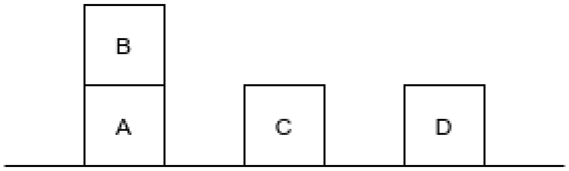
Task 7. Solve block world puzzle using goal stack planning technique

Solve the following block world puzzle using goal stack planning technique



Input Format:

Index of nodes and edges of problem graph.

Output Format:

Sequence of visited nodes of problem graph

Sample Code:

```
#Base Classes

#PREDICATE - ON, ONTABLE, CLEAR, HOLDING, ARMEMPTY
class PREDICATE:
  def __str__(self):
    pass
  def __repr__(self):
    pass
  def __eq__(self, other) :
    pass
  def __hash__(self):
    pass
  def get_action(self, world_state):
    pass


#OPERATIONS - Stack, Unstack, Pickup, Putdown
class Operation:
  def __str__(self):
    pass
  def __repr__(self):
    pass
  def __eq__(self, other) :
    pass
  def precondition(self):
    pass
  def delete(self):
    pass
  def add(self):
    pass
```

```
class ON(PREDICATE):

  def __init__(self, X, Y):
    self.X = X
    self.Y = Y

  def __str__(self):
    return "ON({X},{Y})".format(X=self.X,Y=self.Y)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def __hash__(self):
      return hash(str(self))

  def get_action(self, world_state):
    return StackOp(self.X,self.Y)


class ONTABLE(PREDICATE):

  def __init__(self, X):
    self.X = X

  def __str__(self):
    return "ONTABLE({X})".format(X=self.X)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def __hash__(self):
      return hash(str(self))

  def get_action(self, world_state):
    return PutdownOp(self.X)


class CLEAR(PREDICATE):

  def __init__(self, X):
    self.X = X

  def __str__(self):
    return "CLEAR({X})".format(X=self.X)
    self.X = X

  def __repr__(self):
    return self.__str__()
  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def __hash__(self):
    return hash(str(self))

  def get_action(self, world_state):
    for predicate in world_state:
      #If Block is on another block, unstack
      if isinstance(predicate,ON) and predicate.Y==self.X:
        return UnstackOp(predicate.X, predicate.Y)
    return None


class HOLDING(PREDICATE):

  def __init__(self, X):
    self.X = X

  def __str__(self):
    return "HOLDING({X})".format(X=self.X)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def __hash__(self):
    return hash(str(self))

  def get_action(self, world_state):
    X = self.X
    #If block is on table, pick up
    if ONTABLE(X) in world_state:
      return PickupOp(X)
    #If block is on another block, unstack
    else:
      for predicate in world_state:
        if isinstance(predicate,ON) and predicate.X==X:
          return UnstackOp(X,predicate.Y)


class ARMEMPTY(PREDICATE):

  def __init__(self):
    pass

  def __str__(self):
    return "ARMEMPTY"

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def __hash__(self):
    return hash(str(self))

  def get_action(self, world_state=[]):
    for predicate in world_state:
      if isinstance(predicate,HOLDING):
        return PutdownOp(predicate.X)
    return None


class StackOp(Operation):

  def __init__(self, X, Y):
    self.X = X
    self.Y = Y

  def __str__(self):
    return "STACK({X},{Y})".format(X=self.X,Y=self.Y)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def precondition(self):
    return [ CLEAR(self.Y) , HOLDING(self.X) ]

  def delete(self):
    return [ CLEAR(self.Y) , HOLDING(self.X) ]

  def add(self):
    return [ ARMEMPTY() , ON(self.X,self.Y) ]


class UnstackOp(Operation):

  def __init__(self, X, Y):
    self.X = X
    self.Y = Y

  def __str__(self):
    return "UNSTACK({X},{Y})".format(X=self.X,Y=self.Y)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def precondition(self):
    return [ ARMEMPTY() , ON(self.X,self.Y) , CLEAR(self.X) ]
  def delete(self):
    return [ ARMEMPTY() , ON(self.X,self.Y) ]

  def add(self):
    return [ CLEAR(self.Y) , HOLDING(self.X) ]


class PickupOp(Operation):

  def __init__(self, X):
    self.X = X

  def __str__(self):
    return "PICKUP({X})".format(X=self.X)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def precondition(self):
    return [ CLEAR(self.X) , ONTABLE(self.X) , ARMEMPTY() ]

  def delete(self):
    return [ ARMEMPTY() , ONTABLE(self.X) ]

  def add(self):
    return [ HOLDING(self.X) ]


class PutdownOp(Operation):

  def __init__(self, X):
    self.X = X

  def __str__(self):
    return "PUTDOWN({X})".format(X=self.X)

  def __repr__(self):
    return self.__str__()

  def __eq__(self, other) :
    return self.__dict__ == other.__dict__ and self.__class__ ==
other.__class__

  def precondition(self):
    return [ HOLDING(self.X) ]

  def delete(self):
    return [ HOLDING(self.X) ]

  def add(self):
    return [ ARMEMPTY() , ONTABLE(self.X) ]
```

```
def isPredicate(obj):
  predicates = [ON, ONTABLE, CLEAR, HOLDING, ARMEMPTY]
  for predicate in predicates:
    if isinstance(obj,predicate):
      return True
  return False

def isOperation(obj):
  operations = [StackOp, UnstackOp, PickupOp, PutdownOp]
  for operation in operations:
    if isinstance(obj,operation):
      return True
  return False

def arm_status(world_state):
  for predicate in world_state:
    if isinstance(predicate, HOLDING):
      return predicate
  return ARMEMPTY()


class GoalStackPlanner:

  def __init__(self, initial_state, goal_state):
    self.initial_state = initial_state
    self.goal_state = goal_state

  def get_steps(self):

    #Store Steps
    steps = []

    #Program Stack
    stack = []

    #World State/Knowledge Base
    world_state = self.initial_state.copy()

    #Initially push the goal_state as compound goal onto the stack
    stack.append(self.goal_state.copy())

    #Repeat until the stack is empty
    while len(stack)!=0:

      #Get the top of the stack
      stack_top = stack[-1]

      #If Stack Top is Compound Goal, push its unsatisfied goals onto stack
      if type(stack_top) is list:
        compound_goal = stack.pop()
        for goal in compound_goal:
          if goal not in world_state:
            stack.append(goal)

      #If Stack Top is an action
      elif isOperation(stack_top):
        #Peek the operation
        operation = stack[-1]

        all_preconditions_satisfied = True

        #Check if any precondition is unsatisfied and push it onto program
stack
        for predicate in operation.delete():
          if predicate not in world_state:
            all_preconditions_satisfied = False
            stack.append(predicate)

        #If all preconditions are satisfied, pop operation from stack and
execute it
        if all_preconditions_satisfied:

          stack.pop()
          steps.append(operation)

          for predicate in operation.delete():
            world_state.remove(predicate)
          for predicate in operation.add():
            world_state.append(predicate)


      #If Stack Top is a single satisfied goal
      elif stack_top in world_state:
        stack.pop()

      #If Stack Top is a single unsatisfied goal
      else:
        unsatisfied_goal = stack.pop()

        #Replace Unsatisfied Goal with an action that can complete it
        action = unsatisfied_goal.get_action(world_state)

        stack.append(action)
        #Push Precondition on the stack
        for predicate in action.precondition():
          if predicate not in world_state:
            stack.append(predicate)

    return steps

if __name__ == '__main__':
  initial_state = [
    ON('B','A'),
    ONTABLE('A'),ONTABLE('C'),ONTABLE('D'),
    CLEAR('B'),CLEAR('C'),CLEAR('D'),
    ARMEMPTY()
  ]

  goal_state = [
    ON('B','D'),ON('C','A'),
    ONTABLE('D'),ONTABLE('A'),
    CLEAR('B'),CLEAR('C'),
    ARMEMPTY()
  ]

  goal_stack = GoalStackPlanner(initial_state=initial_state,
goal_state=goal_state)
  steps = goal_stack.get_steps()
  print(steps)
```