

Chapter 1: The Fundamentals of Python

```
python3 | cody@cody-Serval-WS: ~ | xonsh
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python3
Python 3.7.0b3 (default, Mar 30 2018, 04:35:22)
[GCC 7.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> █
```

```
python | cody@cody-Serval-WS: ~ | xonsh
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python
Python 2.7.14 |Anaconda custom (64-bit)| (default, Dec 7 2017, 17:05:42)
[GCC 7.2.0] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> █
```

```
python3 | cody@cody-Serval-WS: ~ | xonsh
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python3
Python 3.7.0b3 (default, Mar 30 2018, 04:35:22)
[GCC 7.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> print("We are the knights who say 'Ni'.")
We are the knights who say 'Ni'.
>>> █
```

```
python3 | cody@cody-Serval-WS: ~ | xonsh
File Edit View Search Terminal Help
>>> 2+2
4
>>> 4*4
16
>>> 5**2
25
>>> import math
>>> math.pow(5, 2)
25.0
>>> math.sqrt(81)
9.0
>>> █
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help
>>> var = "This is a string." # Create a variable
>>> print(var) # Print the variable's value
This is a string.
>>> █
```

```
cody@cody-Serval-WS ~  
File Edit View Search Terminal Help  
cody@cody-Serval-WS ~ $ python3 random_dice_roller.py  
1d6 = 4  
2d6 = 2  
3d6 = 12  
4d6 = 17  
1d10 = 2  
2d10 = 12  
3d10 = 10  
1d100 = 78  
cody@cody-Serval-WS ~ $
```

```
IPython: home/cody
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ ipython3
Python 3.6.5 (default, Apr 7 2018, 19:35:51)
Type 'copyright', 'credits' or 'license' for more information
IPython 6.3.1 -- An enhanced Interactive Python. Type '?' for help.

In [1]: 2+2
Out[1]: 4

In [2]: print("I'm a lumberjack")
I'm a lumberjack

In [3]: import math

In [4]: math.exp(2, 8)
-----
TypeError                                 Traceback (most recent call last)
<ipython-input-4-78bd99106cd0> in <module>()
----> 1 math.exp(2, 8)

TypeError: exp() takes exactly one argument (2 given)

In [5]: math.pow(2, 8)
Out[5]: 256.0

In [6]: !ping www.yahoo.com
PING www.yahoo.com(media-router-fp1.prod1.media.vip.gq1.yahoo.com (2001:4998:c:1023::4)) 56 data bytes
64 bytes from media-router-fp1.prod1.media.vip.gq1.yahoo.com (2001:4998:c:1023::4): icmp_seq=1 ttl=48 time=68.4 ms
64 bytes from media-router-fp1.prod1.media.vip.gq1.yahoo.com (2001:4998:c:1023::4): icmp_seq=2 ttl=48 time=67.5 ms
64 bytes from media-router-fp1.prod1.media.vip.gq1.yahoo.com (2001:4998:c:1023::4): icmp_seq=3 ttl=48 time=74.9 ms
^C
--- www.yahoo.com ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 67.599/70.309/74.915/3.273 ms

In [7]:
KeyboardInterrupt

In [7]:

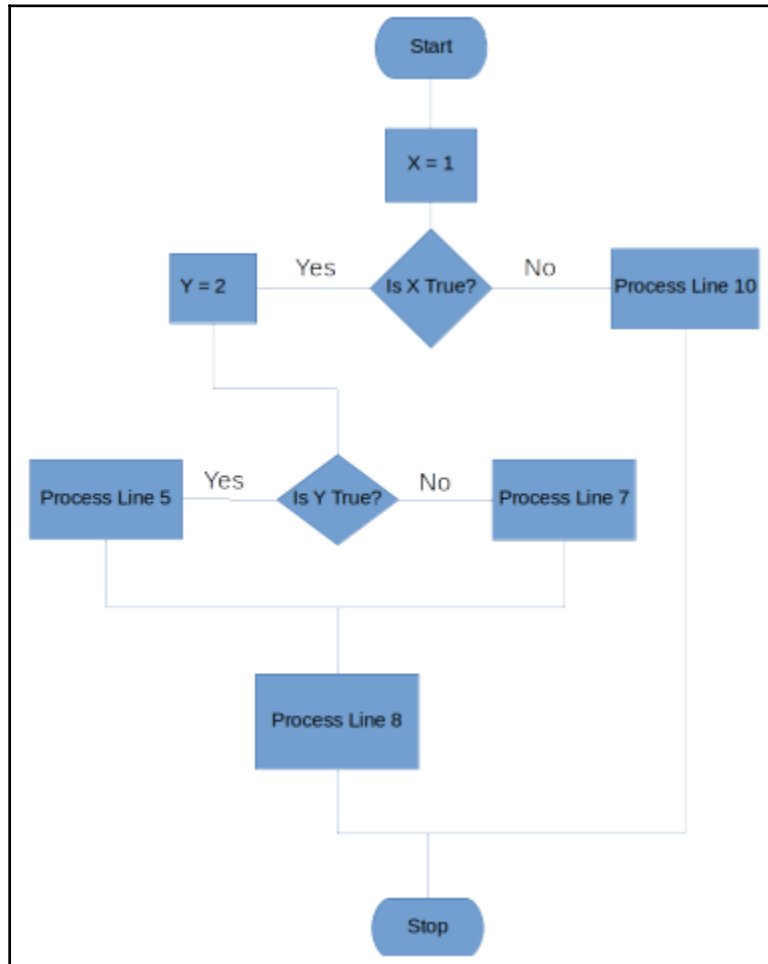
In [7]: !pwd
/home/cody

In [8]:
```

```
cody@cody-Serval-WS ~ - [x]
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ 1+1
1+1: command not found
cody@cody-Serval-WS ~ $ import sys
^C
cody@cody-Serval-WS ~ $ if True:
> print(1)
bash: syntax error near unexpected token `1'
cody@cody-Serval-WS ~ $ █
```

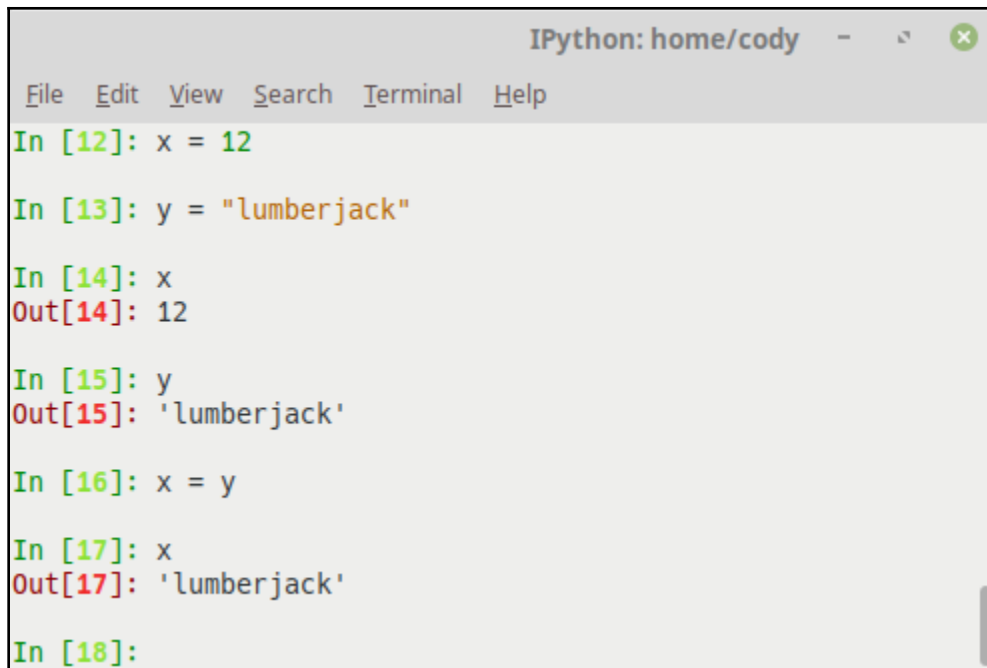
```
cody@cody-Serval-WS: ~ |xonsh - [x]
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ 1+1
2
cody@cody-Serval-WS ~ $ import sys
cody@cody-Serval-WS ~ $ print(sys.version)
3.6.5 (default, Apr 7 2018, 19:35:51)
[GCC 5.4.0 20160609]
cody@cody-Serval-WS ~ $ if True:
..... print(True)
..... else:
..... print(False)
.....
True
cody@cody-Serval-WS ~ $ █
```

Chapter 2: Data Types and Modules



```
IPython: home/cody
File Edit View Search Terminal Help
In [7]: x = 1
In [8]: if x: # if x is True...
...:     y = 2 # process this line
...:     if y: # if y is True
...:         print("x = true, y = true") # process this line
...:     else: # if y is False
...:         print("x = true, y = false") # process this line
...:     print("x = true, y = unknown") # if x is True, process this line
...: else: # if x is False...
...:     print("x = false") # process this line
...:
...:
x = true, y = true
x = true, y = unknown
In [9]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [9]: span = """This is
...: a multi-line block
...: of text; Python puts
...: an end-of-line marker
...: after each line."""
In [10]: span
Out[10]: 'This is\na multi-line block\nof text; Python puts \nan end-of-line mar
ker\nafter each line.'
In [11]: print(span)
This is
a multi-line block
of text; Python puts
an end-of-line marker
after each line.
In [12]: █
```



The image shows a screenshot of an IPython terminal window. The title bar reads "IPython: home/cody" with standard window controls. The menu bar includes "File", "Edit", "View", "Search", "Terminal", and "Help". The terminal content is as follows:

```
In [12]: x = 12
In [13]: y = "lumberjack"
In [14]: x
Out[14]: 12
In [15]: y
Out[15]: 'lumberjack'
In [16]: x = y
In [17]: x
Out[17]: 'lumberjack'
In [18]:
```



```
IPython: home/cody
File Edit View Search Terminal Help

In [21]: "abc" + "def" # concatenation makes a new, combined string
Out[21]: 'abcdef'

In [22]: 4 + 4
Out[22]: 8

In [23]: 4 + "4"
-----
TypeError                                 Traceback (most recent call last)
<ipython-input-23-f027878f74dd> in <module>()
----> 1 4 + "4"

TypeError: unsupported operand type(s) for +: 'int' and 'str'

In [24]: "Ni!" * 3
Out[24]: 'Ni!Ni!Ni!'

In [25]: 3 * 3
Out[25]: 9

In [26]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [26]: str(3)
Out[26]: '3'

In [27]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [27]: myjob = "lumberjack"

In [28]: for char in myjob:
...:     print(char)
...:
l
u
m
b
e
r
j
a
c
k

In [29]: for char in myjob:
...:     print(char, end="")
...:
lumberjack
In [30]:
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [30]: index_me = "spam me"

In [31]: index_me[0], index_me[-2]
Out[31]: ('s', 'm')

In [32]:
```

```
IPython: home/cody - [x]
File Edit View Search Terminal Help
In [32]: S = "spam"
In [33]: S[1:3], S[1:], S[:-1]
Out[33]: ('pa', 'pam', 'spa')
In [34]:
```

```
IPython: home/cody - [x]
File Edit View Search Terminal Help
In [1]: bird = "parrot"
In [2]: d = 1
In [3]: print("That is %d dead %s!" % (d, bird)
...:
...:
...: )
That is 1 dead parrot!
In [4]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [21]: first_phrase = "{0}, {1}, and {2}".format("chicken", "beef", "spam")
In [22]: second_phrase = "{smell}, {color}, and {flavor}".format(smell="sweet",
...: color="red", flavor="sugary")
In [23]: third_phrase = "{}, {}, and {}".format("spam", "spam", "more spam")
In [24]: first_phrase
Out[24]: 'chicken, beef, and spam'
In [25]: second_phrase
Out[25]: 'sweet, red, and sugary'
In [26]: third_phrase
Out[26]: 'spam, spam, and more spam'
In [27]: █
```

```
IPython: home/cody - █
File Edit View Search Terminal Help
In [27]: string1 = "1 2 3"
In [28]: string2 = "A B C"
In [29]: string3 = string1 + string2
In [30]: string4 = string2.join(string1)
In [31]: print(string3)
1 2 3A B C
In [32]: print(string4)
1A B C A B C2A B C A B C3
In [33]: █
```

```
IPython: home/cody - [x]
File Edit View Search Terminal Help
In [35]: seq_string = ("A1", "B2", "C3")
In [36]: "-".join(seq_string)
Out[36]: 'A1-B2-C3'
In [37]: print("-".join(seq_string))
A1-B2-C3
In [38]: █
```

```
IPython: home/cody - [x]
File Edit View Search Terminal Help
In [38]: split_me = "My wife hates spam."
In [39]: split_me.split()
Out[39]: ['My', 'wife', 'hates', 'spam.']
In [40]: split_me_too = "1, 2, 3"
In [41]: split_me_too.split(",")
Out[41]: ['1', ' 2', ' 3']
In [42]: █
```

```
IPython: home/cody - [ ] [X]
File Edit View Search Terminal Help
In [42]: l = [1, 2, 3, 4, 5]
In [43]: l
Out[43]: [1, 2, 3, 4, 5]
In [44]: print(l)
[1, 2, 3, 4, 5]
In [45]: l[0]
Out[45]: 1
In [46]: l.pop()
Out[46]: 5
In [47]: l
Out[47]: [1, 2, 3, 4]
In [48]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [48]: mylist = ["one", "two", "three"]

In [49]: for item in mylist:
...:     print("number " + item)
...:
number one
number two
number three

In [50]: [item for item in mylist]
Out[50]: ['one', 'two', 'three']

In [51]: ["number " + item for item in mylist]
Out[51]: ['number one', 'number two', 'number three']

In [52]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [1]: l = [1, 2, 3]

In [2]: l.append("number")

In [3]: l
Out[3]: [1, 2, 3, 'number']

In [4]: l.insert(2, 75)

In [5]: l
Out[5]: [1, 2, 75, 3, 'number']

In [6]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [6]: new_l = ["Mary", "had", "a", "little", "spam."]
In [7]: l.extend(new_l)
In [8]: l
Out[8]: [1, 2, 75, 3, 'number', 'Mary', 'had', 'a', 'little', 'spam.']
In [9]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [9]: l.append(new_l)
In [10]: l
Out[10]:
[1,
 2,
 75,
 3,
 'number',
 'Mary',
 'had',
 'a',
 'little',
 'spam.',
 ['Mary', 'had', 'a', 'little', 'spam.']]
```



```
IPython: cody/firefox
File Edit View Search Terminal Help
In [11]: l1 = ["spam", "Spam", "SPAM"]
In [12]: l1[1] = "eggs"
In [13]: l1
Out[13]: ['spam', 'eggs', 'SPAM']
In [14]: l1[0:2] = ["eat", "more"]
In [15]: l1
Out[15]: ['eat', 'more', 'SPAM']
In [16]: del l1[0]
In [17]: l1
Out[17]: ['more', 'SPAM']
In [18]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [19]: d1 = {"cow": "barn", 1: "pig", 2: ["spam", "ham", "bacon"]}
In [20]: len(d1)
Out[20]: 3
In [21]: d1["cow"]
Out[21]: 'barn'
In [22]: d1["chicken": 3]
-----
TypeError                                 Traceback (most recent call last)
<ipython-input-22-a58f975de98b> in <module>()
----> 1 d1["chicken": 3]

TypeError: unhashable type: 'slice'
In [23]: d1["chicken"] = 3
In [24]: d1
Out[24]: {'cow': 'barn', 1: 'pig', 2: ['spam', 'ham', 'bacon'], 'chicken': 3}
In [25]: d1["chicken"] += 1
In [26]: d1
Out[26]: {'cow': 'barn', 1: 'pig', 2: ['spam', 'ham', 'bacon'], 'chicken': 4}
```

```
IPython: cody/firefox
File Edit View Search Terminal Help

In [36]: "chicken" in d1
Out[36]: True

In [37]: d1.items()
Out[37]: dict_items([('cow', 'barn'), (1, 'pig'), (2, ['spam', 'ham', 'bacon']), ('chicken', 4)])

In [38]: d1.keys()
Out[38]: dict_keys(['cow', 1, 2, 'chicken'])

In [39]: d1.values()
Out[39]: dict_values(['barn', 'pig', ['spam', 'ham', 'bacon'], 4])

In [40]: del d1["chicken"]

In [41]: d1
Out[41]: {'cow': 'barn', 1: 'pig', 2: ['spam', 'ham', 'bacon']}

In [42]:
```

```
IPython: cody/firefox
File Edit View Search Terminal Help

In [47]: language_author = {"C": "Dennis Ritchie", "Python": "Guido van Rossum",
...: "C++": "Bjarne Stroustrup"}

In [48]: language = "Python"

In [49]: author = language_author[language]

In [50]: author
Out[50]: 'Guido van Rossum'

In [51]: for lang in language_author.keys():
...:     print(lang, "\t", language_author[lang])
...:
C         Dennis Ritchie
Python    Guido van Rossum
C++       Bjarne Stroustrup

In [52]:
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [2]: inventory = {
...: ("tomato", "red"): 48,
...: ("tomato", "green"): 13,
...: ("carrot", "orange"): 35,
...: ("carrot", "purple"): 8,
...: ("spam", "regular"): 24,
...: ("spam", "bacon"): 3,
...: }

In [3]: quantity = inventory["tomato", "red"]

In [4]: print(quantity)
48

In [5]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [60]: tup = (1, 2, 3, 4)
In [61]: first, second, third, fourth = tup
In [62]: first
Out[62]: 1
In [63]: second
Out[63]: 2
In [64]: third
Out[64]: 3
In [65]: fourth
Out[65]: 4
In [66]: tup2 = 1, 2, 3, 4
In [67]: first, second, third, fourth = tup2
In [68]: first
Out[68]: 1
In [69]: second
Out[69]: 2
In [70]: third
Out[70]: 3
In [71]: fourth
Out[71]: 4
In [72]: █
```

```
IPython: cody/firefox - [X]
File Edit View Search Terminal Help
In [72]: insect = "cricket"
In [73]: bird = "African swallow"
In [74]: insect, bird = bird, insect
In [75]: insect
Out[75]: 'African swallow'
In [76]: bird
Out[76]: 'cricket'
In [77]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [145]: l = ["Sir Galahad", "Sir Lancelot", "King Arthur", "Sir Robin", "black
...: knight", "rabbit"]

In [146]: l.sort()

In [147]: l
Out[147]:
['King Arthur',
 'Sir Galahad',
 'Sir Lancelot',
 'Sir Robin',
 'black knight',
 'rabbit']

In [148]: l.sort(key=str.lower)

In [149]: l
Out[149]:
['black knight',
 'King Arthur',
 'rabbit',
 'Sir Galahad',
 'Sir Lancelot',
 'Sir Robin']

In [150]: l.sort(reverse=True)

In [151]: l
Out[151]:
['rabbit',
 'black knight',
 'Sir Robin',
 'Sir Lancelot',
 'Sir Galahad',
 'King Arthur']

In [152]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help

In [181]: d1 = {1: "A", 2: "C", 3: "D", 4: "B"}

In [182]: len(d1)
Out[182]: 4

In [183]: d1[2]
Out[183]: 'C'

In [184]: d1[4] = "F"

In [185]: d1
Out[185]: {1: 'A', 2: 'C', 3: 'D', 4: 'F'}

In [186]: 3 in d1
Out[186]: True

In [187]: 4 not in d1
Out[187]: False

In [188]: new_d = iter(d1)

In [189]: for i in new_d:
...:     print(i)
...:
1
2
3
4

In [190]: d1.clear()

In [191]: d1
Out[191]: {}

In [192]: d1 = {1: "α", 2: "β", 3: "γ", 4: "δ"}

In [193]: d2 = d1.copy()

In [194]: d2
Out[194]: {1: 'α', 2: 'β', 3: 'γ', 4: 'δ'}
```



```
cody@cody-Serval-WS ~/firefox
File Edit View Search Terminal Help
In [219]: seq = ("A", "B", "C")
In [220]: d2 = dict.fromkeys(seq)
In [221]: d2
Out[221]: {'A': None, 'B': None, 'C': None}
In [222]: d1.get(5)
In [223]: d1.items()
Out[223]: dict_items([(1, 'α'), (2, 'β'), (3, 'γ'), (4, 'δ')])
In [224]: d1.keys()
Out[224]: dict_keys([1, 2, 3, 4])
In [225]: d1.pop(2)
Out[225]: 'β'
In [226]: d1
Out[226]: {1: 'α', 3: 'γ', 4: 'δ'}
In [227]: d1.popitem()
Out[227]: (4, 'δ')
In [228]: d1
Out[228]: {1: 'α', 3: 'γ'}
In [229]: d1.setdefault(5, "Z")
Out[229]: 'Z'
In [230]: d1
Out[230]: {1: 'α', 3: 'γ', 5: 'Z'}
In [231]: d1.update(A=1, B=2, C=3)
In [232]: d1
Out[232]: {1: 'α', 3: 'γ', 5: 'Z', 'A': 1, 'B': 2, 'C': 3}
In [233]: d1.values()
Out[233]: dict_values(['α', 'γ', 'Z', 1, 2, 3])
In [234]: █
```

```
IPython: cody/firefox
File Edit View Search Terminal Help
In [104]: set1 = {"Sir Galahad", "Sir Lancelot", "Sir Robin"}
In [105]: set2 = {"King Arthur",}
In [106]: set1.isdisjoint(set2)
Out[106]: True
In [107]: set1.issubset(set2)
Out[107]: False
In [108]: set1 < set2
Out[108]: False
In [109]: set1.issuperset(set2)
Out[109]: False
In [110]: set1 > set2
Out[110]: False
In [111]: set1.union(set2)
Out[111]: {'King Arthur', 'Sir Galahad', 'Sir Lancelot', 'Sir Robin'}
In [112]: set1.intersection(set2)
Out[112]: set()
In [113]: set1.difference(set2)
Out[113]: {'Sir Galahad', 'Sir Lancelot', 'Sir Robin'}
In [114]: set1.symmetric_difference(set2)
Out[114]: {'King Arthur', 'Sir Galahad', 'Sir Lancelot', 'Sir Robin'}
In [115]: set1.copy()
Out[115]: {'Sir Galahad', 'Sir Lancelot', 'Sir Robin'}
In [116]: █
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help

cody@cody-Serval-WS ~ $ python3 scope_example.py
Unmodified var1: 1
Unmodified var2: 0
Inside function, var1: 42
Inside function, var2: 80
Inside function, var3: 3
Outside function, var1: 1
Outside function, var2: 80
Traceback (most recent call last):
  File "scope_example.py", line 21, in <module>
    print("Outside function, var3: {}".format(var3))
NameError: name 'var3' is not defined
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [1]: sqrt(4)
-----
NameError                                Traceback (most recent call last)
<ipython-input-1-317e033d29d5> in <module>()
----> 1 sqrt(4)

NameError: name 'sqrt' is not defined

In [2]: import math

In [3]: math.sqrt(4)
Out[3]: 2.0

In [4]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [4]: from random import randint
In [5]: randint(0, 100)
Out[5]: 99
In [6]: randrange(0, 100)
-----
NameError                                Traceback (most recent call last)
<ipython-input-6-63e91857a99e> in <module>()
----> 1 randrange(0, 100)
NameError: name 'randrange' is not defined
In [7]: random.randrange(0, 100)
-----
NameError                                Traceback (most recent call last)
<ipython-input-7-34b436f583b6> in <module>()
----> 1 random.randrange(0, 100)
NameError: name 'random' is not defined
In [8]: █
```

Chapter 3: Logic Control

```
IPython: home/cody
File Edit View Search Terminal Help
In [2]: def preference():
...:     answer = input("What is your favorite room in the house?")
...:     if answer == "kitchen":
...:         print("You probably like food.")
...:     elif answer == "bedroom":
...:         print("You probably like to sleep.")
...:     elif answer == "living room":
...:         print("You probably like to watch TV.")
...:     else:
...:         print("Maybe you prefer to be outdoors.")
...:
...:
In [3]: preference()
What is your favorite room in the house?bedroom
You probably like to sleep.
In [4]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [11]: choice = "spam"
In [12]: print({
...:     "chicken": 4.25,
...:     "ham": 6.50,
...:     "spam": 3.25,
...:     "bacon": 5.35}
...:     [choice])
...:
3.25
In [13]: █
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [1]: i = 0
In [2]: while i < 10:
...:     print("{} is less than 10.".format(i))
...:     i += 1
...: else:
...:     print("{} is equal to 10.".format(i))
...:
0 is less than 10.
1 is less than 10.
2 is less than 10.
3 is less than 10.
4 is less than 10.
5 is less than 10.
6 is less than 10.
7 is less than 10.
8 is less than 10.
9 is less than 10.
10 is equal to 10.
In [3]: █
```

```
cody@cody-Serval-WS ~ - [x]
File Edit View Search Terminal Help

In [21]: x = 50

In [22]: while x:
...:     x -= 1
...:     if x % 2 != 0:
...:         continue
...:     print(x)
...:     if x == 10:
...:         break
...:
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10

In [23]: █
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help
In [27]: for i in range(2, 20):
...:     for x in range(2, i):
...:         if i % x == 0:
...:             print("{} equals {} * {}".format(i, x, i/x))
...:             break
...:         else:
...:             print("{} is a prime number".format(i))
...:
2 is a prime number
3 is a prime number
4 equals 2 * 2.0
5 is a prime number
6 equals 2 * 3.0
7 is a prime number
8 equals 2 * 4.0
9 equals 3 * 3.0
10 equals 2 * 5.0
11 is a prime number
12 equals 2 * 6.0
13 is a prime number
14 equals 2 * 7.0
15 equals 3 * 5.0
16 equals 2 * 8.0
17 is a prime number
18 equals 2 * 9.0
19 is a prime number

In [28]: █
```



```
cody@cody-Serval-WS ~ - [x]
File Edit View Search Terminal Help
In [35]: s = "spam, bacon, and eggs"
In [36]: t = (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
In [37]: for char in s:
...:     print(char, end="")
...:
spam, bacon, and eggs
In [38]: for num in t:
...:     print(num, end=",")
...:
1,2,3,4,5,6,7,8,9,10,
In [39]: █
```

```
IPython: home/cody - [x]
File Edit View Search Terminal Help
In [1]: tup1 = (1, 2, 3)
In [2]: tup2 = (4, 5, 6)
In [3]: tup3 = (7, 8, 9)
In [4]: list(zip(tup1, tup2, tup3))
Out[4]: [(1, 4, 7), (2, 5, 8), (3, 6, 9)]
In [5]: █
```

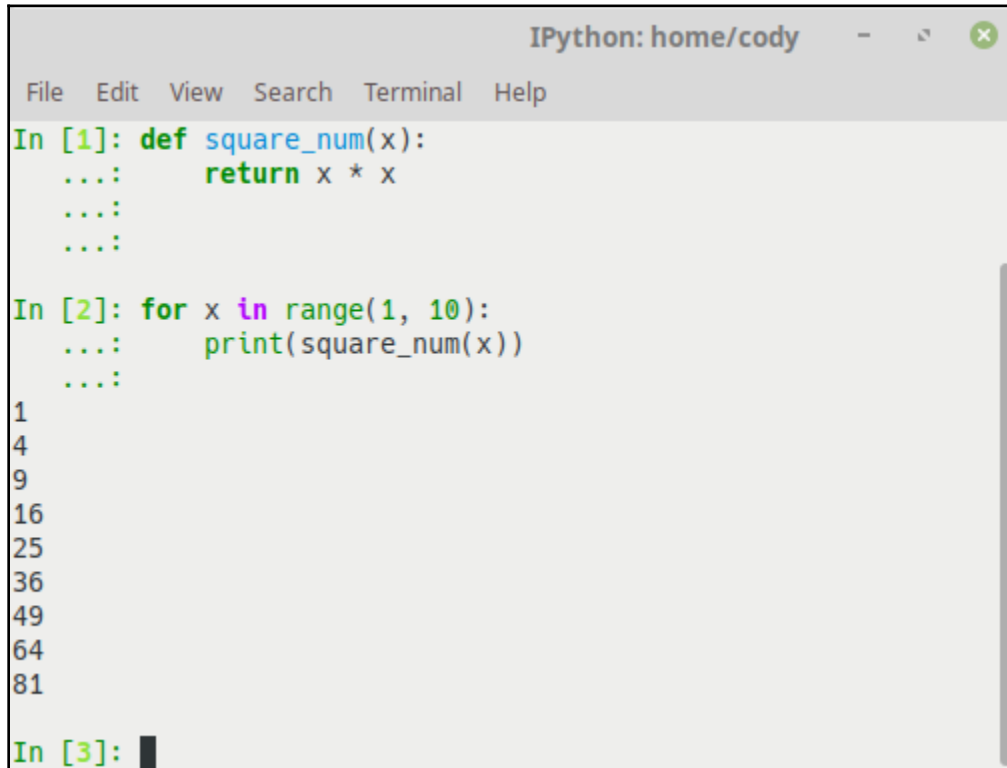
```
IPython: home/cody
File Edit View Search Terminal Help
In [5]: keys = (1, 2, 3)
In [6]: values = ["Sir Gawain", "Sir Robin", "Tim the Enchanter"]
In [7]: combine = dict(zip(keys, values))
In [8]: print(combine)
{1: 'Sir Gawain', 2: 'Sir Robin', 3: 'Tim the Enchanter'}
In [9]: █
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python3 exception_example.py
Enter the first number: 2
Enter the second number: 0
Zero can't be a denominator.
cody@cody-Serval-WS ~ $ python3 exception_example.py
Enter the first number: 4
Enter the second number:
Two numbers are required.
cody@cody-Serval-WS ~ $ python3 exception_example.py
Enter the first number: 34
Enter the second number: 92
34.0/92.0=0.3695652173913043
cody@cody-Serval-WS ~ $ █
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python3 custom_exception.py
Traceback (most recent call last):
  File "custom_exception.py", line 14, in <module>
    squareRoot(-3)
  File "custom_exception.py", line 10, in squareRoot
    raise NegativeNumberError("Square root of negative number not permitted")
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [11]: n = input("Give me a number ")
Give me a number 4j
In [12]: float_check(n)
Not a float number
In [13]: n = input("Give me a number ")
Give me a number 5
In [14]: float_check(n)
In [15]: █
```

Chapter 4: Functions and Object Oriented Programming

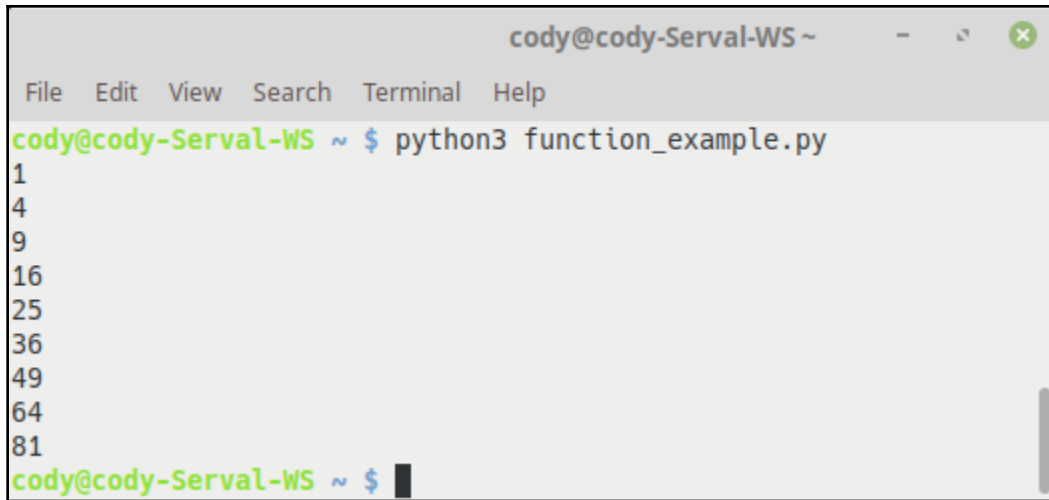


```
IPython: home/cody
File Edit View Search Terminal Help
In [1]: def square_num(x):
...:     return x * x
...:
...:

In [2]: for x in range(1, 10):
...:     print(square_num(x))
...:

1
4
9
16
25
36
49
64
81

In [3]: █
```



A terminal window titled "cody@cody-Serval-WS ~" with a menu bar containing "File", "Edit", "View", "Search", "Terminal", and "Help". The terminal shows the command "python3 function_example.py" being executed, which outputs the numbers 1, 4, 9, 16, 25, 36, 49, 64, and 81. The prompt "cody@cody-Serval-WS ~ \$" is visible at the bottom.

```
cody@cody-Serval-WS ~ $ python3 function_example.py
1
4
9
16
25
36
49
64
81
cody@cody-Serval-WS ~ $
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [1]: def combinator(*args):
...:     combo = args[0]
...:     for val in args[1:]:
...:         combo = combo + val
...:     return combo
...:
...:
In [2]: combinator(3, 4)
Out[2]: 7
In [3]: combinator(12, 4, 56, 11)
Out[3]: 83
In [4]: combinator("spam", "ham", "eggs")
Out[4]: 'spamhameggs'
In [5]: combinator([1, 2, 3], [(4, 5), (6, 7)])
Out[5]: [1, 2, 3, (4, 5), (6, 7)]
In [6]: combinator(["a", "b", "c"], ["d", "e", "f"])
Out[6]: ['a', 'b', 'c', 'd', 'e', 'f']
In [7]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [11]: def func(a, b, c): # regular function
...:     return a*b*c
...:
...:
In [12]: func(2, 3, 4)
Out[12]: 24
In [13]: lam_func = lambda a, b, c: a*b*c # lambda function
In [14]: lam_func(2, 3, 4)
Out[14]: 24
In [15]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [22]: class Knight:
...:     def setName(self, name):
...:         self.name = name
...:     def display(self):
...:         print(self.name)
...:
In [23]: x = Knight()
In [24]: y = Knight()
In [25]: z = Knight()
In [26]: x.setName("Sir Lancelot, the Brave")
In [27]: y.setName("Sir Galahad, the Pure")
In [28]: z.setName("Sir Robin, the Not-Quite-So-Brave-As-Sir-Lancelot")
In [29]: x.display()
Sir Lancelot, the Brave
In [30]: y.display()
Sir Galahad, the Pure
In [31]: z.display()
Sir Robin, the Not-Quite-So-Brave-As-Sir-Lancelot
In [32]: x.name = "Sir Not-Appearing-In-This-Film"
In [33]: x.display()
Sir Not-Appearing-In-This-Film
```



```
IPython: home/cody
File Edit View Search Terminal Help
In [22]: class Knight:
...:     def setName(self, name):
...:         self.name = name
...:     def display(self):
...:         print(self.name)
...:
In [23]: x = Knight()
In [24]: y = Knight()
In [25]: z = Knight()
In [26]: x.setName("Sir Lancelot, the Brave")
In [27]: y.setName("Sir Galahad, the Pure")
In [28]: z.setName("Sir Robin, the Not-Quite-So-Brave-As-Sir-Lancelot")
In [29]: x.display()
Sir Lancelot, the Brave
In [30]: y.display()
Sir Galahad, the Pure
In [31]: z.display()
Sir Robin, the Not-Quite-So-Brave-As-Sir-Lancelot
In [32]: x.name = "Sir Not-Appearing-In-This-Film"
In [33]: x.display()
Sir Not-Appearing-In-This-Film
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [55]: class GrandChild(Child):
...:     def __init__(self, value):
...:         self.data = value
...:     def __add__(self, new_value):
...:         return GrandChild(self.data + new_value)
...:     def __mul__(self, new_value):
...:         self.data = self.data * new_value
...:
In [56]: a = GrandChild("spam")
In [57]: a.display()
My value is spam.
In [58]: b = a + "eggs"
In [59]: b.display()
My value is spameggs.
In [60]: a*3
In [61]: a.display()
My value is spamspamspam.
In [62]:
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [77]: a + "eggs"
Out[77]: <__main__.GrandChild at 0x7fee5ed8a8d0>

In [78]: a.display()
My value is spam.

In [79]: b = a*3

In [80]: b.display()
-----
AttributeError                                Traceback (most recent call last)
<ipython-input-80-c7d745daf641> in <module>()
----> 1 b.display()

AttributeError: 'NoneType' object has no attribute 'display'

In [81]: █
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [81]: class Fahrenheit:
...:     def __init__(self, temp=72):
...:         self.temp = temp
...:
...:     def to_celsius(self):
...:         return (self.temp - 32) / 1.8
...:

In [82]: t = Fahrenheit()

In [83]: print(t)
<__main__.Fahrenheit object at 0x7fee5ed64828>

In [84]: t.temp
Out[84]: 72

In [85]: t.temp = 50

In [86]: t.temp
Out[86]: 50

In [87]: t.to_celsius()
Out[87]: 10.0

In [88]: █
```

```
File Edit View Search Terminal Help
In [90]: class Fahrenheit:
...:     def __init__(self, temp=72):
...:         self.set_temp(temp)
...:
...:     def to_celsius(self):
...:         return (self.get_temp() - 32) / 1.8
...:
...:     def set_temp(self, temp):
...:         if temp < -459.67:
...:             raise ValueError("Temperature cannot be less than absolute
...: zero")
...:         self._temp = temp
...:
...:     def get_temp(self):
...:         return self._temp
...:

In [91]: f = Fahrenheit()

In [92]: f.get_temp()
Out[92]: 72

In [93]: f.set_temp(-460)
-----
ValueError                                Traceback (most recent call last)
<ipython-input-93-a748fd671613> in <module>()
----> 1 f.set_temp(-460)

<ipython-input-90-6dd57dfdeee7> in set_temp(self, temp)
      8     def set_temp(self, temp):
      9         if temp < -459.67:
--> 10             raise ValueError("Temperature cannot be less than absolute z
ero")
     11         self._temp = temp
     12

ValueError: Temperature cannot be less than absolute zero

In [94]: f.set_temp(32)

In [95]: f.get_temp()
Out[95]: 32

In [96]: f.temp
-----
AttributeError                                Traceback (most recent call last)
<ipython-input-96-31d3e6098624> in <module>()
----> 1 f.temp

AttributeError: 'Fahrenheit' object has no attribute 'temp'

In [97]: f._temp
Out[97]: 32

In [98]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [5]: class Fahrenheit:
...:     def __init__(self, temp=72):
...:         self._temp = temp
...:
...:     def to_celsius(self):
...:         return (self._temp - 32) / 1.8
...:
...:     @property
...:     def temp(self):
...:         return self._temp
...:
...:     @temp.setter
...:     def temp(self, value):
...:         if value < -459.67:
...:             raise ValueError("Temperature cannot be less than absolute zero")
...:         self._temp = value
...:
In [6]: f = Fahrenheit(84)
In [7]: f.temp
Out[7]: 84
In [8]: f.temp = 65
In [9]: f.temp
Out[9]: 65
In [10]: f.to_celsius()
Out[10]: 18.333333333333332
In [11]:
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [10]: class Dog():
...:     def __init__(self, breed, age):
...:         self.breed = breed
...:         self.age = age
...:
...:     def dog_age(self):
...:         return self.age
...:
...:     def breed(self):
...:         return self.breed
...:
...:     @staticmethod
...:     def howl():
...:         return "Aroooo!"
...:
...:     @classmethod
...:     def type(cls):
...:         if cls.__name__ == "Dog":
...:             return "It's a mutt."
...:         else:
...:             return cls.__name__
...:
...:     def __repr__(self):
...:         return "{breed}, {age}".format(breed = self.breed, age = self.a
...: ge)
...:
In [11]: Lucky = Dog("Collie", 3)
In [12]: print(Lucky.breed)
Collie
In [13]: print(Lucky.age)
3
In [14]: print(Dog.breed)
<function Dog.breed at 0x7f9423560e18>
In [15]: print(Dog.age)
-----
AttributeError                                Traceback (most recent call last)
<ipython-input-15-fe0cc3055506> in <module>()
----> 1 print(Dog.age)
AttributeError: type object 'Dog' has no attribute 'age'
```

```
IPython: home/cody - ↵ ×
File Edit View Search Terminal Help
In [26]: print(Lucky.howl())
Aroooo!

In [27]: print(Dog.howl())
Aroooo!

In [28]: class ShibaInu(Dog):
...:     pass
...:
...:

In [29]: Koko = ShibaInu("cream", 2)

In [30]: print(Lucky.type())
It's a mutt.

In [31]: print(Koko.type())
ShibaInu

In [32]: █
```

Chapter 5: Files and Databases

A screenshot of an IPython terminal window titled "IPython: home/cody". The window has a menu bar with "File", "Edit", "View", "Search", "Terminal", and "Help". The terminal shows a series of Python commands and their outputs. The commands are: opening a file for writing, writing a line of text, closing the file, opening the file for reading, reading a line, and reading another line. The outputs are: the number of bytes written (27), the string "Hello, my little text file.", and an empty string.

```
IPython: home/cody
File Edit View Search Terminal Help

In [22]: this_file = open("myfile.txt", "w")

In [23]: this_file.write("Hello, my little text file.")
Out[23]: 27

In [24]: this_file.close()

In [25]: that_file = open("myfile.txt")

In [26]: that_file.readline()
Out[26]: 'Hello, my little text file.'

In [27]: that_file.readline()
Out[27]: ''
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [28]: new_file = open("myfile.txt", "a")
In [29]: new_file.write("Here's a new line.")
Out[29]: 18
In [30]: new_file.write("Here's another line.")
Out[30]: 20
In [31]: new_file.close()
In [32]: read_file = open("myfile.txt")
In [33]: read_file.readline()
Out[33]: "Hello, my little text file.Here's a new line.Here's another line."
In [34]: newer_file = open("yourfile.txt", "w")
In [35]: newer_file.write("This is a new file.\n")
Out[35]: 20
In [36]: newer_file.write("See how the lines are separate?\n")
Out[36]: 32
In [37]: newer_file.close()
In [38]: read_file = open("yourfile.txt")
In [39]: read_file.readlines()
Out[39]: ['This is a new file.\n', 'See how the lines are separate?\n']
In [40]: print(read_file.readlines())
[]
In [41]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [51]: read_file = open("yourfile.txt")

In [52]: print(read_file.read())
This is a new file.
See how the lines are separate?

In [53]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [53]: file = open("afile")
-----
FileNotFoundError                                Traceback (most recent call last)
<ipython-input-53-02d5a72c1af2> in <module>()
----> 1 file = open("afile")

FileNotFoundError: [Errno 2] No such file or directory: 'afile'

In [54]:
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [69]: f = open("afile.txt", "w")
In [70]: f.write("Hello there, my little friend.\nWill you gracefully fail?")
Out[70]: 56
In [71]: f.close()
In [72]: try:
...:     file = open("afile.txt")
...:     print(file.read())
...:     file.close()
...: except IOError:
...:     print("The file doesn't exist.")
...:
Hello there, my little friend.
Will you gracefully fail?
In [73]: try:
...:     file = open("nofile")
...:     print(file.read())
...:     file.close()
...: except IOError:
...:     print("The file doesn't exist.")
...:
The file doesn't exist.
In [74]: █
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [78]: with open("afile.txt") as this_file:
...:     read_data = this_file.read()
...:     print(read_data)
...:
Hello there, my little friend.
Will you gracefully fail?

In [79]: this_file.closed
Out[79]: True

In [80]:
```

```
IPython: home/cody - [X]
File Edit View Search Terminal Help
In [80]: for line in open("afile.txt"):
...:     print(line)
...:
Hello there, my little friend.

Will you gracefully fail?

In [81]: for line in open("afile.txt"):
...:     print(line, end="")
...:
Hello there, my little friend.
Will you gracefully fail?
In [82]:
```

```
IPython: home/cody
File Edit View Search Terminal Help

In [7]: import os

In [8]: file = open("afile.txt")

In [9]: file.tell()
Out[9]: 0

In [10]: file.seek(4)
Out[10]: 4

In [11]: file.seek(12, 1)
-----
UnsupportedOperation                                Traceback (most recent call last)
<ipython-input-11-f9d10f03891e> in <module>()
----> 1 file.seek(12, 1)

UnsupportedOperation: can't do nonzero cur-relative seeks

In [12]: file.tell()
Out[12]: 4

In [13]: file.seek(file.tell() + 12, os.SEEK_SET)
Out[13]: 16

In [14]: file.seek(0, os.SEEK_END)
Out[14]: 56

In [15]: file.seek(file.tell() - 3, os.SEEK_SET)
Out[15]: 53

In [16]:
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [18]: import pickle
In [19]: my_list = ["one", "two", "a", "bucket", "of", "spam"]
In [20]: save_file = open("pickle_rick", "wb")
In [21]: pickle.dump(my_list, save_file)
In [22]: save_file.close()
In [23]: open_file = open("pickle_rick", "rb")
In [24]: pickled_rick = pickle.load(open_file)
In [25]: print(pickled_rick)
['one', 'two', 'a', 'bucket', 'of', 'spam']
In [26]: █
```

```
IPython: home/cody
File Edit View Search Terminal Help
In [32]: import shelve
In [33]: db = shelve.open("shelf_db")
In [34]: your_list = [1, 2, 3, 4]
In [35]: db["strings"] = my_list
In [36]: db["nums"] = your_list
In [37]: words = db["strings"]
In [38]: numbers = db["nums"]
In [39]: words
Out[39]: ['one', 'two', 'a', 'bucket', 'of', 'spam']
In [40]: numbers
Out[40]: [1, 2, 3, 4]
In [41]:
```

```
IPython: PycharmProjects/Packt_Book
File Edit View Search Terminal Help
In [4]: cursor.execute("SELECT LName, FName, Order_Number FROM Customers, Orders
WHERE Customers.id = Orders.customer_id")
...: results = cursor.fetchall()
...: for row in results:
...:     print(row)
...:
('Johnson', 'Jack', 4455)
('Johnson', 'Jack', 4455)
('Johnson', 'Jack', 7690)
('Smith', 'John', 3490)
('Smith', 'John', 5512)

In [5]:
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help
cody@cody-Serval-WS ~ $ python3 sqlite_retrieval.py
Box Knife, Small, 15
Drill, Medium, 35
Axe, Large, 55
Putty Knife, Small, 25
Hammer, Small, 25
Screwdriver, Small, 10
Crowbar, Large, 60
cody@cody-Serval-WS ~ $
```



```
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book
File Edit View Search Terminal Help
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book $ python3 sqlite_retrieval.py
-----
ID: 1
Name: Box Knife
Size: Small
Price: 15
-----
-----
ID: 2
Name: Drill
Size: Medium
Price: 35
-----
-----
ID: 3
Name: Axe
Size: Large
Price: 55
-----
-----
ID: 4
Name: Putty Knife
Size: Small
Price: 25
-----
-----
ID: 5
Name: Hammer
Size: Small
Price: 25
-----
-----
ID: 6
Name: Screwdriver
Size: Small
Price: 10
-----
-----
ID: 7
Name: Crowbar
Size: Large
Price: 60
-----
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book $
```

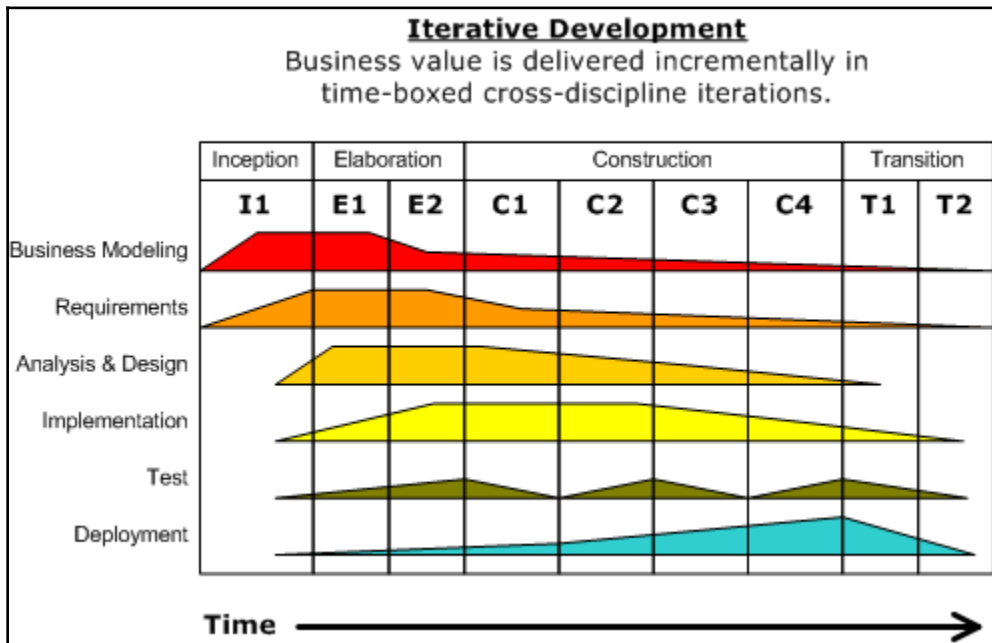
```
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book
File Edit View Search Terminal Help
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book $ python sqlalchemy_query.py
Box Knife
Drill
Axe
Putty Knife
Hammer
Screwdriver
Crowbar

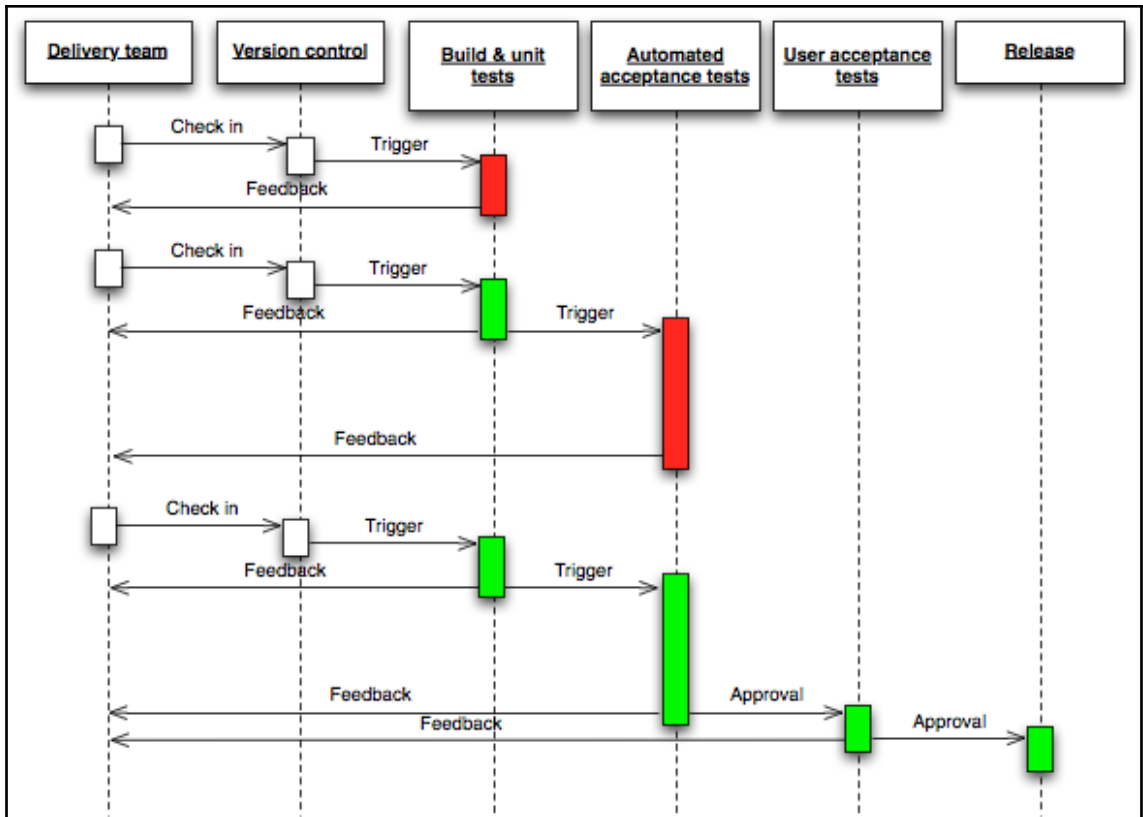
Box Knife

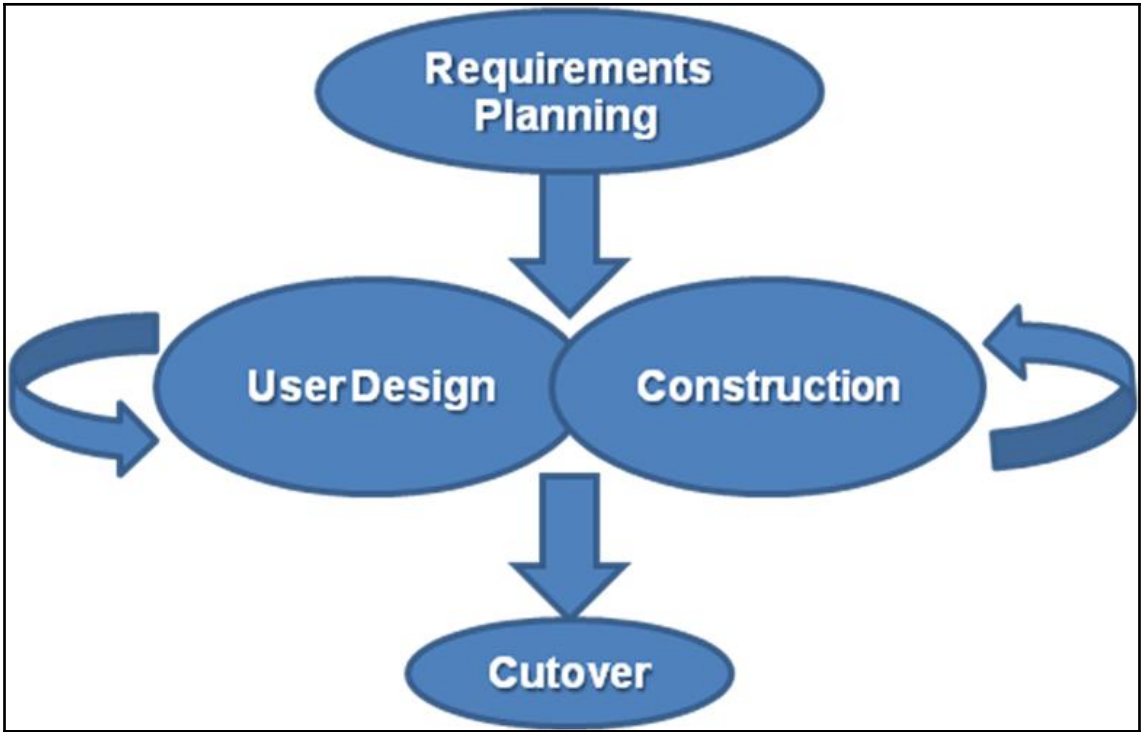
Screwdriver

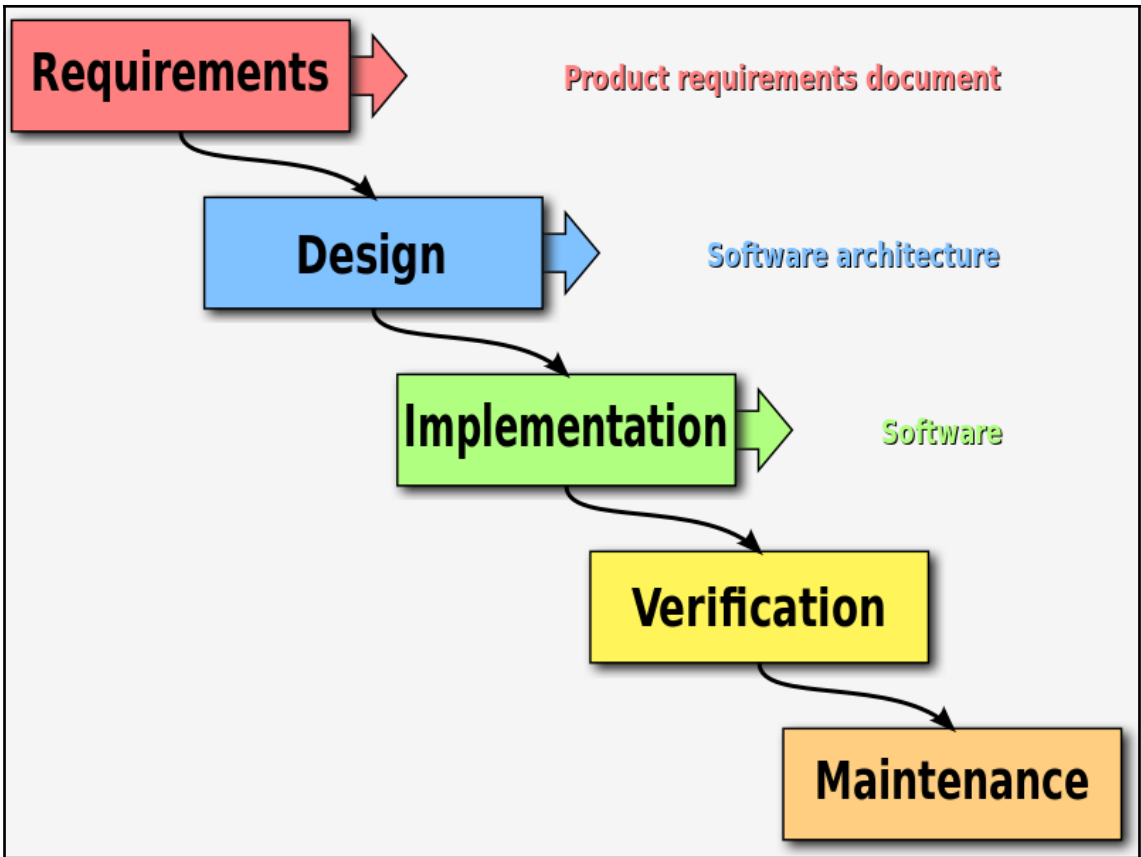
Putty Knife
Hammer
cody@cody-Serval-WS ~/PycharmProjects/Packt_Book $
```

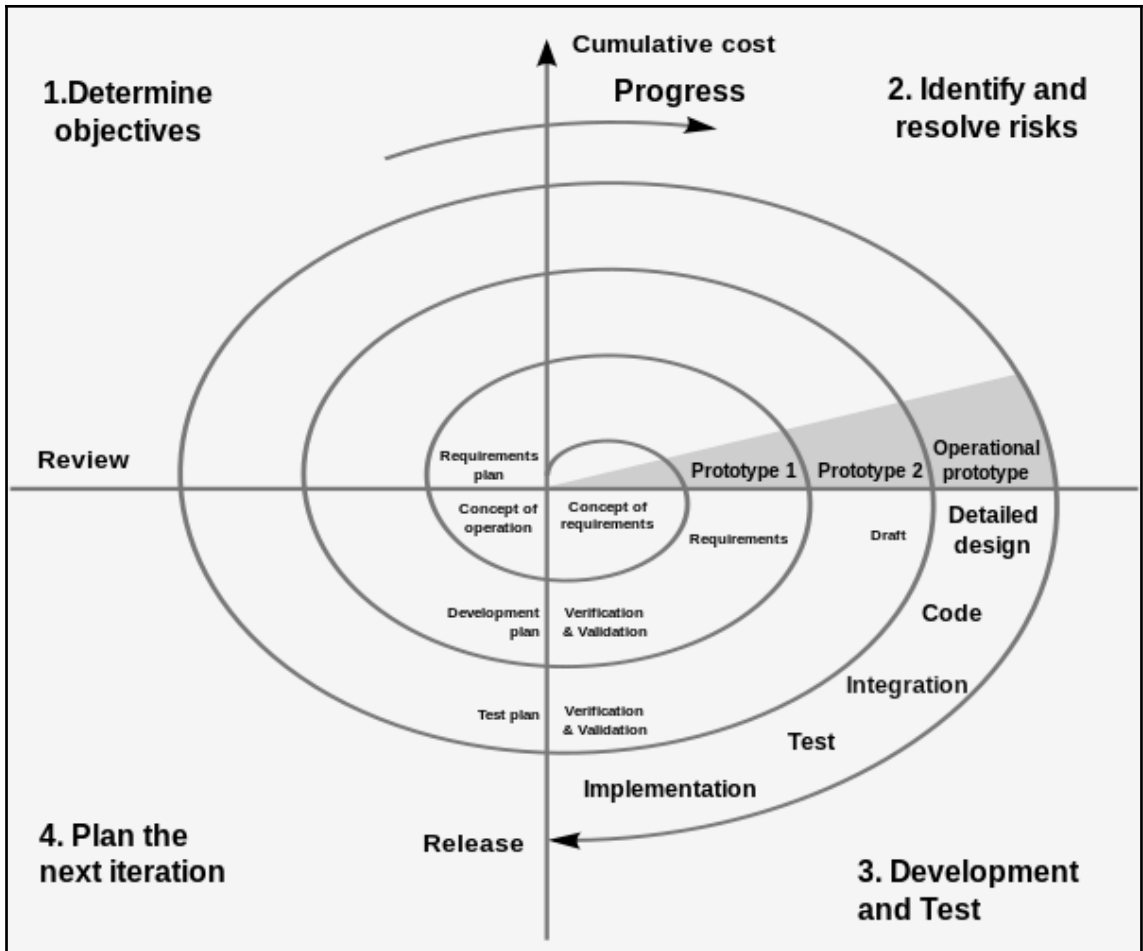
Chapter 6: Application Planning



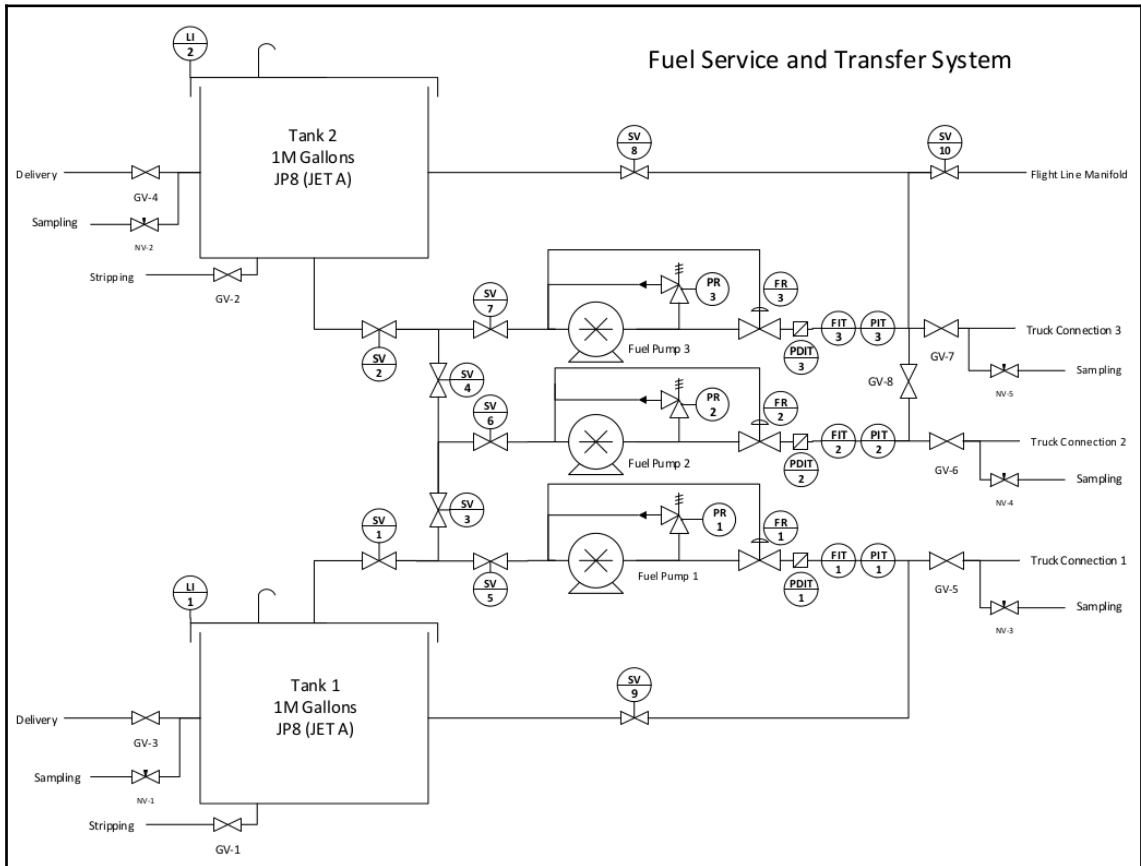








Chapter 7: Writing the Imported Program



```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ python3 utility_formulas.py
191.3767672898554
65.01829166666667
149.93395288120846
65.02863302566867
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $
```



```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ python3 ./PipingSystems/storage_tank/tank.py
10.0
4.334552777777777
8.0
3.467642222222222
Traceback (most recent call last):
  File "./PipingSystems/storage_tank/tank.py", line 90, in <module>
    tank1.level = "a"
  File "./PipingSystems/storage_tank/tank.py", line 63, in level
    raise TypeError("Numeric values only.")
TypeError: Numeric values only.
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ python3 ./PipingSystems/valve/valve.py
Pump inlet created
Pump inlet is closed.
Pump inlet is open.
Pump inlet is closed.
Pump inlet is open.

Throttle valve created

Throttle valve is 0% open.

Throttle valve is 100% open.

Throttle valve is 0% open.

Throttle valve is 40% open.

Pressure relief created

Pressure relief is closed.
The open setpoint is 25 psi.
The close setpoint is 20 psi.
The open setpoint is 75 psi.
The close setpoint is 73 psi.

Pressure relief is open.

Pressure relief is closed.
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ python3 ./PipingSystems/pump/pump.py
Pumpy created.
The pump is running at 125 rpm.
The pump output flow rate is 75.0 gpm.
The power usage for the pump is 0.18 kW.
The pump pressure is 25.00 psi.
The pump is running at 50 rpm.
The pump output flow rate is 30.0 gpm.
The power usage for the pump is 0.02 kW.
The pump pressure is 4.00 psi.
The pump is stopped.
The pump output flow rate is 0.0 gpm.
The power usage for the pump is 0.00 kW.
The pump pressure is 0.00 psi.

Grumpy created.
The pump is running at 300 rpm.
The pump outlet flow rate is 100.0 gpm.
The power usage for the pump is 3.77 kW.
The pump is running at 50 rpm.
The pump outlet flow rate is 7.5 gpm.
The power usage for the pump is 0.28 kW.
The pump is stopped.
The pump outlet flow rate is 0.0 gpm.
The power usage for the pump is 0.00 kW.
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $
```

Chapter 8: Automated Software Testing

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping $
pytest test_functions.py
===== test session starts =====
platform linux -- Python 3.6.5, pytest-3.8.2, py-1.7.0, pluggy-0.7.1
rootdir: /home/cody/PycharmProjects/VirtualPLC/tests/piping, inifile:
collected 37 items

test_functions.py ..... [100%]

===== 37 passed in 0.07 seconds =====
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping $
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping $
pytest test_functions.py
===== test session starts =====
platform linux -- Python 3.6.5, pytest-3.8.2, py-1.7.0, pluggy-0.7.1
rootdir: /home/cody/PycharmProjects/VirtualPLC/tests/piping, inifile:
collected 37 items

test_functions.py F..... [100%]

===== FAILURES =====
----- test_grav_flow -----
    def test_grav_flow():
        flow_rate = utility_formulas.gravity_flow_rate(2, 1.67)
>       assert flow_rate == 319.2800807738842
E       assert 319.28008077388426 == 319.2800807738842

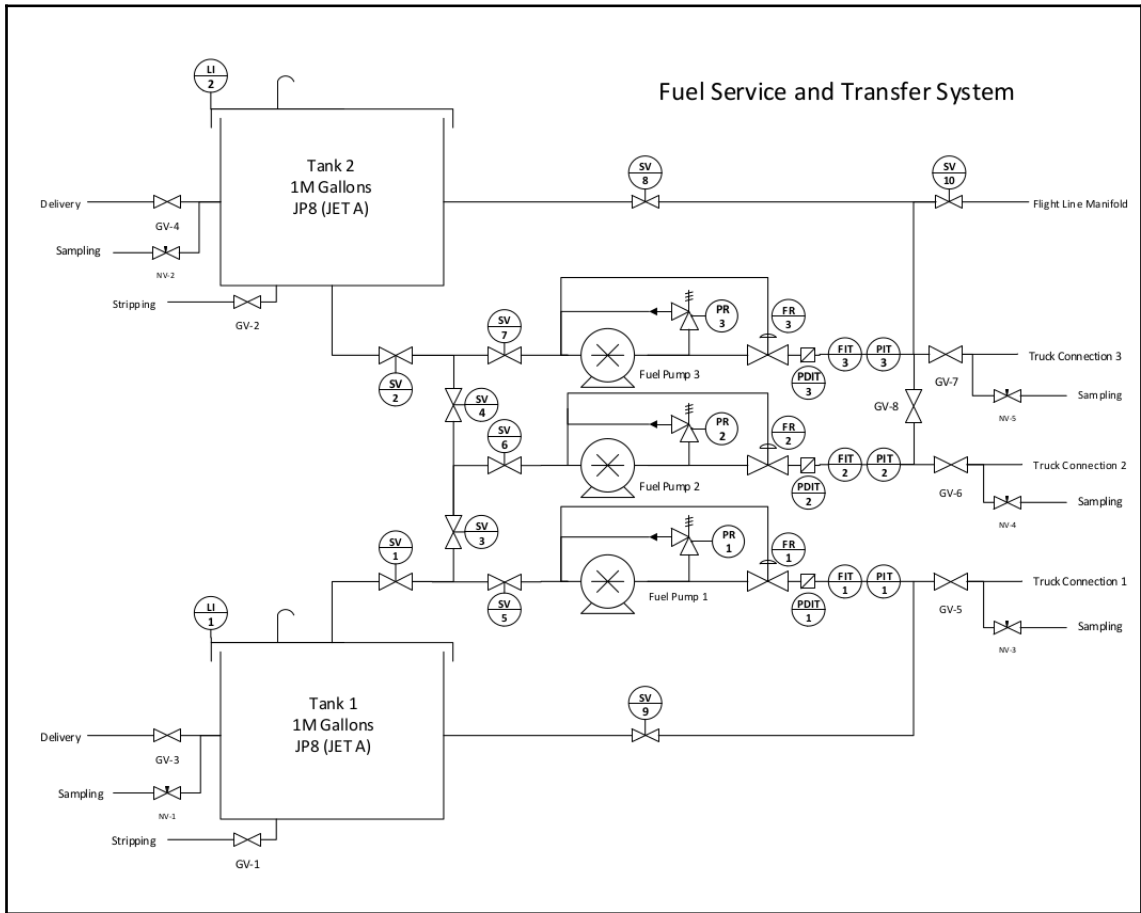
test_functions.py:26: AssertionError
===== 1 failed, 36 passed in 0.10 seconds =====
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests/piping $
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests
File Edit View Search Terminal Help
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests $ pytest
piping
===== test session starts =====
platform linux -- Python 3.6.5, pytest-3.8.2, py-1.7.0, pluggy-0.7.1
rootdir: /home/cody/PycharmProjects/VirtualPLC/tests, inifile:
collected 149 items

piping/test_centrifPump.py ..... [ 8%]
piping/test_change_values.py ..... [ 13%]
piping/test_functions.py ..... [ 38%]
piping/test_gate.py .. [ 39%]
piping/test_generic_pump.py ..... [ 44%]
piping/test_generic_valve.py ..... [ 57%]
piping/test_globe.py .... [ 60%]
piping/test_parameters.py ..... [ 85%]
piping/test_positiveDisplacement.py ..... [ 90%]
piping/test_relief.py .... [ 93%]
piping/test_tank.py ..... [100%]

===== 149 passed in 0.30 seconds =====
(cody-Vi_4YmwP) cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC/tests $
```

Chapter 9: Writing the Fueling Scenario



```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Tabs Help

cody@cody-Serval-WS ~/PycharmProjects/... x  cody@cody-Serval-WS ~/PycharmProjects/... x  [?] v

__init__.py
Models
├── FuelFarm
│   ├── components.py
│   ├── functionality.py
│   ├── hmi
│   │   ├── fuel_schematic.png
│   │   ├── hmi.kv
│   │   ├── hmilayout.py
│   │   └── __init__.py
│   └── __init__.py
└── __init__.py
PipingSystems
├── __init__.py
├── pump
│   ├── __init__.py
│   └── pump.py
├── storage_tank
│   ├── __init__.py
│   └── tank.py
├── user_creation_script.py
├── valve
│   ├── __init__.py
│   └── valve.py
└── tests
    ├── __init__.py
    ├── models
    │   ├── fuel_farm
    │   │   ├── __init__.py
    │   │   └── test_fuel_components.py
    │   └── hmi
    │       └── __init__.py
    └── piping
        ├── initial_conditions.py
        ├── __init__.py
        ├── test_centrifPump.py
        ├── test_change_values.py
        ├── test_gate.py
        ├── test_generic_pump.py
        ├── test_generic_valve.py
        ├── test_globe.py
        ├── test_parameters.py
        ├── test_positiveDisplacement.py
        ├── test_relief.py
        └── test_tank.py
Utilities
├── __init__.py
└── utility_formulas.py
venv
├── bin
│   ├── python
│   └── python3
└── pyvenv.cfg

15 directories, 38 files
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $
```

```
cody@cody-Serval-WS ~
File Edit View Search Terminal Help

def test_gate5_tank2(self):
    fff.gate1_close()
    assert ffc.gate1.position == 0
    assert ffc.gate1.flow_out == 0.0
    assert ffc.gate1.press_out == 0.0

    fff.gate2_open()
    assert ffc.gate2.position == 100
    assert ffc.gate2.flow_out == 19542.86939891452
    assert ffc.gate2.press_out == 13.109851301499999

    fff.gate4_open()
    assert ffc.gate4.position == 100
    assert ffc.gate4.flow_in == 19542.86939891452
    assert ffc.gate4.press_in == 13.109851301499999
    assert ffc.gate4.flow_out == 19542.86939891452
    assert ffc.gate4.press_out == 13.109851301499999

    fff.gate3_open()
    assert ffc.gate3.position == 100
    assert ffc.gate3.flow_in == 19542.86939891452
    assert ffc.gate3.press_in == 13.109851301499999
    assert ffc.gate3.flow_out == 19542.86939891452
    assert ffc.gate3.press_out == 13.109851301499999
> assert ffc.gate6.flow_in == 39085.73879782904 # Not doubled as only tan
k 2 supplying
E      assert 19542.86939891452 == 39085.73879782904
E      + where 19542.86939891452 = <PipingSystems.valve.valve.Gate object at
0x7f6c157b0438>.flow_in
E      + where <PipingSystems.valve.valve.Gate object at 0x7f6c157b0438> =
ffc.gate6

PycharmProjects/VirtualPLC/tests/models/fuel_farm/test_fuel_components.py:376: A
ssertionError
----- TestPump1.test_pump1_no_flow -----

self = <VirtualPLC.tests.models.fuel_farm.test_fuel_components.TestPump1 object
at 0x7f6c15af2b70>

def test_pump1_no_flow(self):
    assert ffc.gate1.position == 0
    assert ffc.gate2.position == 0
    assert ffc.gate3.position == 0
    assert ffc.gate4.position == 0
    assert ffc.gate5.position == 0
> assert ffc.gate5.flow_in == 0.0
E      assert 19542.86939891452 == 0.0
E      + where 19542.86939891452 = <PipingSystems.valve.valve.Gate object at
0x7f6c157b0400>.flow_in
E      + where <PipingSystems.valve.valve.Gate object at 0x7f6c157b0400> =
ffc.gate5

PycharmProjects/VirtualPLC/tests/models/fuel_farm/test_fuel_components.py:425: A
ssertionError
===== 2 failed, 21 passed in 0.21 seconds =====
(cody-Vi_4YmwP) cody@cody-Serval-WS ~ $
```



```
cody@cody-Serval-WS ~  
File Edit View Search Terminal Help  
(cody-Vi_4YmwP) cody@cody-Serval-WS ~ $ pytest ~/PycharmProjects/VirtualPLC/test  
s/models/fuel_farm/test_fuel_components.py  
===== test session starts =====  
platform linux -- Python 3.6.5, pytest-3.8.2, py-1.7.0, pluggy-0.7.1  
rootdir: /home/cody, inifile:  
collected 23 items  
  
PycharmProjects/VirtualPLC/tests/models/fuel_farm/test_fuel_components.py . [ 4  
%]  
..... [100%]  
  
===== 23 passed in 0.18 seconds =====  
(cody-Vi_4YmwP) cody@cody-Serval-WS ~ $
```

Chapter 10: Software Post-Production

```
conf.py (~/PycharmProjects/VirtualPLC)
File Edit View Search Tools Documents Help
index.rst x conf.py x utility_formulas.py x
1 # -*- coding: utf-8 -*-
2 #
3 # Configuration file for the Sphinx documentation builder.
4 #
5 # This file does only contain a selection of the most common options. For a
6 # full list see the documentation:
7 # http://www.sphinx-doc.org/en/stable/config|
8
9 # -- Path setup -----
10
11 # If extensions (or modules to document with autodoc) are in another directory,
12 # add these directories to sys.path here. If the directory is relative to the
13 # documentation root, use os.path.abspath to make it absolute, like shown here.
14 #
15 import os
16 import sys
17 sys.path.insert(0, os.path.abspath('./PipingSystems/valve'))
18 sys.path.insert(0, os.path.abspath('./PipingSystems/pump'))
19
20
21 # -- Project information -----
22
23 project = u'VirtualPLC'
24 copyright = u'2018, Cody Jackson'
25 author = u'Cody Jackson'
26
27 # The short X.Y version
28 version = u''
29 # The full version, including alpha/beta/rc tags
30 release = u'0.2'
31
32
33 # -- General configuration -----
34
35 # If your documentation needs a minimal Sphinx version, state it here.
36 #
37 # needs_sphinx = '1.0'
38
39 # Add any Sphinx extension module names here, as strings. They can be
40 # extensions coming with Sphinx (named 'sphinx.ext.*') or your custom
41 # ones.
42 extensions = [
43     'sphinx.ext.autodoc',
44 ]
45
Python Tab Width: 4 Ln 7, Col 45 INS
```

```
index.rst (~/PycharmProjects/VirtualPLC)
File Edit View Search Tools Documents Help
index.rst x conf.py x utility_formulas.py x
1 .. VirtualPLC documentation master file, created by
2 sphinx-quickstart on Sat Oct 27 10:12:57 2018.
3 You can adapt this file completely to your liking, but it should at least
4 contain the root `toctree` directive.
5
6 Welcome to VirtualPLC's documentation!
7 =====
8
9 .. toctree::
10 :maxdepth: 2
11 :caption: Contents:
12
13 .. automodule:: valve
14 :members:
15 :undoc-members:
16 :show-inheritance:
17
18 .. automodule:: pump
19 :members:
20 :undoc-members:
21 :show-inheritance:
22
23
24
25 Indices and tables
26 =====
27
28 * :ref:`genindex`
29 * :ref:`modindex`
30 * :ref:`search`
reStructuredText Tab Width: 4 Ln 21, Col 22 INS
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ make html
Running Sphinx v1.7.2
loading pickled environment... done
building [mo]: targets for 0 po files that are out of date
building [html]: targets for 0 source files that are out of date
updating environment: 0 added, 1 changed, 0 removed
reading sources... [100%] index
WARNING: autodoc: failed to import module u'pump'; the following exception was raised:
Traceback (most recent call last):
  File "/home/cody/anaconda3/lib/python2.7/site-packages/sphinx/ext/autodoc/importer.py", line 140, in import_module
    __import__(modname)
  File "/home/cody/PycharmProjects/VirtualPLC/PipingSystems/pump/pump.py", line 25, in <module>
    from Utilities import utility_formulas
  File "/home/cody/PycharmProjects/VirtualPLC/Utilities/utility_formulas.py", line 16
SyntaxError: Non-ASCII character '\xe2' in file /home/cody/PycharmProjects/VirtualPLC/Utilities/utility_formulas.py on line 17, but no encoding declared; see http://python.org/dev/peps/pep-0263/ for details

looking for now-outdated files... none found
pickling environment... done
checking consistency... done
preparing documents... done
writing output... [100%] index
generating indices... genindex py-modindex
writing additional pages... search
copying static files... done
copying extra files... done
dumping search index in English (code: en) ... done
dumping object inventory... done
build succeeded, 1 warnings.
```

```
utility_formulas.py (~\PycharmProjects/VirtualPLC/Utilities)
File Edit View Search Tools Documents Help
index.rst x conf.py x utility_formulas.py x
1 #!/usr/bin/env python3
2 # -*- coding: utf-8 -*-
3
4 import math
5
6 GRAVITY = 32.174 # ft/s^2
7 WATER_SPEC_WEIGHT = 62.4 # lb/ft^3
8 WATER_DENSITY = 1.94 # slugs/ft^3
9 WATER_SPEC_GRAV = 1.0
10
11
12 def gravity_flow_rate(diameter, slope, rough_coeff=140):
13     """Calculates approximate fluid flow due to gravity.
14
15     Should be within 5% of actual value.
16
17     Based on the Hazen-Williams equation (https://en.wikipedia.org/wiki/Hazen-Williams\_equation). Assumes a 2 inch,
18     polyethylene pipe.
19
20     :param diameter: Pipe diameter, in inches
21     :param slope: Slope of pipe, from reservoir to measure point
22     :param rough_coeff: Roughness coefficient of pipe
23
24     :return: Approximate fluid flow rate, in gpm
25     """
26     coeff = math.pow(rough_coeff, 1.852)
27     diam = math.pow(diameter, 4.8704)
28     root_flow = math.sqrt(((coeff * diam * slope) / 4.52))
29     return root_flow
30
Python 3 Tab Width: 4 Ln 5, Col 1 INS
```

```
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC
File Edit View Search Terminal Help
dumping object inventory... done
build succeeded, 1 warnings.

The HTML pages are in _build/html.
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ ^C
cody@cody-Serval-WS ~/PycharmProjects/VirtualPLC $ make html
Running Sphinx v1.7.2
loading pickled environment... done
building [mo]: targets for 0 po files that are out of date
building [html]: targets for 0 source files that are out of date
updating environment: 0 added, 1 changed, 0 removed
reading sources... [100%] index
looking for now-outdated files... none found
pickling environment... done
checking consistency... done
preparing documents... done
writing output... [100%] index
generating indices... genindex py-modindex
writing additional pages... search
copying static files... done
copying extra files... done
dumping search index in English (code: en) ... done
dumping object inventory... done
build succeeded.

The HTML pages are in _build/html.
```


File Edit View Bookmarks Tools Window Help Welcome to VirtualPLC's documentation! — VirtualPLC 0.2 documentation

Welcome to VirtualPLC's d

file:///home/cody/PycharmProjects/VirtualPLC/_build/html/index.html Search DuckDuckGo

Table Of Contents

Welcome to VirtualPLC's documentation!

- Date: 4/9/18
- Date: 4/12/18

Indices and tables

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Show Source

Quick search

Welcome to VirtualPLC's documentation!

VirtualPLC valve.py

Purpose: Creates a generic Valve class for PLC-controlled SCADA systems.

Classes:

- Valve: Generic superclass Gate: Valve subclass; provides for an open/close valve Globe: Valve subclass; provides for a throttling valve Relief: Valve subclass; provides for a pressure-operated open/close valve

Author: Cody Jackson

Date: 4/9/18

Version 0.1

Initial build

```
class valve.Gate(name="", sys_flow_in=0.0, sys_flow_out=0.0, drop=0.0, position=0, flow_coeff=0.0, press_in=0.0)
```

Bases: **valve.Valve**

Open/closed valve.

Subclasses Valve.

Methods:

- read_position() turn_handle()

read_posittton()

Identify the position of the valve.

Returns: Indication of whether the valve is open or closed.

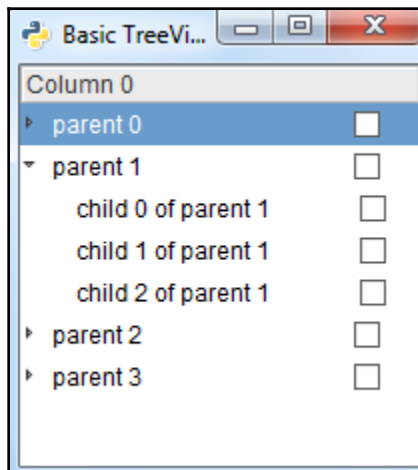
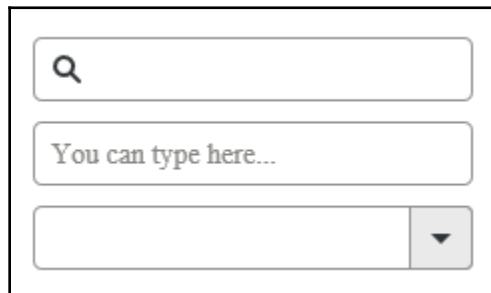
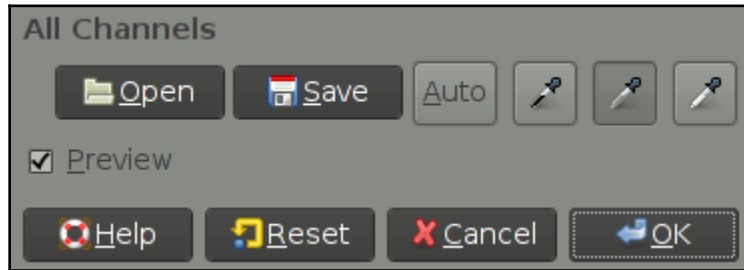
Return type: str

turn_handle(new_position)

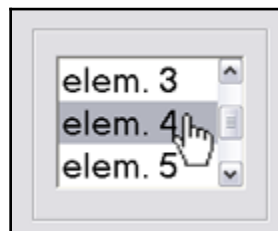
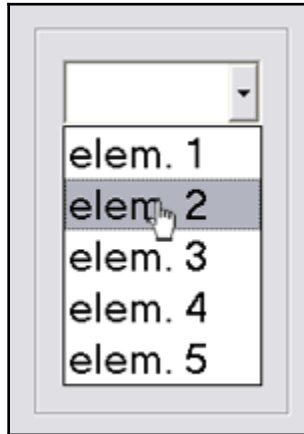
Change the status of the valve.

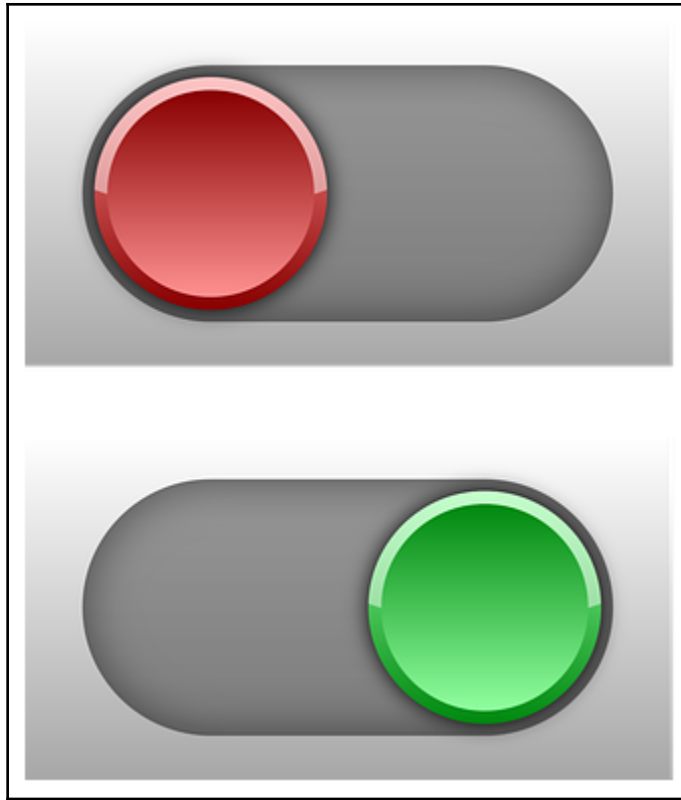
Parameters: new_position – New valve position

Chapter 11: Graphical User Interface Planning



-
- Radio Button One
 - Radio Button Two
 - Radio Button Three

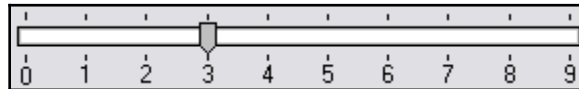
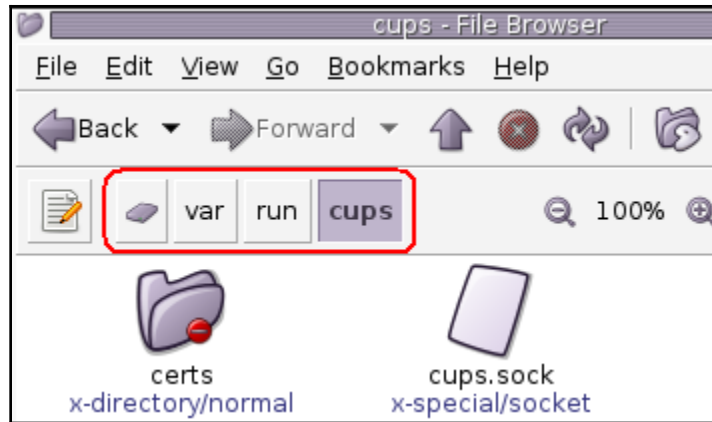




Date:

Date:

◀		Sep		▶		2023		▶	
Su	Mo	Tu	We	Th	Fr	Sa			
					1	2			
3	4	5	6	7	8	9			
10	11	12	13	14	15	16			
17	18	19	20	21	22	23			
24	25	26	27	28	29	30			



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Wolna encyklopedia

1 154 000+ hasel



soccer|

ES ▾



Fútbol

deporte de equipo jugado entre dos conjuntos de once jugadores cada uno y cuatro árbitros



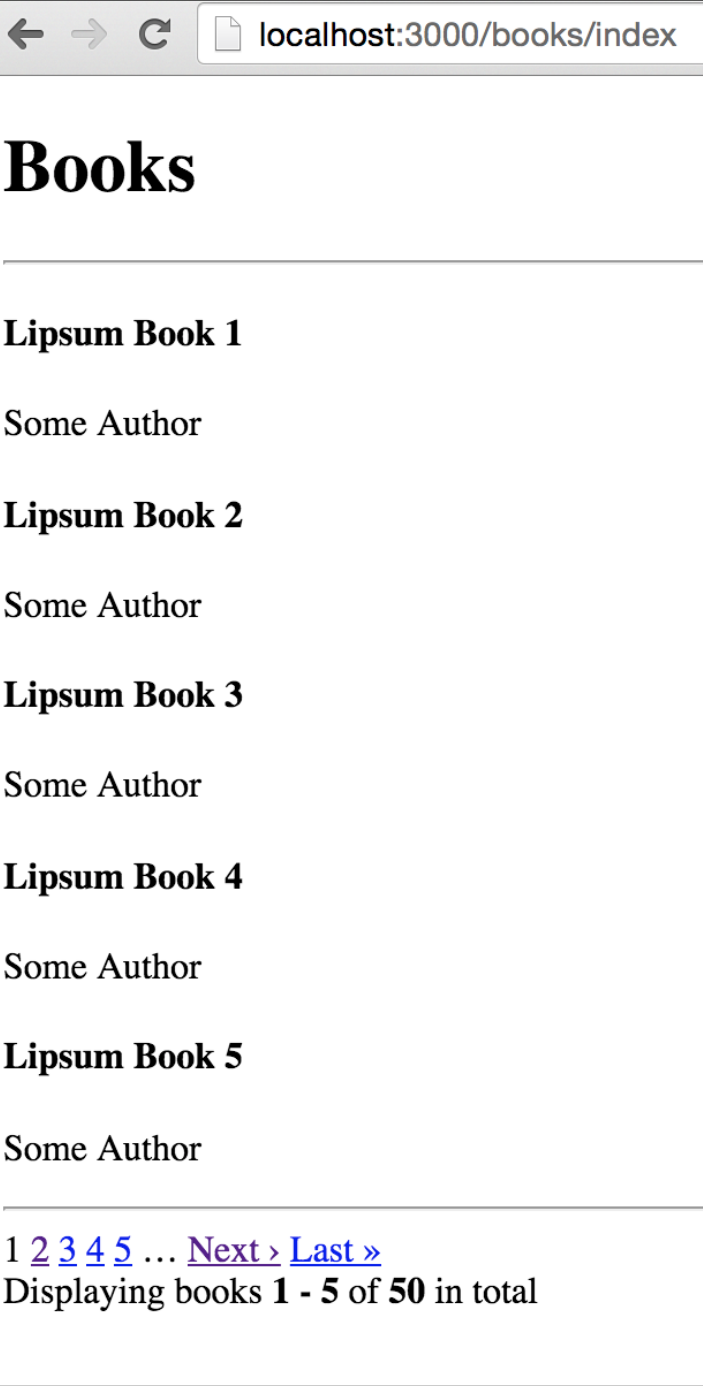
Soccer Bowl



Selección de fútbol de Australia

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й • Sinugboanong Binisaya • Svenska •



The screenshot shows a web browser window with the address bar containing "localhost:3000/books/index". The page content includes a main heading "Books", followed by five book entries. Each entry consists of a bold title "Lipsum Book X" and the text "Some Author". At the bottom, there is a pagination link "1 2 3 4 5 ... Next > Last »" and a status message "Displaying books 1 - 5 of 50 in total".

← → ↻ localhost:3000/books/index

Books

Lipsum Book 1
Some Author

Lipsum Book 2
Some Author

Lipsum Book 3
Some Author

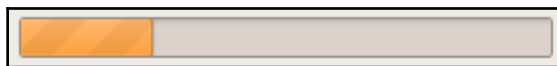
Lipsum Book 4
Some Author

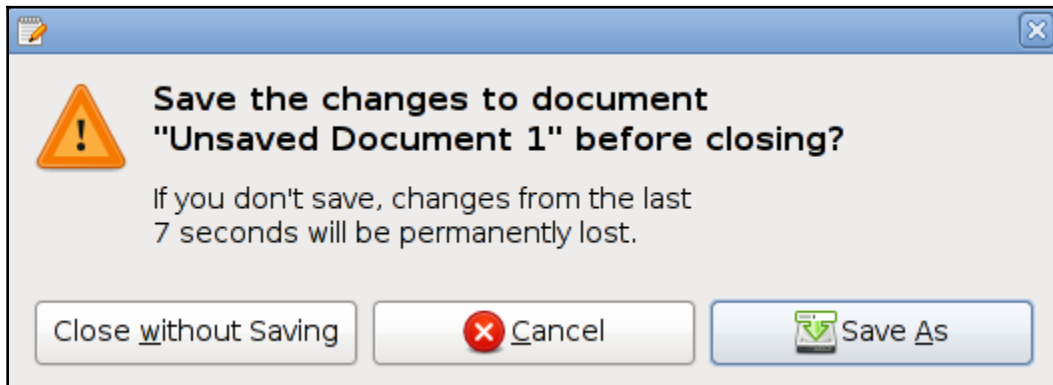
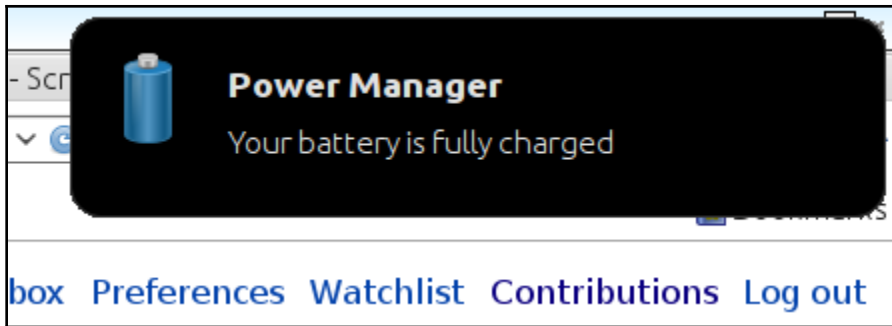
Lipsum Book 5
Some Author

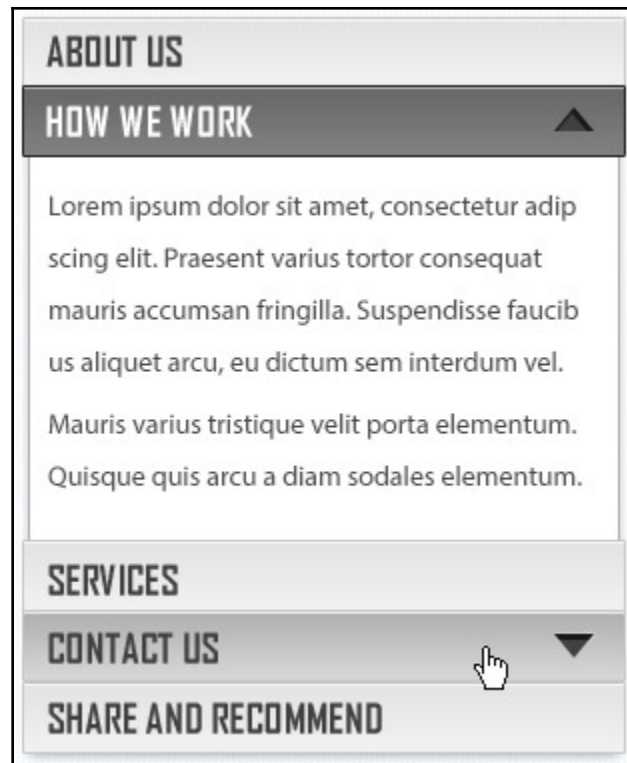
1 [2](#) [3](#) [4](#) [5](#) ... [Next >](#) [Last »](#)
Displaying books **1 - 5** of **50** in total



Demonstrations of tooltip usage are prevalent on Web pages. Many graphical [Web browsers](#) display the `title` attribute of an [HTML](#) element as a tooltip when a user hovers the mouse cursor over that element; in such a browser you should be able to hover over Wikipedia images and hyperlinks and see a tooltip application. [Hypertext Markup Language](#) Microsoft's [Internet Explorer](#),







entry	discussion	citations	edit	history	move	watch
-----------------------	----------------------------	---------------------------	----------------------	-------------------------	----------------------	-----------------------

jam

See also: [jamb](#), [Jam.](#) and [JAM](#)

English	Etymology [edit]
Albanian	From Latin <i>iam</i> .
Czech	Adverb [edit]
Dutch	jam
Esperanto	1. already
Indonesian	Esperanto categories: Esperanto terms derived from Latin
Interlingua	
Latgalian	

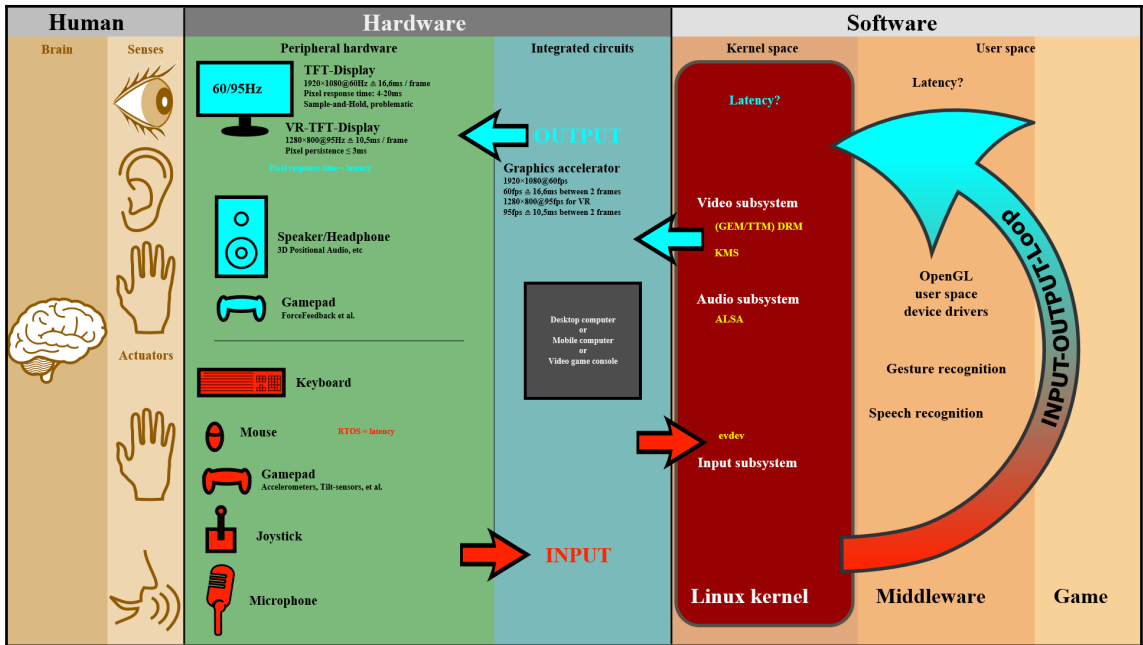
Review of Test Data Indicates Conservatism for Tile Penetration

- **The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data**
 - **Crater overpredicted penetration of tile coating significantly**
 - ◆ **Initial penetration to described by normal velocity**
 - Varies with volume/mass of projectile (e.g., 200ft/sec for 3cu. In)
 - ◆ **Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating**
 - Test results do show that it is possible at sufficient mass and velocity
 - ◆ **Conversely, once tile is penetrated SOFI can cause significant damage**
 - Minor variations in total energy (above penetration level) can cause significant tile damage
 - **Flight condition is significantly outside of test database**
 - ◆ **Volume of ramp is 1920cu in vs 3 cu in for test**

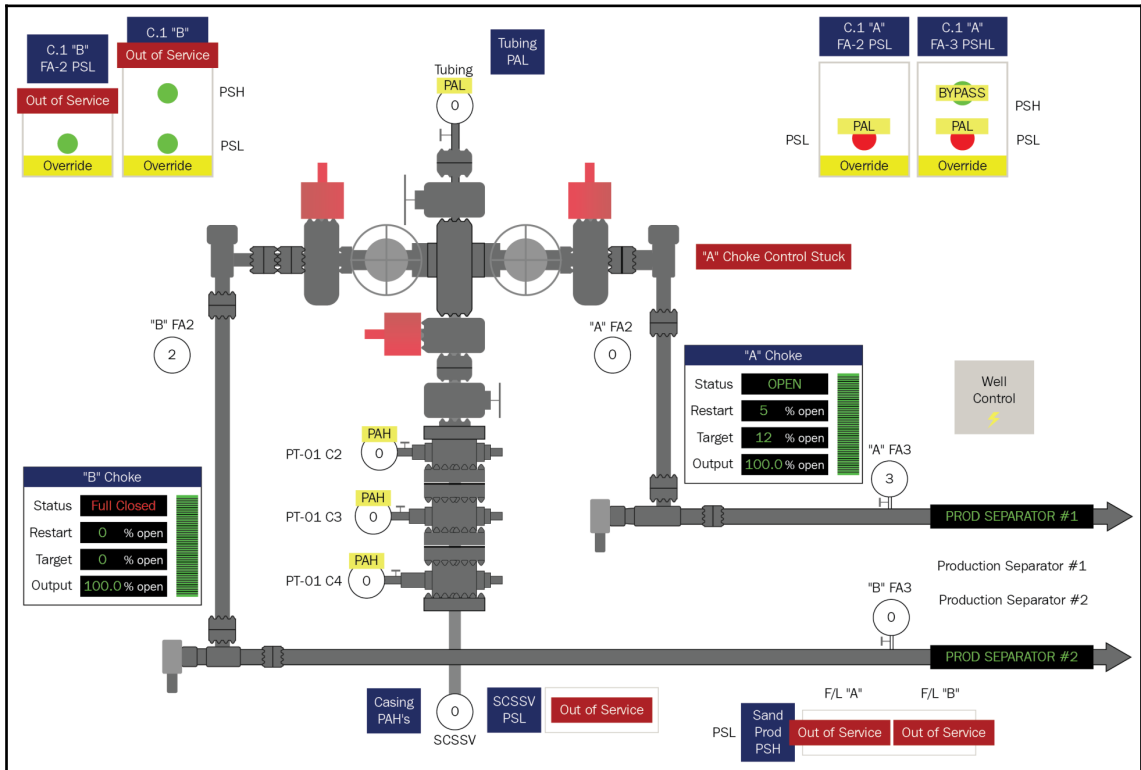


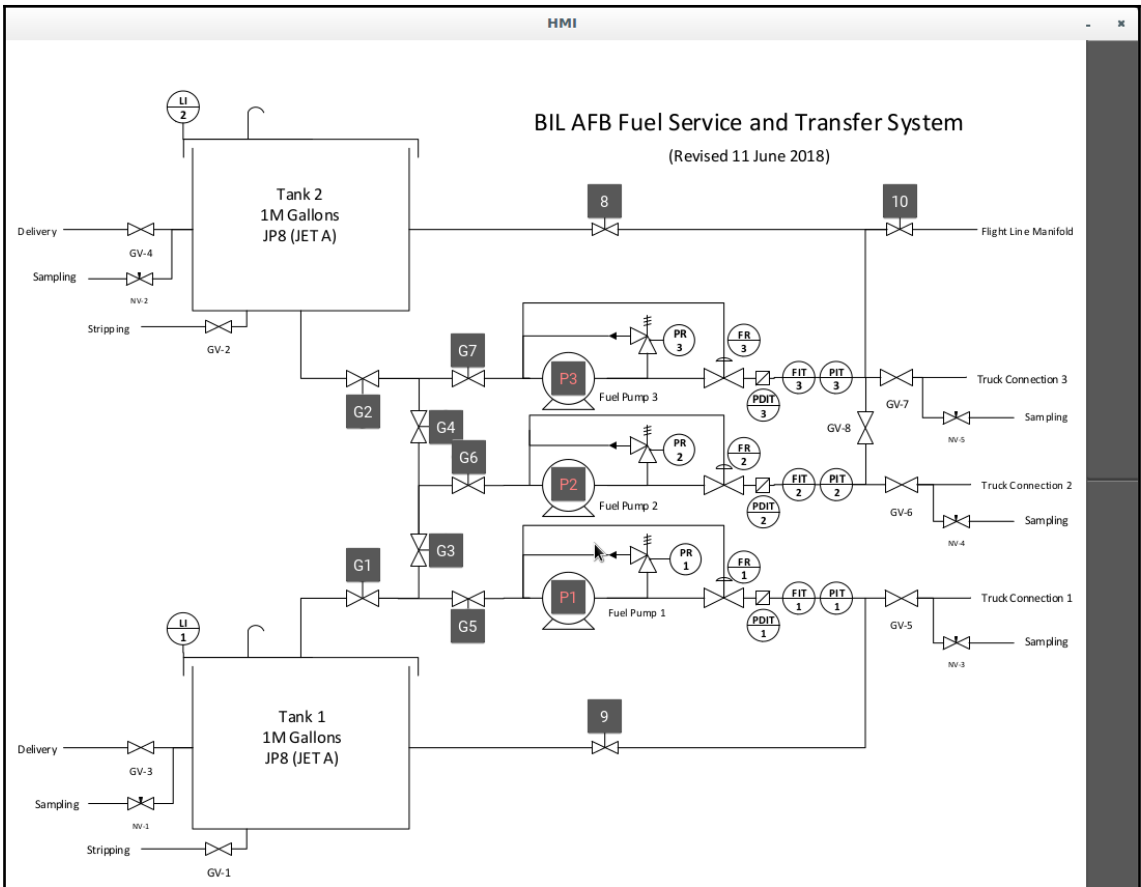
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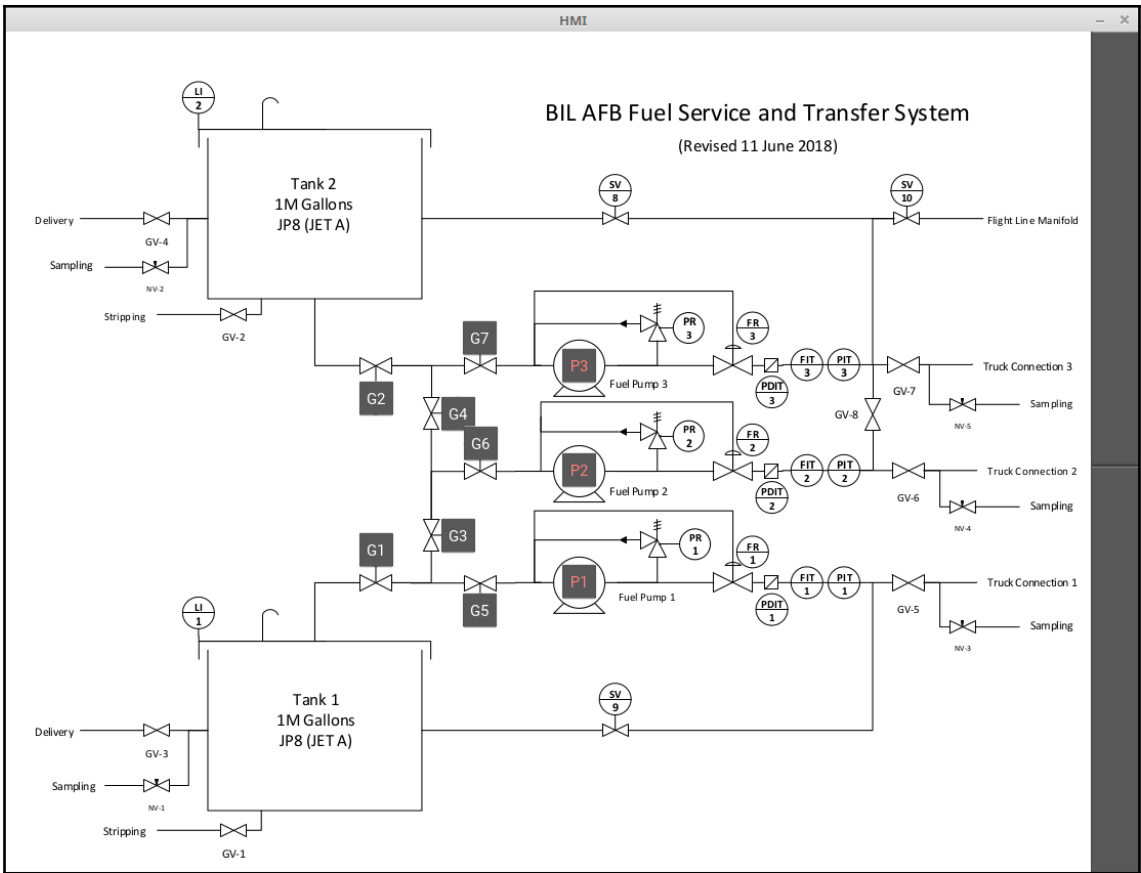


Chapter 12: Creating a Graphical User Interface

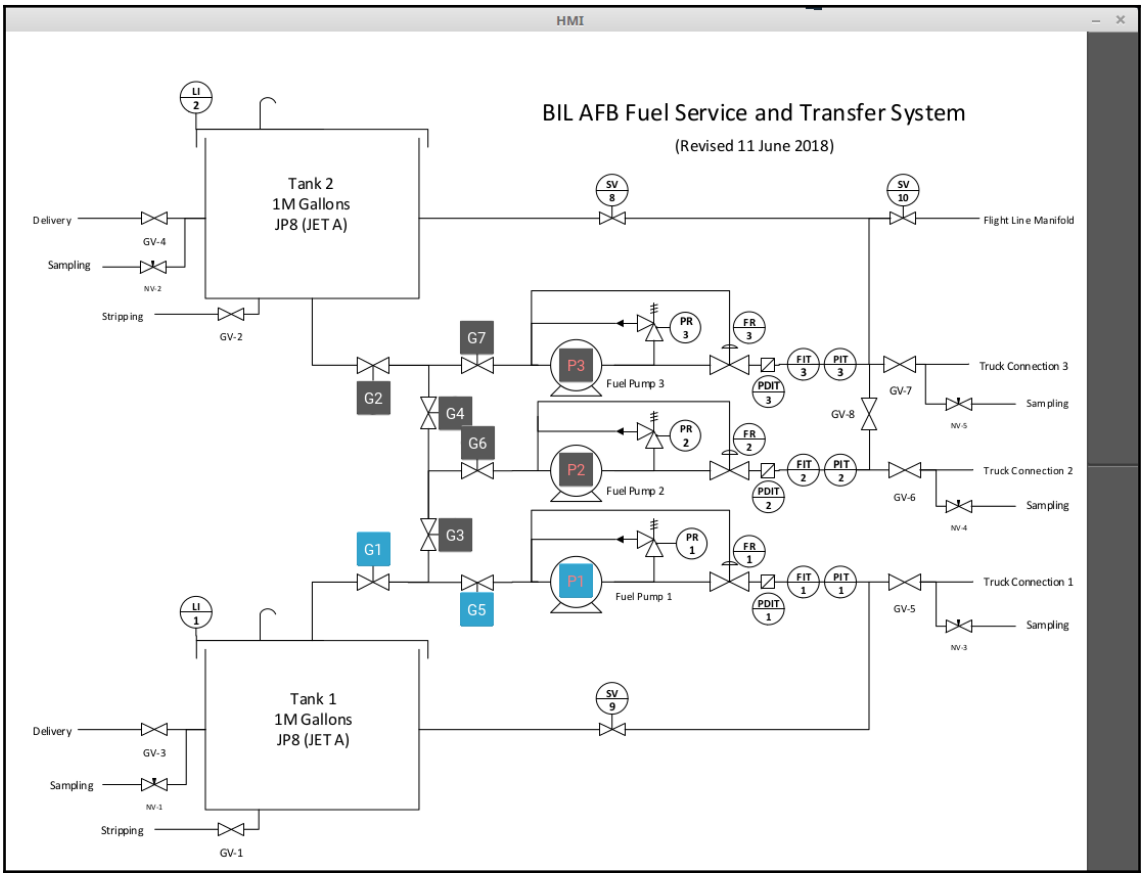




HMI						
Populate list	Tank	Level	Pressure Out	Flow Out		
	Tank 1	36.0	13.11	19542.87		
	Tank 2	36.0	13.11	19542.87		
	Valve	Position	Pressure In	Flow In	Pressure Out	Flow Out
	Gate valve 1	100	13.11	19542.87	13.11	19542.87
	Gate valve 2	0	13.11	19542.87	0.00	0.00
Clear list	Gate valve 3	0	13.11	19542.87	0.00	0.00
	Gate valve 4	0	0.00	0.00	0.00	0.00
	Gate valve 5	100	13.11	19542.87	13.11	19542.87
	Gate valve 6	0	0.00	0.00	0.00	0.00
	Gate valve 7	0	0.00	0.00	0.00	0.00
	Gate valve 8	0	0.00	0.00	0.00	0.00
	Gate valve 9	0	50.00	355.20	0.00	0.00
	Gate valve 10	0	0.00	0.00	0.00	0.00



HMI						
Populate list	Tank	Level	Pressure Out	Flow Out		
	Tank 1	36.0	13.11	19542.87		
	Tank 2	36.0	13.11	19542.87		
	Valve	Position	Pressure In	Flow In	Pressure Out	Flow Out
	Gate valve 1	0	13.11	19542.87	0.00	0.00
	Gate valve 2	0	13.11	19542.87	0.00	0.00
Clear list	Gate valve 3	0	0.00	0.00	0.00	0.00
	Gate valve 4	0	0.00	0.00	0.00	0.00
	Gate valve 5	0	0.00	0.00	0.00	0.00
	Gate valve 6	0	0.00	0.00	0.00	0.00
	Gate valve 7	0	0.00	0.00	0.00	0.00
	Pump	Speed	Wattage	Pressure Out	Flow Out	
Pump 1	0.00	0.00	0.00	0.00		



HMI						
Populate list	Tank 2	36.0	13.11	19542.87		
	Valve	Position	Pressure In	Flow In	Pressure Out	Flow Out
	Gate valve 1	100	13.11	19542.87	13.11	19542.87
	Gate valve 2	0	13.11	19542.87	0.00	0.00
	Gate valve 3	0	13.11	19542.87	0.00	0.00
	Gate valve 4	0	0.00	0.00	0.00	0.00
	Gate valve 5	100	13.11	19542.87	13.11	19542.87
Clear list	Gate valve 6	0	0.00	0.00	0.00	0.00
	Gate valve 7	0	13.11	19542.87	0.00	0.00
	Pump	Speed	Wattage	Pressure Out	Flow Out	
	Pump 1	1480.00	0.88	50.00	355.20	
	Pump 2	0.00	0.00	0.00	0.00	
	Pump 3	0.00	0.00	0.00	0.00	

