* Course Overview
* Iterators and Iterables
  + Iterators decouple retrieval from structure
  + Iterable: object which you can iterate
  + Iterators: encapsulate the current position in the iterable
    - Interface that allows us to get next value
    - And when iterable is exhausted
  + Python uses forward iterators
    - Traverse iterable in a forward direction
    - No option to jump around and go back
  + Can create reverse iterator
    - Forward iterator with their sense of forward reverse
  + Obtaining and advancing an iterator
    - iterator = iter(iterable)
    - try:
    - item = next(iterator)
    - print(item)
    - except StopIteration:
    - print(“No more items”)
  + Creating iterables
    - list = []
    - tuple = ()
    - dictionary = dict(a=””, b=””)
    - def iterable\_function()
    - yield value1
    - yield value2
    - iterable\_square = (x \* x for x in range(10))
  + Iterable
    - Object that can be passed successfully to built in iter function
    - iter call \_\_iter\_\_() on object, which returns an iterator
  + Iterator
    - Object that fulfills the iterator protocol
    - \_\_iter\_\_()
    - All iterator must also be iterables
    - \_\_next\_\_(): returns the next value or stop iteration
    - When next is called, it class \_\_next\_\_()
* Motivating Iterators: Tree Trav..
  + Binary tree can be represented in as a sequence
* Breath-first, Level-order Iterator
  + Perfect tree is (2^h) -1, h being the height of the tree
* Depth-first, Pre-order Iterator
  + Python doesn’t have a dedicated stack collection
  + But list has all the methods to use list as a stack
* Depth-first, In-order Iterator
* Filtering Iterators
* Transforming Iterators
* Iterables
  + Iterators are usually used indirectly, through iterable-consuming functions and for-loops
* The Alternative Iterable Protocol
  + \_\_getitem\_\_
    - Called to implement evaluation of sequence[index]
    - The accepted keys should be integers
    - If a value outside the set of indexes for the sequence IndexError should be raised
  + Ex)
  + def \_\_getitem\_\_(self, index):
  + if index >= self.number\_of\_items():
  + raise IndexError
  + return self.get\_element\_at(index)
* The Extended iter() Form
  + Two forms of iter()
    - iterator = iter(iterable)
    - iterator = iter(callable, sentinel)
  + iterator = iter(callable, sentinel)
    - Zero-argument callable: invoked once per iteration
    - Iteration ends when the callable produces this value
    - Converts simple functions into iterators
* Summary
  + next(iterator) delegates to iterator.\_\_next\_\_()
  + Iterators must support \_\_next\_\_()
  + \_\_next\_\_() should return the next item in the series
  + If there are no more items, \_\_next\_\_ should raise StopIteration
  + iter(iterable) delegates to iterable.\_\_iter\_\_()
  + Iterable objects must support \_\_iter\_\_()
  + \_\_iter\_\_() should return an iterator
  + Iterators must also be iterable, so implement both \_\_iter\_\_() and \_\_next\_\_()
  + Objects with a \_\_getitem\_\_() method that accepts consecutive integers from zero are also iterable
  + Iterables implemented via \_\_getitem\_\_() must raise IndexError when exhausted
  + The two-argument form of iter() accepts a zero-argument callable and a sentinel
  + On each iteration the callable is invoked, until the sentinel is returned
  + The iterator yields values from the callable
  + Convert simple functions into iterators
* Collection Protocols
  + Collections: container, sized, iterable, sequence, set, mapping, mutable sequence, mutable set, mutable mapping
  + To implement a protocol objects must support certain operations
  + Most collections implement container, sized, and iterable
  + All except dict, set and frozenset are sequences
  + SortedFrozenSet
    - A collection which is a sized, iterable, sequence container of a set of distinct items, and constructible from an iterable
  + Test Driven Development(TDD)
    - Write unit test before writing code to enable test to pass
    - Red(write test) -> green(write code to pass) -> refactor(improve)
* The Construction Convention
  + Need test\_ prefix for test function
    - This is how they are found and executed by test runner
  + Avoid using mutable collections as arguments
* The Container Protocol
  + Membership testing using in and not in
  + Special method: \_\_contains\_\_
  + Fallback to the iterable protocol
  + When possible always delegate to high level interface
* The Sized Protocol
  + Number of items using len(sized)
  + Must not consume or modify collection
  + Special method \_\_len\_\_()
* The Iterable Protocol
  + Obtain an iterator using iter(iterable)
  + Special method \_\_iter\_\_()
  + Fallback to the alternative iterable protocol with \_\_getitem\_\_()
* The Sequence Protocol
  + Implies container, sized, iterable
  + Retrieve an item by index, item = seq[index]
  + Optionally retrieve items by slicing, items = seq[start:stop]
  + Produce a reverse iterator, r = reversed(seq)
  + Locate an item by value, index = seq.index(item)
  + Count items: num = seq.count(item)
* Indexing
  + Items retrieved using square-brackets operator
  + Special method \_\_getitem\_\_ accepts an integer index
* Slicing
  + Items = sequence[start:stop:step]
  + Slice from start, up to but not including stop
  + Optional step value for stride
  + Implicit start from beginning if start is missing
  + Implicit stop to end if end is missing
  + Full slice for copying all elements if start and end is missing
* String Representation
* Value Equality
  + Default equality test is inherited from object
    - It checks for reference equality(equality of identity)
    - Rather than equivalence(equality of value)
  + List class overrides the default equality tet to be an equivalence test
    - [1, 2, 3] == [1, 2, 3] returns True
* Value Inequality
  + Python will implement inequality by negating the equality operator
  + Can override \_\_ne\_\_
    - Not equal
* The Hashable Protocol
  + When you implementing equality test you should consider hashing
  + Hashable objects can be passed to the built-in hash(hashable) function
  + hash(obj) returns an integer hash-code
  + Hashable objects can be used as dictionary keys, or as set elements
  + Immutable, value equality comparable objects should be hashable
  + Override special method \_\_hash\_\_()
  + Disable hashing for mutable objects by setting \_\_hash\_\_ = None
  + Requirement
    - Equal objects must return the same hash code
    - Unequal objects may return different hash codes
  + Have hashcode be based on type and values it contains
    - Make it more likely if different types of same values have different hashcodes
  + Use tuple to make hashcode from multiple objects
  + Make object immutable
* Reversing a Sequence
  + The built-in reversed() function returns an iterator:
    - Iterator = reversed(sequence)
  + Yields items in reverse order
  + Delegates to the \_\_reversed\_\_() special method
  + Fallback to \_\_getitem\_\_(index) and \_\_len\_\_() if supported
* The index() Method
  + Abstract base class, collections.abc.Sequence
    - Inherits from Collection(Sized, Iterable, Container)
  + Abstract methods
    - \_\_getitem\_\_
    - \_\_len\_\_
  + If abstract methods are implemented, mixin methods include
    - \_\_contains\_\_, \_\_iter\_\_, \_\_reversed, index, count
* The Extended Sequence Prot…
  + Optional extensions
  + Neither enforced nor provided by the Sequence
  + Immutable and mutable sequences
    - Concatenation with \_\_add\_\_ and \_\_radd\_\_
    - Repetition with \_\_mul\_\_ and \_\_rmul\_\_
  + Mutable sequences
    - In-place concatenation with \_\_iadd\_\_
    - In-place repetition with \_\_imull\_\_
    - In-place append extend insert pop reverse remove sort
  + For SortedFrozenSet it makes sense to do concatenation as a set union
    - Since Sets cannot have non-unique elements
* Refactoring for Performance
* Checking Performance
* The Collection Abstract Base
  + issubclass(derived class, base class)
    - Return true if derived class is descendent of base class
* The Set Protocol
  + Set inherits from collection(sized, iterable, container)
  + Abstract methods: \_\_contains\_\_, \_\_iter\_\_, \_\_len\_\_
  + A lot of other mixin methods
  + Relational predicates
* Going Further: Mutability
  + For a mutable version inherit MutableSet
  + Only two overrides needed: add() and discard()
* Summary
  + Collection protocols are at the heart of python
  + Container for membership tests
  + Sized for length determination
  + Iterable and Iterator for collection traversal
  + Sequence for random-access by index
  + Set for distinct elements