Dynamic Data Structures: Hash Tables
Algorithms: Searching

ENGF0002: Design and Professional Skills

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Term 1, 2019

The builtin `dict` type.

The Python dictionary type provides a very efficient key-value store.

- the `dict` function takes a sequence of tuples and returns a dictionary mapping them as key values.
- There is a shorthand for dict literals, eg. `{k1:v1, k2:v2}`
- Get and set operations are as in minimap, eg. `m[k] = v` for set, and `m[k]` for get.
- the `len` function returns the number of items, and an iterator returns an unordered sequence of keys.

For a full list of operations see `https://docs.python.org/3.7/library/stdtypes.html#mapping-types-dict`.

Python `dict` example

```python
dict = {'Name': 'Mark', 'Age': 157, 'Course': 'ENGF0002'}
print("dict['Name']: ", dict['Name'])
print("dict['Age']: ", dict['Age'])

dict['Age'] = 158; # update existing entry
dict['Office'] = "MPEB 6.21"; # Add new entry
print("dict['Name']: ", dict['Name'])
print("dict['Age']: ", dict['Age'])

del dict['Name'] # remove entry with key 'Name'
dict.clear()     # remove all entries in dict
del dict         # delete entire dictionary
```

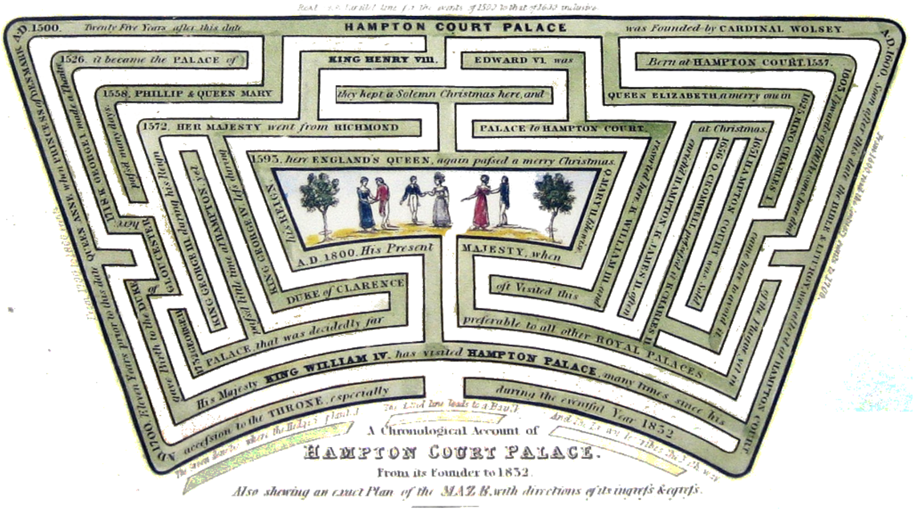
Dict of Dicts

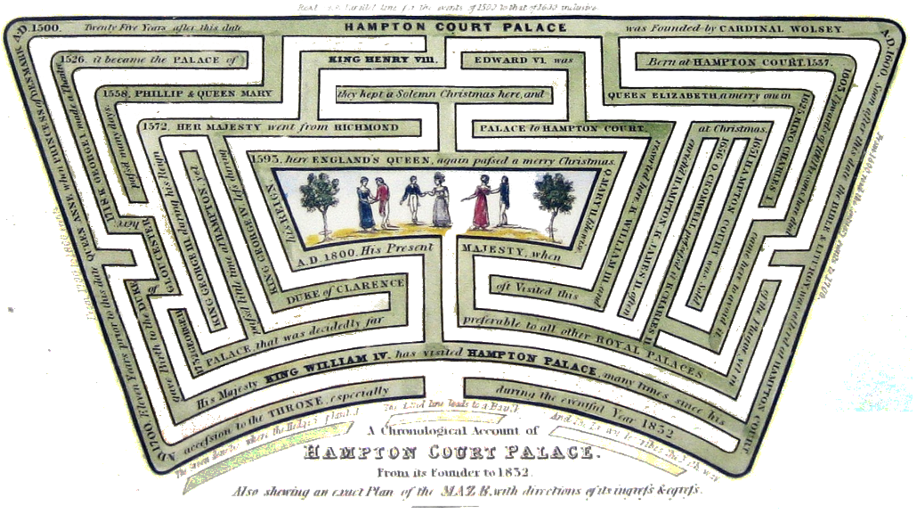
```python
mark = {'Name': 'Mark Handley', 'Age': 157, 'Room': '6.21'}
brad = {'Name': 'Brad Karp', 'Age': None, 'Room': '6.22'}
stefano = {'Name': 'Stefano Vissichio', 'Age': 21, 'Room': '6.19'}

courses = {'ENGF0002': mark, \
           'COMP0023': stefano,\
           'COMP0019': brad}

print(courses['ENGF0002']['Name'])
print(courses['COMP0023']['Room'])
```

Search


A.D. 1500. Twenty Five Years after this date HAMPTON COURT PALACE was Founded by CARDINAL WOLSEY.
1526. it became the PALACE of KING HENRY VIII. EDWARD VI. was Born at HAMPTON COURT. 1537.
1558. PHILLIP & QUEEN MARY they kept a Solemn Christmas here, and QUEEN ELIZABETH a merry one in
1572. HER MAJESTY went from RICHMOND PALACE to HAMPTON COURT. at Christmas.
1593. here ENGLAND'S QUEEN, again passed a merry Christmas.
A.D. 1600. Soon after this date the BIBLE & LITURGY was altered at HAMPTON COURT
1603. Upwards of 100 Persons here died of the Plague, yet in
1625. KING CHARLES I. came here to avoid it.
1651. HAMPTON COURT was Sold
1656. O. CROMWELL passed it R. CHARLES II.
enriched HAMPTON. K. JAMES II. often
resorted here. K. WILLIAM III. and
Q. MARY II. likewise.
A.D. 1700. Eleven Years prior to this date QUEEN ANNE when PRINCESS of DENMARK
gave Birth to the DUKE of GLOUCESTER here
1714. KING GEORGE I. made a Theatre
passed many days.
1732 GEORGE II
KING GEORGE III. during his Reign
passed little time at HAMPTON, yet during
KING GEORGE IV. his REIGN
A.D. 1800. His Present MAJESTY, when DUKE of CLARENCE oft Visited this
PALACE that was decidedly far preferable to all other ROYAL PALACES
His Majesty KING WILLIAM IV. has visited HAMPTON PALACE many times since his
accession to the THRONE, especially during the eventful Year 1832
A Chronological Account of
HAMPTON COURT PALACE.
From its Founder to 1832.
Also shewing an exact Plan of the MAZE, with directions of its ingress & egress.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1603. Upwards of 100 Persons here died of the Plague, yet in
1625. KING CHARLES I.
1636. HAMPTON COURT was Sold to O. CROMWELL paſsed it & CHARLES II came here to avoid it.
WILLIAM III and Q. MARY II likewise, K. JAMES II often resorted here.
A.D.1700. Eleven Years prior to this date QUEEN ANNE when PRINCESS of DENMARK gave Birth to the DUKE of GLOUCESTER
KING GEORGE I. made a Theatre here
1752 GEORGE II. paſsed many days
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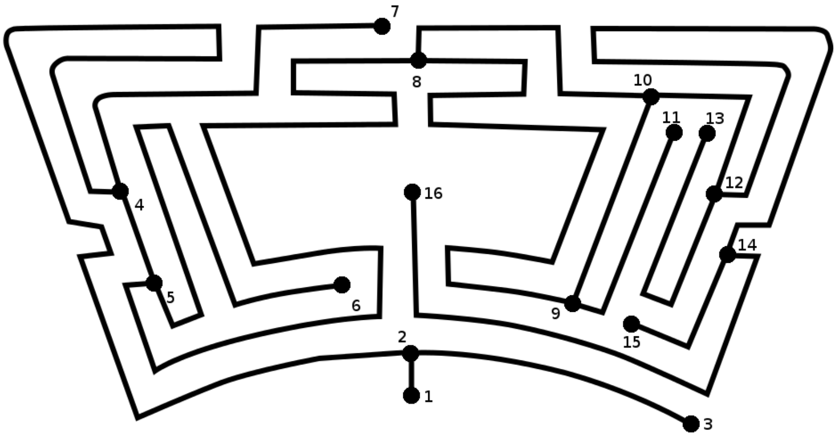

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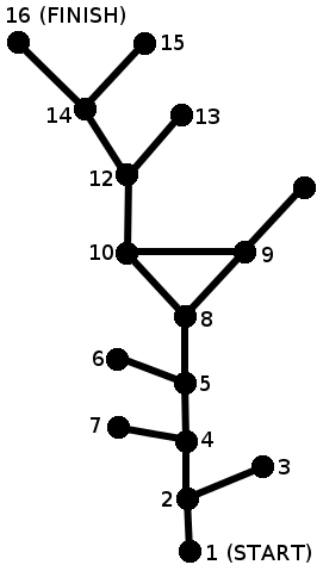
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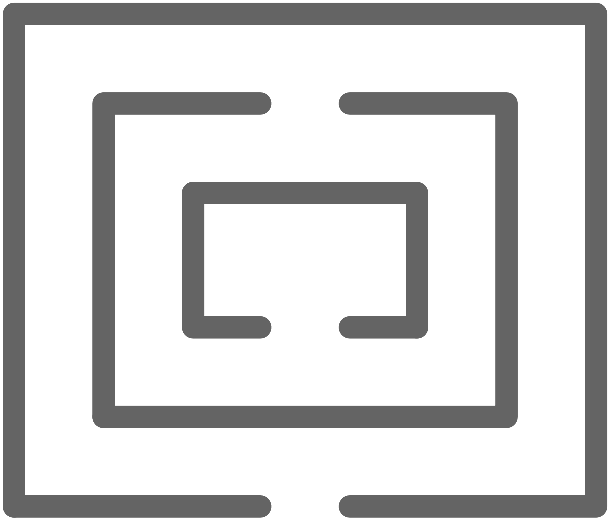

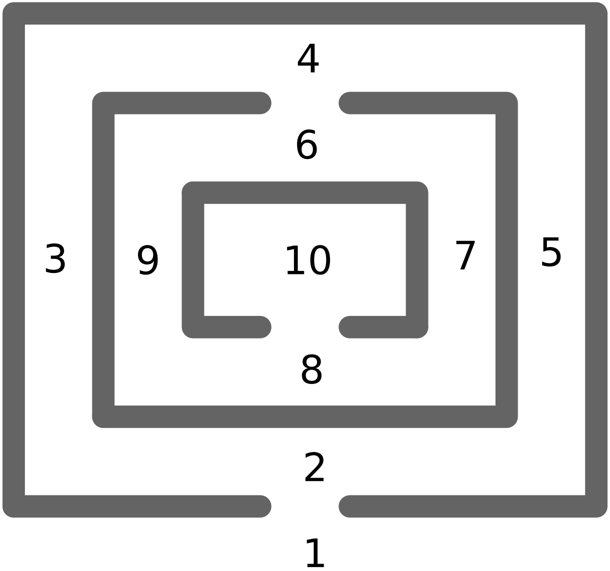
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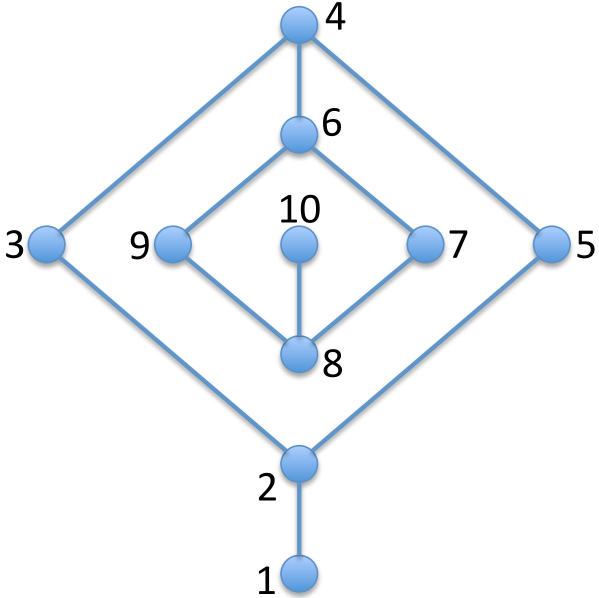
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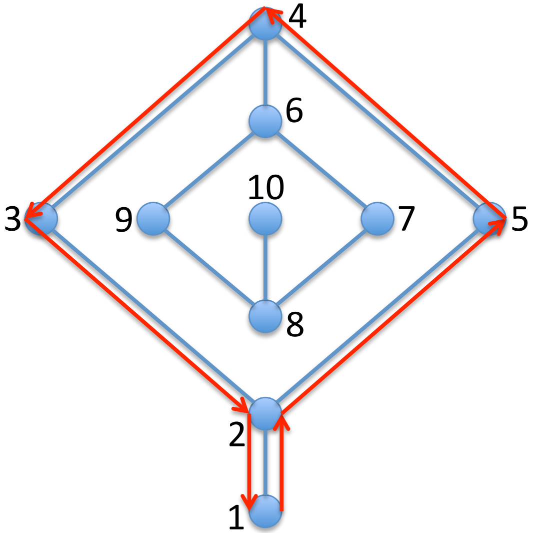
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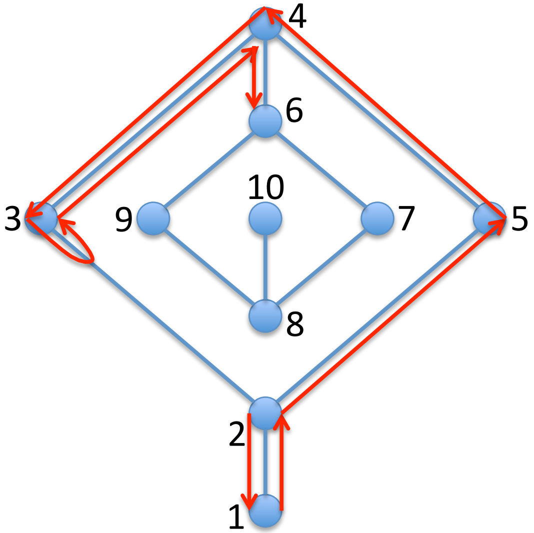
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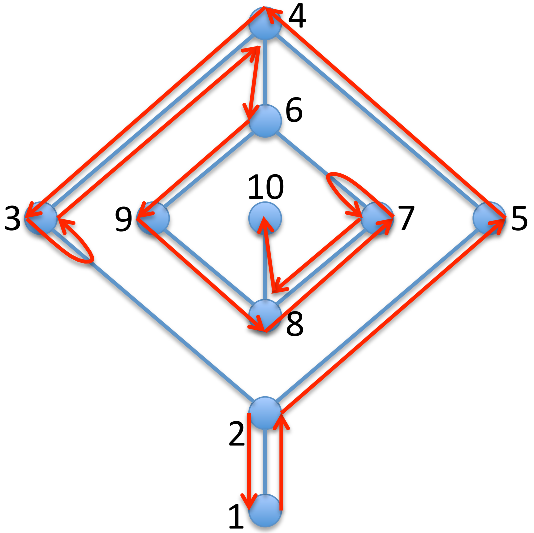
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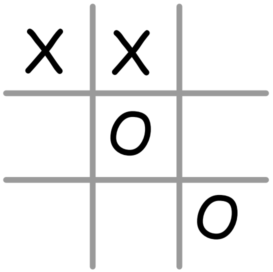
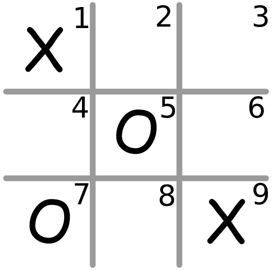
Noughts and Crosses



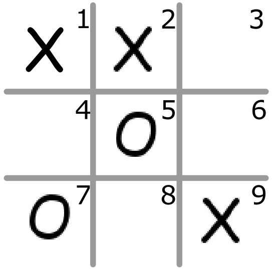
$9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ or $9! = 362{,}880$ moves
Many games finish before board is full, so 255,168 possible different games.
(Actually, less due to symmetry, but I'm going to ignore that.)
Adding one extra rule, *always win if you can*, reduces this to 52,592.

Consider a position close to the end of the game:

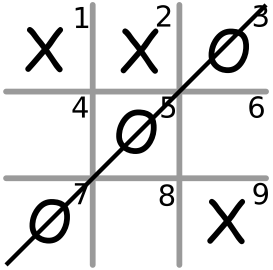


We're playing X and we started, so it's our go. Where should we play?

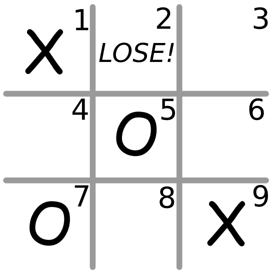
How about position 2?



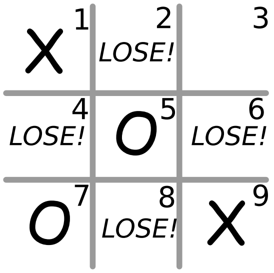
O wins



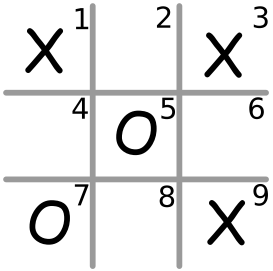
Backtrack, and mark square 2 as “lose”



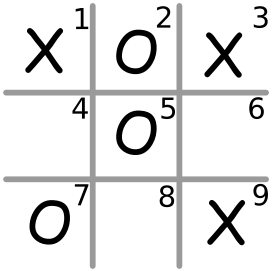
The same thing happens when we explore squares 4, 6, and 8, so those get marked as Lose too.



How about square 3?

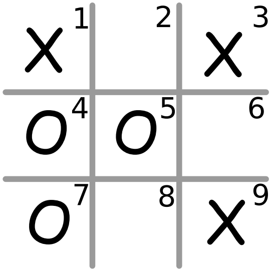


Now we have to try all of O's possible moves.
First try O at square 2.



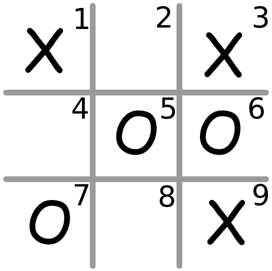
We'll play at 6 to win. But can O play elsewhere to force a win?

Next try O at square 4.



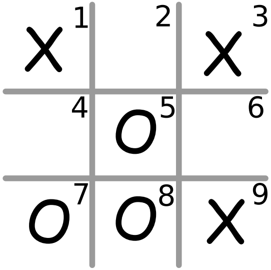
We'll play at 6 to win. But can O play elsewhere to force a win?

Next try O at square 6.



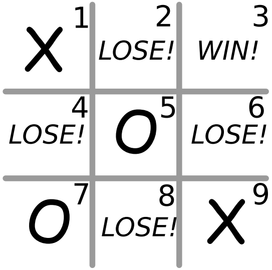
We’ll play at 2 to win. But can O play elsewhere to force a win?

Finally try O at square 8.

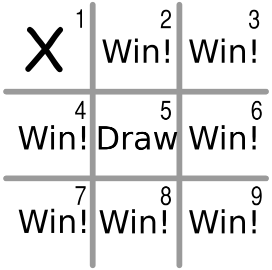


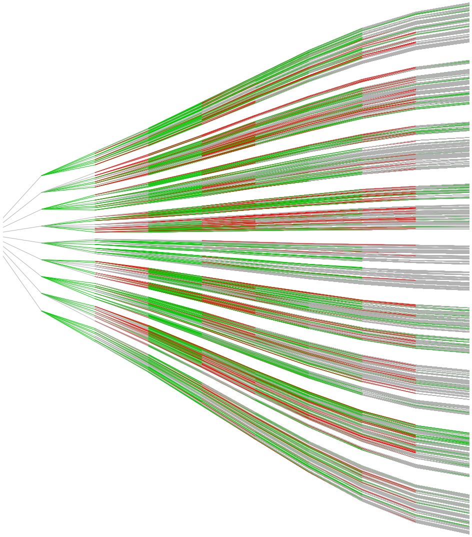
We’ll play at 2 or 6 to win. O has no winning moves.

Backtrack and mark square 3 as “win”.

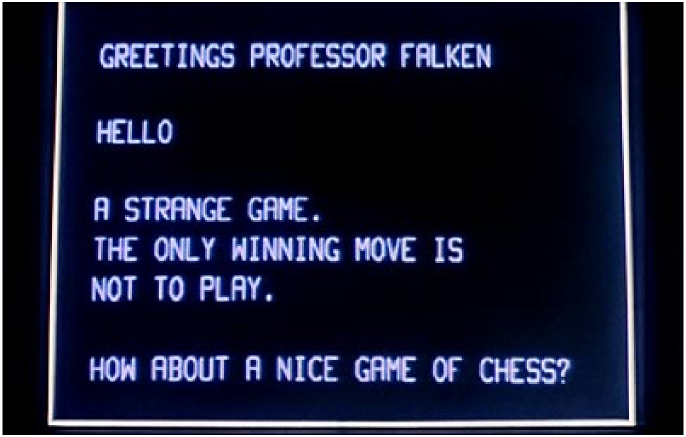


If we do this search from move 1, we get:





Wargames, 1983



```
GREETINGS PROFESSOR FALKEN

HELLO

A STRANGE GAME.
THE ONLY WINNING MOVE IS
NOT TO PLAY.

HOW ABOUT A NICE GAME OF CHESS?
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