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//

//TEST RUN Q1//

//

```
int main(){
    string Example="######  #.  .####@$#$  ##$. .$ ##    $.#########";
    char* Ex=&Example[0];
    Sokoban B=Sokoban(Ex);
    cout<<"1"<<endl;
    B.print_puzzle();
    Sokoban A=Sokoban(1);
    cout<<"2"<<endl;A.print_puzzle();

    A.move_up();
    cout<<"3"<<endl;A.print_puzzle();

    A.move_right();

    cout<<"EE441 "<<endl;A.print_puzzle();

    A.move_down();
    cout<<"HCN"<<endl;A.print_puzzle();

    A.move_down();
  cout<<"2166973"<<endl;A.print_puzzle();
    if(A.is_solved())
        cout<<"Puzzle Solved"<<endl;
    else
        cout<<"Puzzle Not Solved"<<endl;
```

```
1
# # # # # #
# .     . # # #
# @ $ # $     #
# $ .   . $   #
#         $ . #
# # # # # # # #

2
# # # # # #
# .     . # # #
# @ $ # $     #
# $ .   . $   #
#         $ . #
# # # # # # # #

3
# # # # # #
# +     . # # #
#   $ # $     #
# $ .   . $   #
#         $ . #
# # # # # # # #

EE441
# # # # # #
# . @   . # # #
#   $ # $     #
# $ .   . $   #
#         $ . #
# # # # # # # #

HCN
# # # # # #
# .     . # # #
#   @ # $     #
# $ *   . $   #
#         $ . #
# # # # # # # #

2166973
# # # # # #
# .     . # # #
#     # $     #
# $ +   . $   #
#   $     $ . #
# # # # # # # #

Puzzle Not Solved
```

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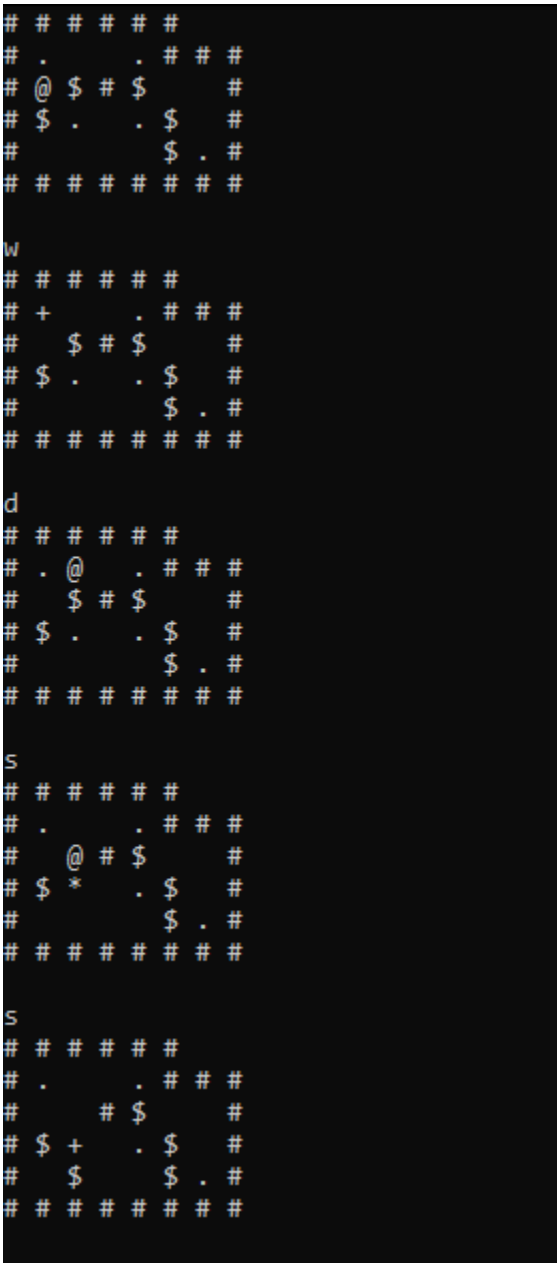
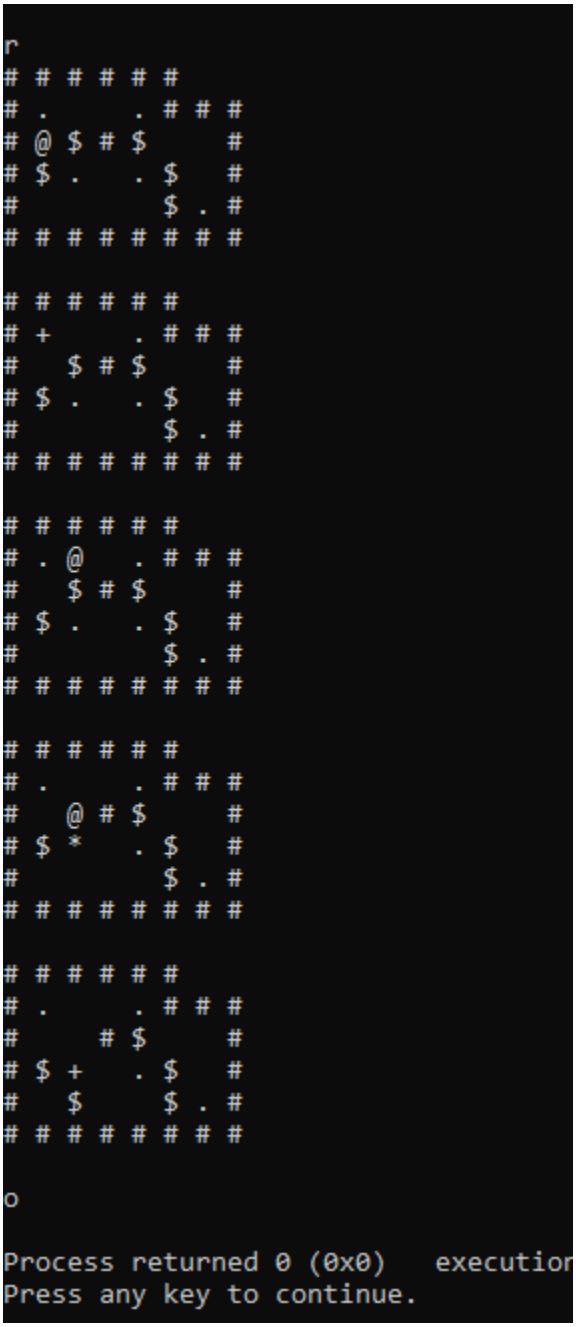
//

//TEST RUN Q3orQ4//

//

w, d, s, s, r, o key presses were performed.





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EE441 Programming Assignment I: *Classes, Stacks, Queues and Linked Lists*

Q1) Implement a class Sokoban that represents a Sokoban puzzle.

```
const int nRow = 6;
const int nColumn = 8;
const int nElement= nRow*nColumn;
const int nSize=100;

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban Declaration
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
class Sokoban{
   private:
      char mMap[nElement];//array that holds the game map.
      int findPlayer() const;//Method that returns the player location such that row 3 column 3 will return 27
      int moveCheck(int pLoc, int shift, int i=0);//method that determines if the move is valid.
      void Edit(int pLoc, int shift, int i);//edits the game map according to provided parameters.
   public:
      //Constructors
      Sokoban(const char Map[nElement]);//initializes the class from a char array
      Sokoban();//default constructor
      Sokoban(int i);// initializes the class from a text file.

      Sokoban(const Sokoban &obj);//a copy constructor
      Sokoban& operator=(const Sokoban &rhs);//copy assignment operator
      //move methods
```

```
        bool move_up();
        bool move_down();
        bool move_left();
        bool move_right();

        bool is_solved();//checks puzzle if it is solved.

        void print_puzzle() const;//prints current puzzle map
};
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban Method Definitions
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban default constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
Sokoban::Sokoban(){}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban constructor (initializes the class from a char array)
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
Sokoban::Sokoban(const char Map[nElement]){
//copies each array element one by one
for(int i=0; i<nElement;i++)
    *(mMap+i)=*(Map+i);}
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban constructor (initializes the class from a text file.)
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
Sokoban::Sokoban(int i){//int i is used to have parameter difference between constructors
string filename = "sample_puzzle.txt";
char* fileloc = &filename[0];//char * is solved the problem I had with the file.open(fileloc) line
//used the provided code with minor changes.
char data[6][8];
char dummy;

ifstream file;
file.open(fileloc);
for(int i=0; i<6; ++i){
   for(int j=0; j<8; ++j){
      file >> noskipws >> data[i][j];
      mMap[i*8+j]=data[i][j];//assigns char values to dynamic memory.
   }
   file >> noskipws >> dummy;
}file.close(); }
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban copy constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
Sokoban::Sokoban(const Sokoban &obj){
//copies each array element one by one
for(int i=0; i<nElement;i++)
   *(mMap+i) = *(obj.mMap+i); }
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban = operator definition
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
Sokoban& Sokoban::operator=(const Sokoban &rhs){
//copies each array element one by one
for(int i=0; i<nElement;i++)
   *(mMap+i)=*(rhs.mMap+i);
return *this;//this object is returned
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban puzzle print function
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void Sokoban::print_puzzle() const{//prints all 48 elements of the mMap[48]
for(int i=0; i<6; ++i){
   for(int j=0; j<8; ++j){
      cout<<mMap[i*8+j]<<" ";}
   cout<<endl;}
cout<<endl;}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban is_solved function
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
bool Sokoban::is_solved(){
for(int i=1; i<nRow-1; ++i){
   for(int j=1; j<nColumn-1; ++j){
      if(mMap[i*8+j]=='.' || mMap[i*8+j]=='+')
         return false;}}
return true;//returns true if there are no target location or the player at a target location is found
}
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban findPlayer function
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
int Sokoban::findPlayer() const{
// returns the location of "the player" or "the player at a target location"
for(int i=1; i<nRow-1; ++i){
   for(int j=1; j<nColumn-1; ++j){
      if(mMap[i*8+j]=='@' || mMap[i*8+j]=='+')
         return i*8+j;
   }
}
cerr<<"Error: Player not found."<<endl;
return -1;}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban moveCheck function
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
int Sokoban::moveCheck(int pLoc, int shift, int i){          //int i=0 by default.
//Shift= 1 for move right, -8 for //move up. pLoc is player location
if(mMap[pLoc+shift]=='#')                                    //if there is a wall ahead
   return 0;                                                 //move is invalid
else if(mMap[pLoc+shift]=='$' || mMap[pLoc+shift]=='*')   //if there is a box ahead
   if(i==0)                                                  //if moveCheck called for the first time
      return moveCheck(pLoc+shift, shift, 1);                //check what is behind the box
   else                                 //another box is found ahead at 2nd call of the function
      return 0;                                              //move is invalid
else                              //move is valid returns 2 if function is called once, 3 if called twice
   return 2+i;                                               //valid move.
}//returning integer lets us know the how many elements will be edited in the mMap[]
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban Edit function(edits game map)
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void Sokoban::Edit(int pLoc, int shift, int i){
//pLoc player location shift== 1 for move right, -8 for move up. i = moveCheck()(2 or 3)
//called only if the move is valid.
    for(int k=0; k<i; k++){
// pLoc+k*shift -> k=0 player location k=1 location front of the player...
// here comments start with if player means if there is a player at the pLoc+k*shift
//if it is true then under the statement I commented what will that location will be converted to
        if(mMap[pLoc+k*shift]=='@')//if player //can be true only for k=0
            mMap[pLoc+k*shift]=' ';// empty cell
        else if(mMap[pLoc+k*shift]=='+')//if player on target//can be true only for k=0
            mMap[pLoc+k*shift]='.';// target location.
        else if(mMap[pLoc+k*shift]=='$') // if box  //can be true only for k>0
            mMap[pLoc+k*shift]='@';//player
        else if(mMap[pLoc+k*shift]=='*')//if box on target  //can be true only for k>0
            mMap[pLoc+k*shift]='+';//player on target
        else if(mMap[pLoc+k*shift]==' ')//if empty cell  //can be true only for k>0
            if(k==1)//if the first location further the Player Location
                mMap[pLoc+k*shift]='@';//player
            else// if the second location further the Player Location
                mMap[pLoc+k*shift]='$';//box
        else if(mMap[pLoc+k*shift]=='.')//if target  //can be true only for k>0
            if(k==1)//if the first location further the Player Location
                mMap[pLoc+k*shift]='+';//player on target
            else// if the second location further the Player Location
                mMap[pLoc+k*shift]='*';//box on target
```

```
        else;//line is added to eliminate ambiguity of else statement.
    }
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban move_up function//move functions have same structure.
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
bool Sokoban::move_up(){
    int pLoc = findPlayer();//returns player location
    int moveCase = moveCheck(pLoc, -1*nColumn );//returns 0, 2 or 3
    if(moveCase==0)//invalid move
        return false;
    else{//valid move
        Edit(pLoc, -1*nColumn, moveCase);//edits the map according to shift amount and case2or3
        return true;
    }
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban move_down function//only 2nd parameter of edit and movecheck function
differs
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
bool Sokoban::move_down(){
    int pLoc = findPlayer();//returns player location
    int moveCase = moveCheck(pLoc, nColumn );//returns 0, 2 or 3
    if(moveCase==0)//invalid move
        return false;
    else{//valid move
        Edit(pLoc, nColumn, moveCase);//edits the map according to shift amount and case2or3
        return true;
    }}
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban move_left function//only 2nd parameter of edit and movecheck function differs
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
bool Sokoban::move_left(){
    int pLoc = findPlayer();//returns player location
    int moveCase = moveCheck(pLoc, -1 );//returns 0, 2 or 3
    if(moveCase==0)//invalid move
        return false;
    else{//valid move
        Edit(pLoc, -1, moveCase);//edits the map according to shift amount and case2or3
        return true;
    }
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Sokoban move_right function//only 2nd parameter of edit and moveCheck function
differs
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
bool Sokoban::move_right(){
    int pLoc = findPlayer();//returns player location
    int moveCase = moveCheck(pLoc, 1 );
    if(moveCase==0)//invalid move
        return false;
    else{//valid move
        Edit(pLoc, 1, moveCase);//edits the map according to shift amount and case2or3
        return true;
    }
}
```

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//

//TEST RUN//

//

```
int main(){
    string Example="######  #.  .####@$#$  ##$. .$ ##    $.#########";
    char* Ex=&Example[0];
    Sokoban B=Sokoban(Ex);
    cout<<"1"<<endl;
    B.print_puzzle();
    Sokoban A=Sokoban(1);
    cout<<"2"<<endl;A.print_puzzle();

    A.move_up();
    cout<<"3"<<endl;A.print_puzzle();

    A.move_right();

    cout<<"EE441 "<<endl;A.print_puzzle();

    A.move_down();
    cout<<"HCN"<<endl;A.print_puzzle();

    A.move_down();
  cout<<"2166973"<<endl;A.print_puzzle();
    if(A.is_solved())
        cout<<"Puzzle Solved"<<endl;
    else
        cout<<"Puzzle Not Solved"<<endl;
```

```
1
# # # # # #
# .       . # # #
# @ $ # $       #
# $ .     . $     #
#             $ . #
# # # # # # # # #

2
# # # # # #
# .       . # # #
# @ $ # $       #
# $ .     . $     #
#             $ . #
# # # # # # # # #

3
# # # # # #
# +       . # # #
#     $ # $       #
# $ .     . $     #
#             $ . #
# # # # # # # # #

EE441
# # # # # #
# . @     . # # #
#     $ # $       #
# $ .     . $     #
#             $ . #
# # # # # # # # #

HCN
# # # # # #
# .       . # # #
#     @ # $       #
# $ *     . $     #
#             $ . #
# # # # # # # # #

2166973
# # # # # #
# .       . # # #
#       # $       #
# $ +     . $     #
#     $       $ . #
# # # # # # # # #

Puzzle Not Solved
```

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Q2) Implement a mixed StackQueue template class.

```
const int nSize=100;
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Declaration
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////

template <class T>
class StackQueue{
private:

   T mSQ[nSize];//memory element
   int mTop;//indicates the state of the stack

public:

   StackQueue();//default constructor
   StackQueue(const StackQueue<T>& obj);//copy constructor
   StackQueue<T>& operator=(const StackQueue<T>& rhs);//assignment operator

   void Push_front(const T& item);//Push method
   T Pop_front();//pop method
   T Pop_rear();//pop rear method
   T Peek() const;//peek method

   bool Empty() const;//true if stack is empty
   bool Full() const;//true if stack is full

};
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Method Definitions
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue default constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>::StackQueue():mTop(0){}//default constructor assigns 0 to mTop
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue copy constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>::StackQueue(const StackQueue<T>& obj){
mTop=obj.mTop;//copy the state of the obj stackqueue

if(!obj.Empty())//checks if the obj was empty
for(int i=0;i<mTop;i++)//copy each element till the the mTop^th element
   mSQ[i]=obj.mSQ[i];}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue overloading assignment operator
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>& StackQueue<T>::operator=(const StackQueue<T>& rhs){
   mTop=rhs.mTop;//copy the state of the obj stackqueue

   if(!rhs.Empty())//checks if the obj was empty
      for(int i=0;i<mTop;i++)//copy each element till the the mTop^th element
         mSQ[i]=rhs.mSQ[i];
return* this;}
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue empty method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
bool StackQueue<T>::Empty()const{
   if(mTop==0)//only checking the state of the stack queue using mTop
      return true;
   else
      return false;}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue full method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
bool StackQueue<T>::Full()const{
   if(mTop==nSize-1)//similar to empty method checking state only using mTop
      return true;
   else
      return false;}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue push front method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
void StackQueue<T>::Push_front(const T& item){
if(!Full()){//action taken if the stack is not full
   mSQ[mTop]=item;//item is added to stack
   mTop++;}//state of the  stack is changed
else
   cout<<"Error: SQ is full!"<<endl; }//prints out a message if the stack is full
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue pop front method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Pop_front(){
if(!Empty()){//action taken for non-empty stack
   mTop--;//state of the  stack is changed
   return mSQ[mTop];}//popped item returned
else{//if empty
   T UNDEF;//uninitialized variable
   cout<<"Error: SQ is empty!"<<endl;//prints out a message if the stack is empty
   return UNDEF;}}//stack returnes declared but uninitialized variable
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue pop rear method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Pop_rear(){
if(!Empty()){//action taken for non-empty stack
   T temp = mSQ[0];//return first added element
   for(int i=0;i<mTop-1;i++)//shifting each variable in the stack
      mSQ[i]=mSQ[i+1];
   mTop--;//state of the  stack is changed
   return temp;}//popped item returned
else{
   T UNDEF;//uninitialized variable
   cout<<"Error: SQ is empty!"<<endl;//prints out a message if the stack is empty
   return UNDEF;} }//stack returnes declared but uninitialized variable
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue peek method(front)
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Peek()const{
if(!Empty()){//action taken for non-empty stack
   return mSQ[mTop-1];}//return last added element
else{
   T UNDEF;//uninitialized variable
   cout<<"Error: SQ is empty!"<<endl;//prints out a message if the stack is empty
   return UNDEF;}}//stack returnes declared but uninitialized variable
```

Q3) In your main function, instantiate a Sokoban class and a StackQueue class with the template argument Sokoban. You can use the puzzle in Q1 as the initial state. Write a code to respond to given key press events.

I have made an infinite loop for this question. Key press events are handled with ‘cin>>’ command.

```
int main()
{
   Sokoban A=Sokoban(1);
  //  cout<<"2"<<endl;
   A.print_puzzle();
   StackQueue<Sokoban> S1;//S1 stackqueue of Sokoban template class
   S1.Push_front(A);//added A to S1

   int i = 1;//initialize i=1
   char X;//declared input character
   while(i==1){//infinite loop
```

```
    cin>>X;
// Movement keys: w, a, s, d; Go Back: z; Replay: r; Quit: o.
    if(X=='o')//pressing 'o' will cause exit the program
      return 0;
    else if(X=='w'&& A.move_up()){
      A.print_puzzle();
      S1.Push_front(A);
    }
    else if(X=='a'&& A.move_left()){
      A.print_puzzle();
      S1.Push_front(A);
    }
    else if(X=='s'&& A.move_down()){
      A.print_puzzle();
      S1.Push_front(A);
    }
    else if(X=='d'&& A.move_right()){
      A.print_puzzle();
      S1.Push_front(A);
    }
    else if(X=='z'){
      S1.Pop_front();
      if(!S1.Empty())
        A=S1.Peek();// A is used as a temp variable
      else
        S1.Push_front(A);//if S1 is empty then A is loaded again
      A.print_puzzle();//so S1 is never becomes empty outside of this else if statement
    }
```

```
        else if(X=='r'){
            StackQueue<Sokoban> S2(S1);
            //S2=S1;
            while(!S2.Empty())
                S2.Pop_rear().print_puzzle();
            return 0;
        }
        if(A.is_solved())
            cout<<"Puzzle Solved"<<endl;//printed if the puzzle is solved
    }
    return 0;
}
```

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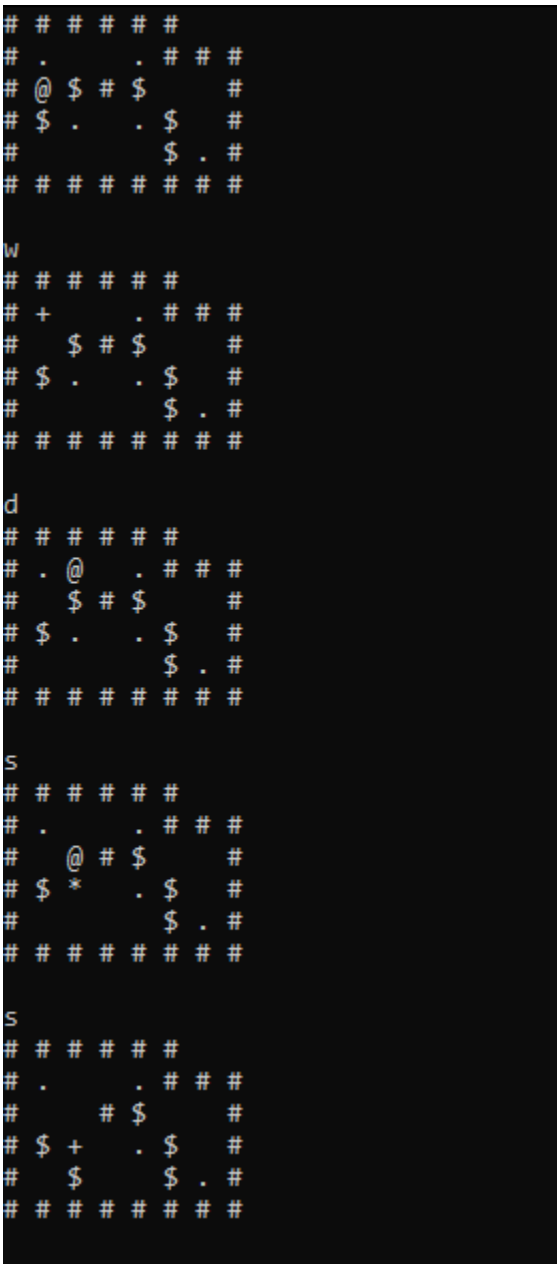
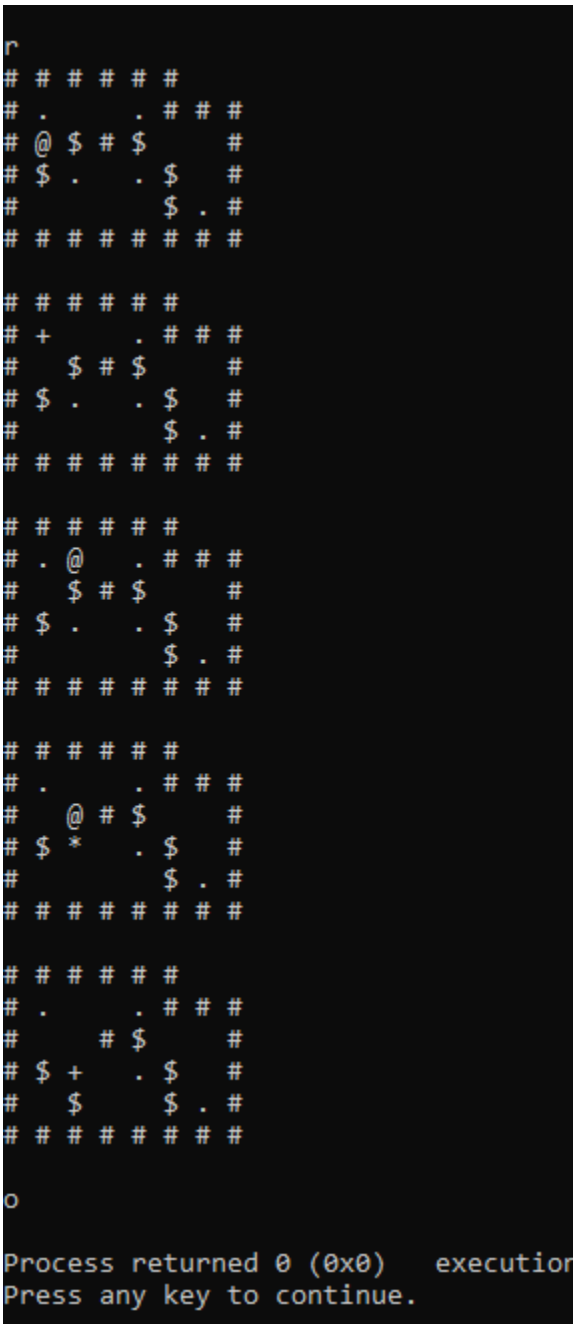
//

//TEST RUN//

//

w, d, s, s, r, o key presses were performed.





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Q4) Implement a doubly-linked list class.

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node Decleration
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template<class T>
class node
{
private:
   node<T>* mNext;//pointer for next node
   node<T>* mPrev;//pointer for previous node
public:
   T mData;//data(memory element)
   node();//constructor
   node(const T& x);//alternative constructor

        node *getprev();//returns pointer to previous node
        node *getnext();//returns pointer to next node

        void InsertF(node<T> *p);//inserts a node poited by p to front of the current node
        void InsertB(node<T> *p);//inserts a node poited by p to back of the current node
        node<T>* DeleteF();//deletes the node front of the current node
        node<T>* DeleteB();//deletes the node back of the current node
};
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node default constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//initally both pointers of the node points the node itself
node<T>::node() : mNext(this), mPrev(this){}

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node alternative constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//initally both pointers of the node points the node itself
node<T>::node(const T& x) : mNext(this), mPrev(this), mData(x) {}//node also have data member initialized

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node getprev method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//returns pointer to previous node
node<T>* node<T>::getprev(){return mPrev;}

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node getnext method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//returns pointer to next node
node<T>* node<T>::getnext(){return mNext;}

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node insertfront method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//inserts another node front in 4 steps
```

```
void node<T>::InsertF(node<T> *p){
    p->mNext=mNext;
    p->mPrev=this;
    p->getnext()->mPrev=p;
    mNext=p;}


////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node InsertBack method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>//inserts another node at back in 4 steps
void node<T>::InsertB(node<T> *p){
    p->getprev=mPrev;
    p->mNext=this;
    p->getPrev->mNext=p;
    mPrev=p;}


////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node DeleteFront Method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
node<T>* node<T>::DeleteF(){//deletes node at front
    node* temp=getnext();//save the memory location to delete the node later
    if (temp!=this){//deletion will not happen if this is a header for the stackqueue class.
        getnext()->getnext()->mPrev=this;//2 pointers edited for skipping an element in the list
        mNext=getnext()->mNext;}
    return temp;}//pointer to node is returned so that it can be deleted
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class Node DeleteBack Method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
node<T>* node<T>::DeleteB(){//deletes node at back
    node* temp=getprev();//save the memory location to delete the node prior
  //  T tempdata=temp->mData;//data stored in the node back is saved
    if (temp!=this){//deletion will not happen if this is a header for the stackqueue class.
        getprev()->getprev()->mNext=this;//2 pointers edited for skipping an element in the list
        mPrev=getprev()->mPrev;}
    return temp; }//data hold in the deleted node is returned
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Decleration
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
class StackQueue{
private:
   int mTop;//holds number of memory elements in SQ
   node<T> mHead;//defined the head node
   node<T>* mSQHead;//=&mHead;//head node pointer
   void ClearSQ();//clears the stackqueue

public:

   StackQueue();//default constructor
   ~StackQueue();//destructor

   StackQueue(const StackQueue<T>& obj);//copy constructor
   StackQueue<T>& operator=(const StackQueue<T>& rhs);//overloading assignment operator

   void Push_front(const T& item);//method for Push operation
   T Pop_front();//popfront method
   T Pop_rear();//poprear method
   T Peek() const;//peek method

   bool Empty() const;//checks if the stackqueue is empty
   //bool Full() const;//not necessary anymore
};
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue default constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>::StackQueue():mTop(0),mSQHead(&mHead){}//size is set to zero
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue destructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>::~StackQueue(){ClearSQ();}//deletes all dynamically allocated nodes

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue copy constructor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>::StackQueue(const StackQueue<T>& obj){
mTop=0;//size set to zero
node<T>* temp = obj.mSQHead;//temporary pointer is initialized for iteration
if(!obj.Empty())//if object is not empty
   for(int i=0;i<obj.mTop;i++){//number of iterations determined by the size
      temp=temp->getprev();//because the list is circular temp(obj.mSQHead) is iterated
backwards
      Push_front(temp->mData);}}//nodes pushed to the current object
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue overloaded assignment operator
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
StackQueue<T>& StackQueue<T>::operator=(const StackQueue<T>& rhs){
ClearSQ();//clearing SQ to make sure memory is freed clears dynamically allocated nodes.
if(mTop!=0) cout<<"Error"<<endl;
node<T>* temp = rhs.mSQHead;//temporary pointer is initialized for iteration
if(!rhs.Empty())//if object is not empty
   for(int i=0;i<rhs.mTop;i++){//number of iterations determined by the size
      temp=temp->getprev();//because the list is circular temp is iterated backwards
      Push_front(temp->mData);}//nodes pushed to the current object
return* this;}//returns current object
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue empty method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
bool StackQueue<T>::Empty()const{
   if(mTop==0)//checks the size of the stackqueue
      return true;
   else
      return false;}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue clearSQ method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
void StackQueue<T>::ClearSQ(){
while(!Empty()) Pop_front();}//popfront method also deletes the allocated memory of a node
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Push_Front method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
void StackQueue<T>::Push_front(const T& item){
   mTop++;
   node<T>* ptr = new node<T>(item);//node is allocated
   mSQHead->InsertF(ptr);}//node is placed in front of the head node like a stack


////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Pop_front method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Pop_front(){
if(!Empty()){//if list is not empty
   mTop--;
   node<T>* temp= mSQHead->DeleteF();//returned pointer is saved to free the allocated
memory
   T tempdata= temp->mData;// data in the node is saved to be returned
   delete temp;
   return tempdata;}
else{
   cout<<"Error: SQ is empty!"<<endl;
   return mSQHead->mData;}}//data hold by the head node is returned
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Pop_rear method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Pop_rear(){
if(!Empty()){//if list is not empty
   mTop--;
   node<T>* temp= mSQHead->DeleteB();//returned pointer is saved to free the allocated memory
   T tempdata= temp->mData;// data in the node is saved to be returned
   delete temp;
   return tempdata;}
else{
   cout<<"Error: SQ is empty!"<<endl;
   return mSQHead->mData;}}//data hold by the head node is returned

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//class StackQueue Peek Method
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
template <class T>
T StackQueue<T>::Peek()const{
if(!Empty()){//if list is not empty
   return mSQHead->getnext()->mData;}//returns the content of first node
else{
   cout<<"Error: SQ is empty!"<<endl;
   return mSQHead->mData;}}//data hold by the head node is returned
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//MAIN FUNCTION
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
        int main(){
            string Example="######  #.  .####@$#$  ##$. .$ ##    $.#########";

            char* Ex=&Example[0];
            Sokoban A=Sokoban(Ex);
            cout<<"1"<<endl;
            A.print_puzzle();
            Sokoban B=Sokoban(1);
            cout<<"2"<<endl;B.print_puzzle();

            B.move_up();
            cout<<"3"<<endl;B.print_puzzle();

            B.move_right();
            cout<<"EE441 "<<endl;B.print_puzzle();

            B.move_down();
            cout<<"HCN"<<endl;B.print_puzzle();

            B.move_down();
            cout<<"2166973"<<endl;B.print_puzzle();
            if(A.is_solved())
               cout<<"Puzzle Solved"<<endl;
            else
               cout<<"Puzzle Not Solved"<<endl;
```

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//Question 3&4 as an infinite loop// Movement keys: w, a, s, d;
//Go Back: z; Replay&Quit: r; Quit: q.
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////

        StackQueue<Sokoban> S1;//S1 stackqueue of Sokoban template class
        S1.Push_front(A);//added A to S1
        A.print_puzzle();
        int i = 1;//initialize i=1
        char X;//declared input character

        while(i==1){//infinite loop

           cin>>X;
      // Movement keys: w, a, s, d; Go Back: z; Replay: r; Quit: o.
           if(X=='q')//pressing 'o' will cause exit the program
              return 0;
           else if(X=='w'&& A.move_up()){
              A.print_puzzle();
              S1.Push_front(A);
           }
           else if(X=='a'&& A.move_left()){
              A.print_puzzle();
              S1.Push_front(A);
           }
           else if(X=='s'&& A.move_down()){
              A.print_puzzle();
              S1.Push_front(A);
```

```
        }
        else if(X=='d'&& A.move_right()){
            A.print_puzzle();
            S1.Push_front(A);
        }
        else if(X=='z'){
            S1.Pop_front();
            if(!S1.Empty())
                A=S1.Peek();// A is used as a temp variable
            else
                S1.Push_front(A);//if S1 is empty then A is loaded again
            A.print_puzzle();//so S1 is never becomes empty outside of this else if statement
        }
        else if(X=='r'){
            StackQueue<Sokoban> S2;//(S1);
            S2=S1;
            while(!S2.Empty())
                S2.Pop_rear().print_puzzle();
            return 0;
        }
        if(A.is_solved())
            cout<<"Puzzle Solved"<<endl;//printed if the puzzle is solved
    }
    return 0;
}
```