

This is a section of [doi:10.7551/mitpress/11209.001.0001](https://doi.org/10.7551/mitpress/11209.001.0001)

# Teaching Computational Thinking

## An Integrative Approach for Middle and High School Learning

By: Maureen D. Neumann, Lisa Dion

### Citation:

*Teaching Computational Thinking: An Integrative Approach for Middle and High School Learning*

By: Maureen D. Neumann, Lisa Dion

DOI: 10.7551/mitpress/11209.001.0001

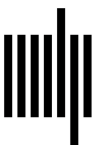
ISBN (electronic): 9780262366144

Publisher: The MIT Press

Published: 2021

### OA Funding Provided By:

The open access edition of this book was made possible by generous funding from Arcadia—a charitable fund of Lisbet Rausing and Peter Baldwin.



The MIT Press

---

## Notes

### Chapter 2

1. At the time of this writing, Codesters is free for teachers but requires payment to create a “classroom” for students to access.

### Chapter 3

1. The information about Conway’s Game of Life is from [http://www.conwaylife.com/wiki/Conway's\\_Game\\_of\\_Life](http://www.conwaylife.com/wiki/Conway's_Game_of_Life).

### Chapter 4

1. These myths are recounted in Plutarch’s *Theseus* and Ovid’s *Metamorphoses*.

2. It has twelve roofed courts, with doors facing one another, six to the north and six to the south and in a continuous line. One wall on the outside encompasses them all. There are double sets of chambers in it, some underground and some above, and their number is three thousand; there are fifteen hundred of each. We ourselves saw the aboveground chambers, for we went through them and so can talk of them, but the underground chambers we can speak of only from hearsay. For the officials of the Egyptians entirely refused to show us these, saying that there were, in them, the coffins of the kings who had built the labyrinth at the beginning and also those of the holy crocodiles. So we speak from hearsay of these underground places; but what we saw above ground was certainly greater than all human works. The passages through the rooms and the winding goings-in and out through the courts, in their extreme complication, caused us countless marvelings as we went through, from the court into the rooms, and from the rooms into the pillared corridors, and then from these corridors into other rooms again, and from the rooms into other courts afterwards.

—Herodotus (1987, book II, §148)

3. Matthews (1922) is available online via Project Gutenberg: <http://www.gutenberg.org/ebooks/46238>.

4. A related exercise is the “telephone challenge,” in which two students are connected by telephone or alternatively seated back-to-back. One student, let’s call her Alice, looks at a simple design, perhaps figure 4.1; the other student, let’s call him Bob, holds a pencil and a sheet of unruled paper. Using only verbal cues, Alice must get Bob to draw a faithful replica of the design she is viewing.

5. The medial axis is an upwardly directed ray that emanates from the center of the cross.

6. This is essentially the definition of what is known as *algorithmic complexity*.
7. Doob (1990, chap. 8) suggests that the *entire* work is designed as a literary labyrinth on many levels; for example, the “circuitous wanderings” of Aeneas and his party through the Mediterranean Sea mirror the twists and turns of a labyrinth.
8. Computer scientists usually include 0 in the natural numbers, which mathematicians sometimes exclude.
9. Interestingly, decimal numbers can also be thought of as lists; for example, 123 represents the value  $3 + 20 + 100$ , which can be associated with the list (3, 2, 1).

## Chapter 5

1. This equation is from <http://www.sciencecalculators.org/mechanics/collisions/>.

## Chapter 6

1. On global warming, see US National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC), <http://www.ncdc.noaa.gov/cdo-web/>, last accessed February 1, 2020.
2. On species extinction, see IUCN, *The IUCN Red List of Threatened Species*, <https://www.iucnredlist.org>, last accessed February 1, 2020.
3. On immigration trends, see Department of Homeland Security, *Immigration Data and Statistics*, <http://www.dhs.gov/immigration-statistics>, last accessed February 1, 2020.
4. On school funding, see US Census Bureau, *Public Education Funding: 2017 Public Elementary–Secondary Education Finance Data*, <https://census.gov/data/tables.html>, last accessed February 1, 2020. You can go to <https://www.census.gov> and <https://www.census.gov/data.html> to gather data on various topics related to census questions.
5. On gun violence in the United States, see Centers for Disease Control and Prevention, Web-Based Injury Statistics Query and Reporting System (WISQARS), *Fatal and Nonfatal Injury Data*, <https://www.cdc.gov/injury/wisqars>, last accessed February 1, 2020.
6. On food insecurity, see US Department of Agriculture, USDA Economic Research Service, *Food Security in the US*, <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/>, last accessed February 1, 2020.
7. On the spread of infectious diseases and other health-related issues, see Centers for Disease Control, Data and Statistics, <https://www.cdc.gov/DataStatistics/>, last accessed February 1, 2020.
8. On wealth distribution, see US Census Bureau, *Small Area Income and Poverty Estimates*, <https://www.census.gov/programs-surveys/saipe/data/datasets.html>, last accessed February 1, 2020.
9. See Mapping Police Violence, database download, <https://mappingpoliceviolence.org/MPVDatasetDownload.xlsx>, last accessed February 1, 2020.
10. US Census Bureau, American Fact Finder, <https://factfinder.census.gov/faces/tableservices/jsp/pages/productview.xhtml?src=bkmk>, last accessed February 1, 2020.
11. FBI, Uniform Crime Reporting, *Table 1: Crime in the United States by Volume and Rate per 100,000 Inhabitants, 1999–2018*, <https://ucr.fbi.gov/crime-in-the-u.s/2018/crime-in-the-u.s.-2018/topic-pages/tables/table-1>, last accessed February 1, 2020.

12. We have 78 years because the data from the weather station we chose in Burlington, Vermont, is not available before December 1940. You may want to include a different time frame if more data is available from your location.

13. If you are using Safari as a web browser, it may not let you download it as a .csv file, so you may need to use another web browser, such as Google Chrome or Firefox, when you click the link that NCDC sends you.

14. One note about this (for our dataset) is that the years start at 1940, so that can influence the curvature. We recommend changing the `years` argument in this line to `range(len(years))` to have it start counting at 0 instead of 1940. This change is also needed when the  $y$  values are calculated inside the `for` loop, so that the data remains consistent.

## Chapter 7

1. To read more about this installation, see <https://www.facebook.com/GeneratorVT/videos/monets-garden-created-and-coded-by-mt-abraham-union-middle-school-with-generator/805713946294145/>.



© 2021 Massachusetts Institute of Technology

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.

The MIT Press would like to thank the anonymous peer reviewers who provided comments on drafts of this book. The generous work of academic experts is essential for establishing the authority and quality of our publications. We acknowledge with gratitude the contributions of these otherwise uncredited readers.

This book was set in Stone Serif and Stone Sans by Westchester Publishing Services.

Library of Congress Cataloging-in-Publication Data

Names: Neumann, Maureen D., author. | Dion, Lisa (Computer scientist), author.

Title: Teaching computational thinking : an integrative approach for middle and high school learning / Maureen D. Neumann and Lisa Dion with Robert Snapp.

Description: Cambridge, Massachusetts : The MIT Press, 2021. | Includes bibliographical references.

Identifiers: LCCN 2021000766 | ISBN 9780262045056 (paperback)

Subjects: LCSH: Computer science—Study and teaching (Secondary) | Critical thinking—Study and teaching (Secondary)

Classification: LCC QA76.27 .N474 2021 | DDC 004.071—dc23

LC record available at <https://lcn.loc.gov/2021000766>