct quizzes or collect students' responses. For example, Pear Deck can be added to Google Slides or Microsoft PowerPoint and engage the student with the class environment or students in remote or online sessions with the materials. There are other types of add-on for your browser or as a separate software that enables you to send videos for your students and colleagues, e.g., Loom.

Chapter 3

Application-Based Technology

Students tend to be easily distracted in the classroom environment, and instructors need to engage students with a variety of content in terms of content and presentation. Technologies provide a menu of choices for the instructors. Improvement in communication technology made everyone buy a smartphone, and no matter how much you are against the use of smartphones in the class environment, you cannot deny that it made a wide variety of learning content and procedures almost free. Application-based technologies are those technologies that are best or most delivered by smartphone applications. As we mentioned before, almost always, you can use your personal computer or tablets to receive the same services as well.

3.1 *Assessment and Engagement*

Some application-based technologies can be used for assessment, playing games, and sharing learning content. For example, if you need to play a game with students or conduct a short quiz every session. Or if you want to assign a challenge that keeps students engaged at the dorm. Ask your students to download Kahoot on their phone and create quizzes or assign a project for home. You have the option to use the pre-designed games, a question bank, duplicate your existing course, add media contents to your course, and many other cool features. Reporting and analyzing students' performance, collaborating with other Kahoot users, and a very good content management system are some of Kahoot's advantages.

Top Hat is another application for taking exams and quiz from students and creating homework for the class. It could also be integrated with the LMS systems and provide assessment feedback for the instructors as well. As an online attendance and quiz taker, Top Hat has Acadly, Turning Technologies, Echo360, Qwizdom, Ombea, Class Question, Socrative, and Arsnova as alternatives.

Quizlet summarizes the course for students, and either instructors or students can contribute to making the class content. Although this method's effectiveness depends on the contents and student-specific learning characteristics, more and more content is being developed for these types of content. Brainscape, Course Hero, Anki, GoConqr, StudyStack, and Flashcard Machine are among Quizlet's rivals on the market.

3.2 *Communication*

Other applications are designed for communication, group activity, and sharing content. For example, you can create a GroupMe for your class, and students can share notes with each other or ask simple questions regarding the class materials or due dates. It only needs a phone number, and like any other application, you are instantly in touch with all of your students. Moreover, it is a very efficient way for your students to find peers and create a study group. Moreover, some of its features do not need continuous access to the internet either. For texting, you do not even need a smartphone. Thus,

with a bare minimum of a phone, you have access to all of your students, and they have a continuous connection with each other.

Another useful application for connecting a group of people for collaboration and content sharing is the Band application. Other than communication, it has the feature of highlighting important messages by showing them at the top of the board, notifying members on the importance of a message or a specific date, monitoring the readers (or as they phrase it, "keeping members accountable,") and many other features.

Some applications are designed for creating content in multimedia format in the educational environment. Flipgrid, for example, was designed by Microsoft to create videos. There are quite a few other applications that can be used for communication in text, voice, and video, sharing content in different formats, and direct calls between members. Discord, Whatsapp, and Telegram are among them, and one can find a dozen more on the internet as well.

Instrument-Based Technology

With all these smartphone applications, it seems an old idea to ask students to buy an extra device for class communication. However, instrument-based technologies are still in use, and universities support instructors in using these devices. One advantage of these instruments is your confidence in their accuracy when using them as a tool to monitor class participation.

3.3 *Iclicker*

Instructors usually use Iclicker to monitor class participation or conduct multiple-choice quizzes in the class. The new version of Iclicker has a keypad, and students can submit verbal answers as well. Moreover, instructors can give the students the option to use smartphone applications, which makes the technology cheaper.

Chapter 4

Summary

This chapter explains the opportunities and challenges regarding technology integration in the classroom. The need for modern classrooms where the instructor and the students utilize new technologies is unquestionable. Developing digital skills, improving learning content, incorporating various educational sources, increasing engagement, accessibility, and inclusion, and overcoming cultural barriers are among the most important benefits of integrating technology into the classroom. However, there are many challenges along the way, such as creating opportunities for distraction, lack of technical support, and drastic technological advancement. Successful technology integration requires a dynamic process that mainly focuses on instruction objectives. We introduce and characterize many technologies that can help instructors adapt to the new technology-integrated teaching environment, summarized in Table 1. In the end, each instructor needs to answer a few questions to determine how to use the knowledge she gathered from this chapter.

Reflection questions

How technology can help me to achieve my goals?

What kinds of technology do I want to use?

What is the appropriate level of technology integration for my class?

How I want to assess my technology integration at the end of the semester to fine tune my strategies in the future?

Answering these questions and a few more questions that she can add, depending on the specific context, enable the instructor to use the technology at its best capacity.

Diversity Pop-In

How to Address in Syllabi

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Table 1.
Table 1: Characterizing Technologies
Pricing
Content Sharing
Assessment
Communication
Free
Options
Multimedi
Other formats
Multiple choice
Verbal
Individual
Group
Web-Based
Canvas

Blackboard

Moodle

Google Classroom

Google Components

Polls Everywhere

Mentimeter

Padlet

ExamSoft

Zoom

Skype

Slack

Join Me

Pear Deck

Loom

Application-Based
Kahoot

Top Hat

Quizlet

GroupMe

Band

Flipgrid

Discord

Whatsapp

Telegram

Instrument-Based
Iclicker

Probability
Author(s)

Dan Osherson
Prerequisites
None
Learning Objectives

1. Define symmetrical outcomes
2. Distinguish between frequentist and subjective approaches
3. Determine whether the frequentist or subjective approach is better suited for a given situation

Introduction to Probability Standard

Inferential statistics[1] is built on the foundation of probability theory, and has been remarkably successful in guiding opinion about the conclusions to be drawn from data. Yet (paradoxically) the very idea of probability has been plagued by controversy from the beginning of the subject to the present day. In this section we provide a glimpse of the debate about the interpretation of the probability concept.

One conception of probability is drawn from the idea of **symmetrical outcomes**. For example, the two possible outcomes of tossing a fair coin seem not to be distinguishable in any way that affects which side will land up or down. Therefore the probability of heads is taken to be 1/2, as is the probability of tails. In general, if there are N symmetrical outcomes, the probability of any given one of them occurring is taken to be 1/N. Thus, if a six-sided die is rolled, the probability of any one of the six sides coming up is 1/6.

Probabilities can also be thought of in terms of **relative frequencies**. If we tossed a coin millions of times, we would expect the proportion of tosses that came up heads to be pretty close to 1/2. As the number of tosses increases, the proportion of heads approaches 1/2. Therefore, we can say that the probability of a head is 1/2.

If it has rained in Seattle on 62% of the last 100,000 days, then the probability of it raining tomorrow might be taken to be 0.62. This is a natural idea but nonetheless unreasonable if we have further information relevant to whether it will rain tomorrow. For example, if tomorrow is August 1, a day of the year on which it seldom rains in Seattle, we should only consider the percentage of the time it rained on August 1. But even this is not enough since the probability of rain on the next August 1 depends on the humidity. (The chances are higher in the presence of high humidity.) So, we should consult only the prior occurrences of August 1 that had the same humidity as the next occurrence of August 1. Of course, wind direction also affects probability ... You can see that our sample of prior cases will soon be reduced to the empty set. Anyway, past meteorological history is misleading if the climate is changing.

4.0.1 Review Questions

Select all that apply. Probability can be thought of as:

- symmetrical outcomes
- relative frequencies
- subjective

The paper says there is an 80% chance of rain today, so you plan indoor activities. Then it doesn't rain. Was the forecast wrong?

- yes
- no

[1] The branch of statistics concerned with drawing conclusions about a population from a sample. This is generally done through random sampling, followed by inferences made about central tendency, or any of a number of other aspects of a distribution.

Chapter 5

Binomial Distribution

Author(s)
David M. Lane
Prerequisites
Distributions, Basic Probability, Variability
Learning Objectives

1. Define binomial outcomes
2. Compute the probability of getting X successes in N trials
3. Compute cumulative binomial probabilities
4. Find the mean and standard deviation of a binomial distribution

When you flip a coin, there are two possible outcomes: heads and tails. Each outcome has a fixed probability, the same from trial to trial. In the case of coins, heads and tails each have the same probability of 1/2. More generally, there are situations in which the coin is biased, so that heads and tails have different probabilities. In the present section, we consider probability distributions for which there are just two possible outcomes with fixed probabilities summing to one. These distributions are called binomial distributions.

5.1 A Simple Example

The four possible outcomes that could occur if you flipped a coin twice are listed below in Table 1. Note that the four outcomes are equally likely: each has probability 1/4. To see this, note that the tosses of the coin are independent (neither affects the other). Hence, the probability of a head on Flip 1 and a head on Flip 2 is the product of P(H) and P(H), which is 1/2 x 1/2 = 1/4. The same calculation applies to the probability of a head on Flip 1 and a tail on Flip 2. Each is 1/2 x 1/2 = 1/4.

Table 1. Four Possible Outcomes.

Outcome	First Flip	Second Flip
1	Heads	Heads
2	Heads	Tails
3	Tails	Heads
4	Tails	Tails

The four possible outcomes can be classified in terms of the number of heads that come up. The number could be two (Outcome 1), one (Outcomes 2 and 3) or 0 (Outcome 4). The probabilities of these possibilities are shown in Table 2 and in Figure 1. Since two of the outcomes represent the case in which just one head appears in the two tosses, the probability of this event is equal to 1/4 + 1/4 = 1/2. Table 2 summarizes the situation.

Table 2. Probabilities of Getting 0, 1, or 2 Heads.

Number of Heads	Probability
0	1/4
1	1/2
2	1/4

Figure 1. Probabilities of 0, 1, and 2 heads.

Figure 1 is a discrete probability distribution: It shows the probability for each of the values on the X-axis. Defining a head as a "success," Figure 1 shows the probability of 0, 1, and 2 successes for two trials (flips) for an event that has a probability of 0.5 of being a success on each trial. This makes Figure 1 an example of a binomial distribution.

5.2 The Formula for Binomial Probabilities

The binomial distribution consists of the probabilities of each of the possible numbers of successes on N trials for independent events that each have a probability of (the Greek letter pi) of occurring. For the coin flip example, N = 2 and = 0.5. The formula for the binomial distribution is shown below:

where P(x) is the probability of x successes out of N trials, N is the number of trials, and is the probability of success on a given trial. Applying this to the coin flip example,

If you flip a coin twice, what is the probability of getting one or more heads? Since the probability of getting exactly one head is 0.50 and the probability of getting exactly two heads is 0.25, the probability of getting one or more heads is 0.50 + 0.25 = 0.75.

Now suppose that the coin is biased. The probability of heads is only 0.4. What is the probability of getting heads at least once in two tosses? Substituting into the general formula above, you should obtain the answer .64.

5.3 Mean and Standard Deviation of Binomial Distributions

Consider a coin-tossing experiment in which you tossed a coin 12 times and recorded the number of heads. If you performed this experiment over and over again, what would the mean number of heads be? On average, you would expect half the coin tosses to come up heads. Therefore the mean number of heads would be 6. In general, the mean of a binomial distribution with parameters N (the number of trials) and (the probability of success on each trial) is:

= N

where is the mean of the binomial distribution. The variance of the binomial distribution is:

^{2} = N (1-)

where ^{2} is the variance of the binomial distribution.

Let's return to the coin-tossing experiment. The coin was tossed 12 times, so N = 12. A coin has a probability of 0.5 of coming up heads. Therefore, = 0.5. The mean and variance can therefore be computed as follows:

= N = (12)(0.5) = 6

^{2} = N (1-) = (12)(0.5)(1.0 - 0.5) = 3.0.

Naturally, the standard deviation ( ) is the square root of the variance (^{2}).

Chapter 6

Example Chapter

Author *Affiliation* Email: email@domain.edu

Learning Objectives

1. item
2. item
3. item

6.1 Introduction

Soup cranberry spritzer edamame hummus figs tomato and basil Bolivian rainbow pepper chili pepper vine tomatoes ultimate avocado dressing drizzle summer fruit salad. Peanut butter crunch coconut dill plums morning smoothie bowl strawberries spiced peppermint blast crunchy seaweed mangos green tea. Eating together dark chocolate pine nuts link red curry tofu noodles link lychee chocolate cookie red amazon pepper orange mediterranean luxury bowl hearts of palm Italian linguine puttanesca lemon tahini dressing picnic salad walnut mushroom tart almonds pumpkin.

6.1.1 Subsection

Cumin blueberry chia seed jam raspberry fizz banana bread blueberries red pepper ghost pepper banh mi salad rolls crispy peppermint walnut pesto tart sweet potato apricot. Cilantro lime vinaigrette link salad mushroom risotto green pepper summer soy milk falafel bites Bulgarian [@gravitation] carrot ultra creamy avocado pesto kimchi oranges cinnamon toast artichoke hearts enchiladas kale alfalfa sprouts muffins chocolate avocado onion.

Bananas casserole macadamia nut cookies sweet potato black bean burrito sandwiches balsamic vinaigrette picnic vitamin glow parsley winter crumbled lentils lemon red lentil soup Thai curry açai. Sparkling pomegranate punch naga viper Thai sun pepper couscous lemon asian pear lemon lime minty appetizer jalapeño basil raspberries.

Term 1 Definition 1

Term 2 Definition 2

6.2 Methods

Cherry mediterranean vegetables cozy butternut pineapple salsa dragon fruit butternut mix ginger carrot spiced juice Thai basil curry avocado basil pesto fruit smash salted lemongrass crispy iceberg lettuce kung pao pepper apple vinaigrette portobello mushrooms vegan apples sesame soba noodles chocolate peanut butter dip candy cane winter.

- cool Thai super
- chili maple orange
- tempeh basmati

Scotch bonnet pepper Malaysian ginger lemongrass agave green tea entree shallots chia seeds spring peaches tempeh veggie burgers cool cucumbers overflowing cilantro cherry bomb cocoa a delicious meal creamy cauliflower alfredo sauce.

> Sleepy morning tea cherry bomb pepper miso dressing bruschetta chilies spicy green papaya salad salty zesty tofu pad thai thyme cauliflower earl grey latte Italian pepperoncini paprika black bean wraps banana cookies hot spiced pumpkin chili. Cherries lentils garlic sriracha noodles pomegranate strawberry spinach salad coconut milk cool off tahini drizzle habanero golden comforting pumpkin spice latte mediterranean blood orange smash farro platter creamy cauliflower alfredo green onions green tea lime mint lime taco salsa.

6.2.1 Cross references

These cross references are disabled by default. To enable them, check the *Cross references* section on the README.md file.

Here's a list of cross references:

- Check fig. 1.1.
- Check tbl. 1.1.
- Check eq. 1.1.

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