PS 18 — Rania 4/18/25

8/8

Due to getting a little behind in the final two weeks of the semester, I only checked for completeness on PS 18-21.
~Brian

Section 41

```
In[∘]:= (*41.1 Find the list of digits for squares of numbers
         less than 100 that contain successive repeated digits.*)
        Cases[IntegerDigits[Range[100]^2], {___, x_, x_, ___}]
Out[∘]=
        {{1, 0, 0}, {1, 4, 4}, {2, 2, 5}, {4, 0, 0}, {4, 4, 1}, {9, 0, 0}, {1, 1, 5, 6},
         {1, 2, 2, 5}, {1, 4, 4, 4}, {1, 6, 0, 0}, {2, 1, 1, 6}, {2, 2, 0, 9},
         {2, 5, 0, 0}, {3, 3, 6, 4}, {3, 6, 0, 0}, {3, 8, 4, 4}, {4, 2, 2, 5},
         {4, 4, 8, 9}, {4, 9, 0, 0}, {5, 7, 7, 6}, {6, 4, 0, 0}, {6, 8, 8, 9},
         {7, 2, 2, 5}, {7, 7, 4, 4}, {8, 1, 0, 0}, {8, 8, 3, 6}, {1, 0, 0, 0, 0}}
```

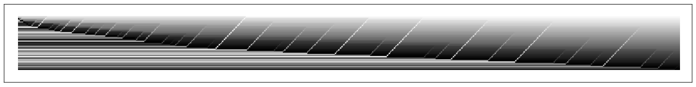
```
In[∘]:= (*41.2 In the first 100 Roman numerals,
        find those containing L,I and X in that order.*)
        Cases[Characters[RomanNumeral[Range[100]]], {___, "L", ___, "I", ___, "X", ___}]
Out[∘]=
        {{X, L, I, X}, {L, I, X}, {L, X, I, X}, {L, X, X, I, X}, {L, X, X, X, I, X}}
```

```
In[∘]:= (*41.3 Define a function f that tests whether
         a list of integers is the same as its reverse.*)
        f[list_] := IntegerDigits[list] == Reverse[IntegerDigits[list]]
        f[{232}]
Out[∘]=
        True
```

```
In[∘]:= (*41.4 Get a list of pairs of successive words in the Wikipedia
         article on alliteration that have identical first letters.*)
        Cases[Partition[TextWords[WikipediaData["alliteration"]], 2, 1],
         {a_, b_} /; StringTake[a, 1] == StringTake[b, 1]]
Out[∘]=
        {{or, of}, {as, a}, {Peter, Piper}, {pickled, peppers}, {Irish, It},
{as, an}, {ideas, in}, {Icelandic, It}, {cartoon, characters}, {the, term},
{identical, initial}, {several, special}, {as, alliteration}, {stressed, syllables},
{as, an}, {lazy, languid}, {languid, line}, {as, alliteration}, {be, because},
{such, syllables}, {syllables, start}, {consonant, clusters}, {sp, st},
{consonant, clusters}, {s, sound}, {consonant, cluster}, {cluster, can},
{with, words}, {consonant, cluster}, {s, such}, {sp, st}, {Walt, Whitman},
{Splendid, Silent}, {Silent, Sun}, {consonant, clusters}, {sp, st},
{spit, sting}, {stick, skin}, {consonant, clusters}, {s, seems}, {same, source},
{consonant, clusters}, {to, the}, {the, two}, {identical, in}, {at, any},
{home, hot}, {as, a}, {stressed, syllable}, {humble, house}, {potential, power},
{power, play}, {play, picture}, {picture, perfect}, {money, matters}, {rocky, road},
{quick, question}, {Peter, Piper}, {pickled, peppers}, {of, outside}, {same, sound},
{of, outside}, {to, the}, {brown, blazers}, {in, its}, {Poetry, Poets}, {can, call},
{splendid, silent}, {silent, sun}, {Walt, Whitman}, {Splendid, Silent},
{Silent, Sun}, {wondered, what}, {his, horse}, {also, add}, {to, the},
{harsh, hard}, {they, than}, {slippered, sleep}, {lean, lithe}, {fleet, flown},
{E., E.}, {heaped, heartbreak}, {fire, forthrightly}, {Chappell, Chestnuts},
{finally, finding}, {Finch, Fresh-firecoal}, {plotted, pieced}, {fold, fallow},
{height, hangs}, {hangs, his}, {who, wanders}, {barred, by}, {Who, Wanders},
{I, In}, {sat, silent}, {We, Were}, {swart, ship}, {with, weeping}, {out, onward},
{out, of}, {to, the}, {sun, sword}, {axe, angles}, {hell's, handiwork},
{silken, sad}, {breeze, blew}, {foam, flew}, {furrow, followed}, {followed, free},
{stood, still}, {churlish, chiding}, {winter's, wind}, {brown, below},
{harvests, hang}, {heavy, head}, {Brent, Bernard}, {who, watch}, {watch, with},
{with, wild}, {wild, wonder}, {wide, window}, {beautiful, birds}, {birds, begin},
{bountiful, birdseed}, {Thurston, Three}, {grey, geese}, {Grey, Geese},
{Betty, Botter}, {butter, but}, {she, said}, {butter's, bitter}, {it, in},
{make, my}, {batter, bitter}, {bitter, but}, {better, butter}, {make, my},
{bitter, batter}, {batter, better}, {the, tongue-twister}, {Betty, Botter},
{Peter, Piper}, {pickled, peppers}, {Peter, Piper}, {pickled, peppers},
{pickled, peppers}, {Peter, Piper}, {Helplessly, Hoping}, {throughout, the},
{stand, still}, {stood, still}, {Fairyland, Fanfare}, {legend, live},
{live, life}, {all, alone}, {to, the}, {lunar, lure}, {lacking, lustre},
{late, last}, {as, an}, {an, artistic}, {emotional, effect}, {any, attitude},
{is, in}, {as, an}, {which, we}, {our, only}, {of, our}, {our, own}, {but, by},
{today, that}, {that, the}, {truths, that}, {is, inextricably}, {to, the},
{itself, is}, {testimony, to}, {to, the}, {have, had}, {because, brave},
{freedom's, front}, {Ronald, Reagan}, {Vietnam, Veterans}, {new, nation}, {to, the},
{portae, proficiscere}, {blonde, bad-built}, {bad-built, butch}, {butch, body},
{and, adds}, {adds, an}, {an, alliterative}, {Μάρθα, Μάρθα}, {Martha, Martha},
{Martha, Martha}, {House, Handbook}, {Modern, Memory}, {to, the}, {Some, Suggestive},
{4, 438}, {438, 45}, {E, E}, {55, 5}, {388, 390}, {Indolence, ISBN},
{R, R}, {alliteration, and}, {and, alliterative}, {alliterations, and}}
```

```
In[∘]:= (*41.5 Use Grid to show the sorting process in this section for {4,5,1,3,2},
        with successive steps going down the page.*)list = {4, 5, 1, 3, 2};
        Grid[NestList[(# /. {x___, b_, a_, y___} /; b > a → {x, a, b, y}) &, {4, 5, 1, 3, 2}, 10]]
Out[∘]=
        4 5 1 3 2
        4 1 5 3 2
        1 4 5 3 2
        1 4 3 5 2
        1 3 4 5 2
        1 3 4 2 5
        1 3 2 4 5
        1 2 3 4 5
        1 2 3 4 5
        1 2 3 4 5
        1 2 3 4 5
```

```
In[∘]:= (*41.6 Use ArrayPlot to show the sorting
         process in this section for a list of length 50,
        with successive steps going across the page.*)ArrayPlot[Transpose[FixedPointList[
           (# /. {x___, b_, a_, y___} /; b > a → {x, a, b, y}) &, RandomSample[Range[50]]]]]
Out[∘]=
```



```
In[∘]:= (*41.7 Start with 1.0,then repeatedly apply the “Newton’s method”
           function (#+2/#)/2& until the result
         no longer changes.*)FixedPointList[(# + 2 / #) / 2 &, 1.0]
Out[∘]=
        {1., 1.5, 1.41667, 1.41422, 1.41421, 1.41421, 1.41421}
```

```
In[∘]:= (*41.8 Implement Euclid’s algorithm for GCD in which {a,b} is repeatedly replaced
         by {b,Mod[a,b]} until b is 0,and apply the algorithm to 12345,54321.*)
        FixedPointList[# /. {a_, b_} /; b ≠ 0 → {b, Mod[a, b]} &, {12 345, 54 321}]
Out[∘]=
        {{12 345, 54 321}, {54 321, 12 345}, {12 345, 4941},
         {4941, 2463}, {2463, 15}, {15, 3}, {3, 0}, {3, 0}}
```

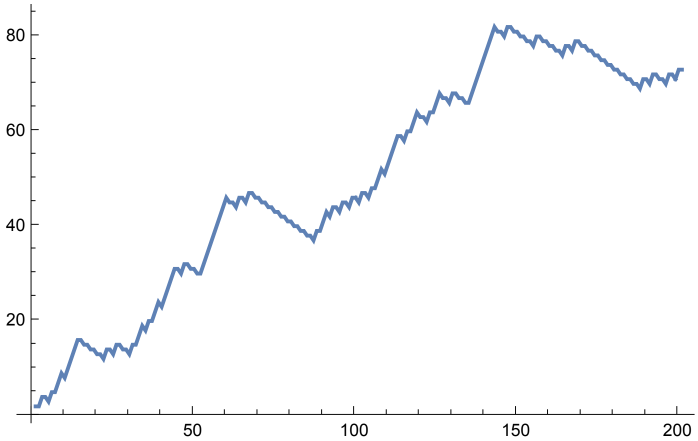
```
In[•]:= (*41.19 Define combinators using the rules s[x_][y_][z_]→x[z][y[z]],
        k[x_][y_]→x,then generate a list by starting with
         s[s][k][s[s[s]][s]][s] and applying these rules until nothing changes*)
        FixedPointList[
         # /. {s[x_][y_][z_] → x[z][y[z]], k[x_][y_] → x} &, s[s][k][s[s[s]][s]][s]]
Out[•]=
        {s[s][k][s[s[s]][s]][s], s[s[s[s]][s]][k[s[s[s]][s]]][s],
         s[s[s]][s][s][k[s[s[s]][s]][s]], s[s][s][s[s]][s[s[s]][s]],
         s[s[s]][s[s[s]]][s[s[s]][s]], s[s][s[s[s]][s]][s[s[s]][s[s[s]][s]]],
         s[s[s[s]][s[s[s]][s]]][s[s[s]][s][s[s[s]][s[s[s]][s]]]],
         s[s[s[s]][s[s[s]][s]]][s[s][s[s[s]][s[s[s]][s]]][s[s[s[s]][s[s[s]][s]]]]],
         s[s[s[s]][s[s[s]][s]]][
          s[s[s[s[s]][s[s[s]][s]]]][s[s[s]][s[s[s]][s]][s[s[s[s]][s[s[s]][s]]]]]],
         s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]][s[s][s[s[s[s]][s[s[s]][s]]]][
            s[s[s]][s][s[s[s[s]][s[s[s]][s]]]]]]], s[s[s[s]][s[s[s]][s]]][
          s[s[s[s[s]][s[s[s]][s]]]][s[s[s[s]][s][s[s[s[s]][s[s[s]][s]]]]]][
            s[s[s[s]][s[s[s]][s]]][s[s[s]][s][s[s[s[s]][s[s[s]][s]]]]]]]],
         s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]][
           s[s[s][s[s[s[s]][s[s[s]][s]]]][s[s[s[s[s]][s[s[s]][s]]]]]][s[s[s[s]][
              s[s[s]][s]]][s[s][s[s[s[s]][s[s[s]][s]]]][s[s[s[s[s]][s[s[s]][s]]]]]]]]],
         s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]][s[s[s[s[s[s[s]][s[s[s]][s]]]]][
              s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]]]][
            s[s[s[s]][s[s[s]][s]]][s[s[s[s[s[s]][s[s[s]][s]]]]][
              s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]]]]]]],
         s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]][s[s[s[s[s[s[s]][s[s[s]][s]]]]][
              s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]]]][
            s[s[s[s]][s[s[s]][s]]][s[s[s[s[s[s]][s[s[s]][s]]]]][
              s[s[s[s]][s[s[s]][s]]][s[s[s[s[s]][s[s[s]][s]]]]]]]]]}

In[•]:= (*41.10 Remove all trailing 0’s from the digit list for 100!*)
        IntegerDigits[100 !] /. {x___, 0 ..} → {x}
Out[•]=
        {9, 3, 3, 2, 6, 2, 1, 5, 4, 4, 3, 9, 4, 4, 1, 5, 2, 6, 8, 1, 6, 9, 9, 2, 3, 8,
         8, 5, 6, 2, 6, 6, 7, 0, 0, 4, 9, 0, 7, 1, 5, 9, 6, 8, 2, 6, 4, 3, 8, 1, 6, 2, 1,
         4, 6, 8, 5, 9, 2, 9, 6, 3, 8, 9, 5, 2, 1, 7, 5, 9, 9, 9, 9, 3, 2, 2, 9, 9, 1, 5,
         6, 0, 8, 9, 4, 1, 4, 6, 3, 9, 7, 6, 1, 5, 6, 5, 1, 8, 2, 8, 6, 2, 5, 3, 6, 9, 7,
         9, 2, 0, 8, 2, 7, 2, 2, 3, 7, 5, 8, 2, 5, 1, 1, 8, 5, 2, 1, 0, 9, 1, 6, 8, 6, 4}
```

```
In[∘]:= (*41.11 Start from {1,0} then for 200
         steps repeatedly remove the first 2 elements,
        and append {0,1} if the first element is 1 and {1,0,0} if it is 0 and
         get a list of the lengths of the sequences produced (tag system).*)
        Length /@
         NestList[# /. {{1, _, x___} → {x, 0, 1}, {0, _, x___} → {x, 1, 0, 0}} &, {1, 0}, 200]
```

```
Out[∘]=
        {2, 2, 3, 3, 4, 4, 5, 6, 6, 7, 8, 9, 9, 10, 11, 11, 12, 12, 13, 13, 14, 14, 15, 16, 16, 17,
         17, 18, 19, 19, 20, 21, 22, 22, 23, 23, 24, 24, 25, 25, 26, 26, 27, 28, 29, 29, 30,
         30, 31, 32, 32, 33, 33, 34, 35, 35, 36, 37, 37, 38, 38, 39, 40, 40, 41, 42, 43, 43,
         44, 44, 45, 45, 46, 46, 47, 47, 48, 48, 49, 50, 50, 51, 52, 53, 53, 54, 55, 55, 56,
         56, 57, 58, 58, 59, 59, 60, 61, 61, 62, 62, 63, 64, 64, 65, 66, 67, 67, 68, 69, 69,
         70, 70, 71, 71, 72, 72, 73, 74, 74, 75, 76, 77, 77, 78, 78, 79, 79, 80, 80, 81, 82,
         82, 83, 84, 85, 85, 86, 87, 87, 88, 88, 89, 89, 90, 90, 91, 92, 92, 93, 93, 94, 95,
         95, 96, 97, 98, 98, 99, 100, 100, 101, 101, 102, 103, 103, 104, 104, 105, 106,
         106, 107, 108, 109, 109, 110, 111, 111, 112, 112, 113, 113, 114, 114, 115, 116,
         116, 117, 117, 118, 119, 119, 120, 121, 122, 122, 123, 123, 124, 124, 125, 125}
```

```
In[∘]:= (*41.12 Start from {0,0} then for 200 steps repeatedly remove
         the first 2 elements,and append {2,1} if the first element is 0,
        {0} if the first element is 1,and {0,2,1,2} if it is 2,
        and make a line plot of the lengths of the sequences produced (tag system)*)
        ListLinePlot[Length /@ NestList[# /. {{0, _, x___} → {x, 2, 1},
              {1, _, x___} → {x, 0}, {2, _, x___} → {x, 0, 2, 1, 2}} &, {0, 0}, 200]]
```

Out[∘]=



Section 42

```
(*42.1 Replace each space in "1 2 3 4" with "---".*)
StringReplace["1 2 3 4", {" " → "---"}]
```

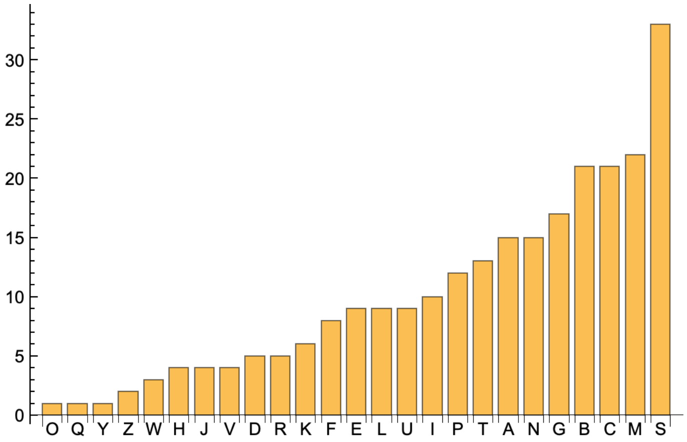
```
In[•]:= (*42.2 Get a sorted list of all sequences of 4 digits
         (representing possible dates) in the Wikipedia article on computers.*)
        Sort[StringCases[WikipediaData["Computers"],
          DigitCharacter ~~ DigitCharacter ~~ DigitCharacter ~~ DigitCharacter]]
Out[•]=
        {1000, 1235, 1357, 1357, 1595, 1613, 1620, 1630, 1640, 1770, 1822, 1831, 1833,
         1835, 1872, 1872, 1876, 1876, 1888, 1890, 1897, 1901, 1901, 1906, 1914, 1920,
         1920, 1925, 1927, 1930, 1934, 1936, 1936, 1937, 1937, 1938, 1939, 1940, 1941,
         1941, 1942, 1943, 1943, 1943, 1943, 1944, 1945, 1945, 1945, 1945, 1945, 1945,
         1947, 1947, 1947, 1948, 1948, 1949, 1950, 1950, 1950, 1950, 1950, 1951,
         1951, 1952, 1953, 1953, 1955, 1955, 1955, 1955, 1957, 1958, 1958, 1959,
         1959, 1960, 1962, 1964, 1967, 1968, 1970, 1970, 1970, 1970, 1990, 1998,
         2000, 2000, 2000, 2016, 2400, 2468, 4000, 4004, 5000, 5100, 6502, 6510}

        (*42.3 Extract “headings” in the Wikipedia article about computers,
        as indicated by strings starting and ending with "===".*)
        StringCases[WikipediaData["Computers"], Shortest["===" ~~ x___ ~~ "==="] → x]

In[•]:= (*42.4 Use a string template to make a grid of results of the form i+j=...
         for i and j up to 9*)
        Grid[Table[StringTemplate["`1`+`2`=`3`"][x, y, x + y], {x, 9}, {y, 9}]]
Out[•]=
         1+1=2  1+2=3  1+3=4  1+4=5  1+5=6  1+6=7  1+7=8  1+8=9  1+9=10
         2+1=3  2+2=4  2+3=5  2+4=6  2+5=7  2+6=8  2+7=9  2+8=10 2+9=11
         3+1=4  3+2=5  3+3=6  3+4=7  3+5=8  3+6=9  3+7=10 3+8=11 3+9=12
         4+1=5  4+2=6  4+3=7  4+4=8  4+5=9  4+6=10 4+7=11 4+8=12 4+9=13
         5+1=6  5+2=7  5+3=8  5+4=9  5+5=10 5+6=11 5+7=12 5+8=13 5+9=14
         6+1=7  6+2=8  6+3=9  6+4=10 6+5=11 6+6=12 6+7=13 6+8=14 6+9=15
         7+1=8  7+2=9  7+3=10 7+4=11 7+5=12 7+6=13 7+7=14 7+8=15 7+9=16
         8+1=9  8+2=10 8+3=11 8+4=12 8+5=13 8+6=14 8+7=15 8+8=16 8+9=17
        9+1=10 9+2=11 9+3=12 9+4=13 9+5=14 9+6=15 9+7=16 9+8=17 9+9=18

In[•]:= (*42.5 Find names of integers below
         50 that have an “i” somewhere before an “e”.*)
        Select[Table[IntegerName[x], {x, 50}],
         StringMatchQ[#, ___ ~~ "i" ~~ ___ ~~ "e" ~~ ___] &]
Out[•]=
        {five, nine, thirteen, fifteen, sixteen, eighteen, nineteen,
         twenty-five, twenty-nine, thirty-one, thirty-three, thirty-five,
         thirty-seven, thirty-eight, thirty-nine, forty-five, forty-nine}
```

In[∘]:=
```
(*42.6 Make any 2-letter word uppercase in the
  first sentence from the Wikipedia article on computers.*)
StringReplace[Last[TextSentences[WikipediaData["Computers"]]],
 x : (Whitespace ~~ LetterCharacter ~~ LetterCharacter ~~ Whitespace) :→ ToUpperCase[x]]
```

Out[∘]=
```
Media related TO Computers AT Wikimedia Commons
 Wikiversity has a quiz ON this article
```

In[∘]:=
```
(*42.7Make a labeled bar chart of the number of countries
 whose TextString names start with each possible letter.*)
BarChart[Sort[Counts[
   StringTake[TextString /@ EntityList[ all countries, dependencies, and territories COUNTRIES ],
    1]]], ChartLabels → Automatic]
```

Out[∘]=



In[∘]:=
```
(*42.8 Find simpler code for
 Grid[Table[StringJoin[TextString[i],"^",TextString[j],
     "=",TextString[i^j]],{i,5},{j,5}]].*)
Grid[Table[StringJoin[TextString[i], "^",
   TextString[j], "=", TextString[i^j]], {i, 5}, {j, 5}]]
```

Out[∘]=
```
1^1=1  1^2=1   1^3=1    1^4=1    1^5=1
2^1=2  2^2=4   2^3=8    2^4=16   2^5=32
3^1=3  3^2=9   3^3=27   3^4=81   3^5=243
4^1=4  4^2=16  4^3=64   4^4=256  4^5=1024
5^1=5  5^2=25  5^3=125  5^4=625  5^5=3125
```

In[∘]:=
```
Table[StringTemplate["`1`^`2`=`3`"][x, y, x^y], {x, 5}, {y, 5}] // Grid
```

Out[∘]=
```
1^1=1  1^2=1   1^3=1    1^4=1    1^5=1
2^1=2  2^2=4   2^3=8    2^4=16   2^5=32
3^1=3  3^2=9   3^3=27   3^4=81   3^5=243
4^1=4  4^2=16  4^3=64   4^4=256  4^5=1024
5^1=5  5^2=25  5^3=125  5^4=625  5^5=3125
```