# Aufgabe 1 - „Behälter“ Vector als ADT

**Lösungsidee:**
wie bei dem beispiel wo die größe des Felds erst zur Laufzeit fixiert wird ein array auf die gleiche Weise erstellen allerdings immer wenn die größe überschritten werden sollte, wird die funktion GrowVector aufgerufen, die die capacity verdopellt und somit auch den allokierten speicher und die werte des allten vectors in den neuen kopiert.

eine mögliche verbesserung meines codes wäre den vector wieder zu verkleinern wenn der count kleiner als die hälfte von capacity ist, oder den vector nicht jedesmal ums doppelte zu vergrößern sondern eine bessere gewählten wert zu verwenden. Aber das ist immer usecase spezifisch, je nachdem was man mit dem vector anfangen will.

**Zeitaufwand:** ~1h 45min

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**Code:**

```
unit VectorUnit;

interface

type
  Vector = Pointer;

procedure InitVector(var v: Vector);
procedure DisposeVector(var v: Vector);
procedure Add(var v: Vector; val: Integer);
procedure SetElementAt(var v: Vector; pos: Integer; val: Integer);
function ElementAt(v: Vector; pos: Integer): Integer;
procedure RemoveElementAt(var v: Vector; pos: Integer);
function Size(v: Vector): Integer;
function Capacity(v: Vector): Integer;

implementation

// using MaxInt for the intArray here so i dont have to disable rangecheck
// error everytime i try to access the array if i used array[0..0] instead.
// There is no allocation of more memory as a consequence because i manually
// set the memory with capacity * SizeOf(Integer) so there shouldnt be a
// problem, also i choose MaxInt because my count and capacity are int anyway
type
  IntArray = array[0..MaxInt] of Integer;
  PIntArray = ^IntArray;
  VecRec = record
```

```
    data: PIntArray;
    count: Integer;
    capacity: Integer;
  end;
  PVector = ^VecRec;

procedure InitVector(var v: Vector);
var
  pv: PVector;
begin
  pv := PVector(v);
  pv^.count := 0;
  pv^.capacity := 1;
  GetMem(pv^.data, pv^.capacity * SizeOf(Integer));
  if pv^.data = nil then
  begin
    WriteLn('Error: Heap overflow.');
    Halt(1);
  end;
end;

procedure DisposeVector(var v: Vector);
var
  pv: PVector;
begin
  pv := PVector(v);
  FreeMem(pv^.data, pv^.capacity * SizeOf(Integer));
end;

procedure GrowVector(var v: VecRec);
var
  newCapacity: longInt;
  newData: PIntArray;
  i: Integer;
begin
  newCapacity := v.capacity * 2;
  if newCapacity >= MaxInt then
  begin
    WriteLn('Error: Vector overflow.');
    Halt(1);
  end;
  GetMem(newData, newCapacity * SizeOf(Integer));
  for i := 0 to v.count - 1 do
    newData^[i] := v.data^[i];
  FreeMem(v.data, v.capacity * SizeOf(Integer));
  v.data := newData;
  v.capacity := newCapacity;
end;
```

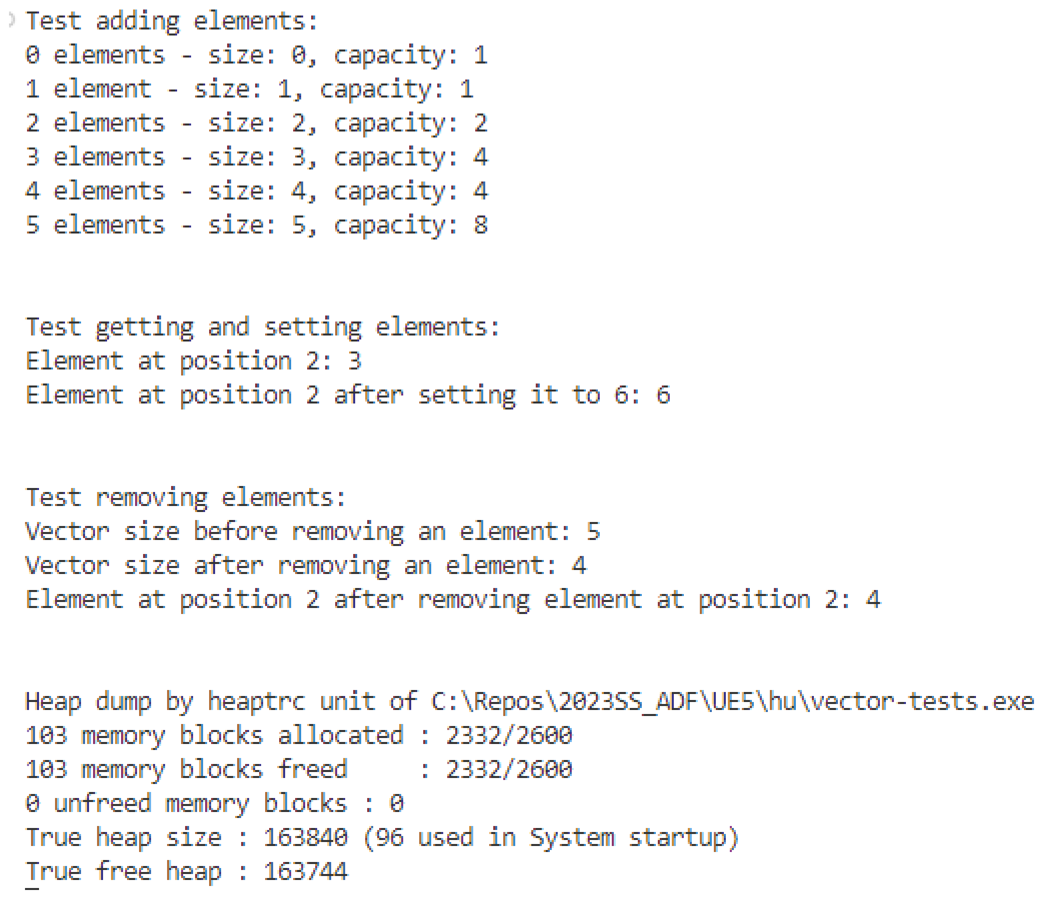
```pascal
procedure Add(var v: Vector; val: Integer);
var
  pv: PVector;
begin
  pv := PVector(v);
  if pv^.count = pv^.capacity then
    GrowVector(pv^);
  pv^.data^[pv^.count] := val;
  Inc(pv^.count);
end;

procedure SetElementAt(var v: Vector; pos: Integer; val: Integer);
var
  pv: PVector;
begin
  pv := PVector(v);
  if (pos < 0) or (pos >= pv^.count) then
  begin
    WriteLn('Error: Index out of range.');
    Halt(1);
  end;
  pv^.data^[pos] := val;

end;

function ElementAt(v: Vector; pos: Integer): Integer;
var
  pv: PVector;
begin
  pv := PVector(v);
  if (pos < 0) or (pos >= pv^.count) then
  begin
    WriteLn('Error: Index out of range.');
    Halt(1);
  end;
  ElementAt := pv^.data^[pos];
end;

procedure RemoveElementAt(var v: Vector; pos: Integer);
var
  i: Integer;
  pv: PVector;
begin
  pv := PVector(v);
  if (pos < 0) or (pos >= pv^.count) then
  begin
    WriteLn('Error: Index out of range.');
    Halt(1);
  end;
  for i := pos to pv^.count - 2 do
    pv^.data^[i] := pv^.data^[i + 1];
  Dec(pv^.count);
end;

function Size(v: Vector): Integer;
var
  pv: PVector;
begin
  pv := PVector(v);
  Size := pv^.count;
end;

function Capacity(v: Vector): Integer;
var
  pv: PVector;
begin
  pv := PVector(v);
  Capacity := pv^.capacity;
end;

end.
```

---

**Test Code:**

```
program VectorTests;

uses VectorUnit;

var
  v: Vector;
begin
  // Initialize an empty vector
  InitVector(v);

  // Test adding elements
  WriteLn('Test adding elements:');
  writeln('0 elements - size: ', Size(v), ', capacity: ', Capacity(v));
  Add(v, 1);
  writeln('1 element - size: ', Size(v), ', capacity: ', Capacity(v));
  Add(v, 2);
  writeln('2 elements - size: ', Size(v), ', capacity: ', Capacity(v));
  Add(v, 3);
  writeln('3 elements - size: ', Size(v), ', capacity: ', Capacity(v));
  Add(v, 4);
  writeln('4 elements - size: ', Size(v), ', capacity: ', Capacity(v));
  Add(v, 5);
  writeln('5 elements - size: ', Size(v), ', capacity: ', Capacity(v));
  WriteLn;
  WriteLn;

  // Test getting and setting elements
  WriteLn('Test getting and setting elements:');
  WriteLn('Element at position 2: ', ElementAt(v, 2)); // should print 3
  SetElementAt(v, 2, 6);
  WriteLn('Element at position 2 after setting it to 6: ', ElementAt(v, 2));
// should print 6
  WriteLn;
  WriteLn;

  // Test removing elements
  WriteLn('Test removing elements:');
  WriteLn('Vector size before removing an element: ', Size(v)); // should
print 5
  RemoveElementAt(v, 2);
  WriteLn('Vector size after removing an element: ', Size(v)); // should print
4
  WriteLn('Element at position 2 after removing element at position 2: ',
ElementAt(v, 2)); // should print 4
  WriteLn;
  WriteLn;

  // Test disposing of vector
  DisposeVector(v);
end.
```

## Test Ausgabe:



```
Test adding elements:
0 elements - size: 0, capacity: 1
1 element - size: 1, capacity: 1
2 elements - size: 2, capacity: 2
3 elements - size: 3, capacity: 4
4 elements - size: 4, capacity: 4
5 elements - size: 5, capacity: 8


Test getting and setting elements:
Element at position 2: 3
Element at position 2 after setting it to 6: 6


Test removing elements:
Vector size before removing an element: 5
Vector size after removing an element: 4
Element at position 2 after removing element at position 2: 4


Heap dump by heaptrc unit of C:\Repos\2023SS_ADF\UE5\hu\vector-tests.exe
103 memory blocks allocated : 2332/2600
103 memory blocks freed     : 2332/2600
0 unfreed memory blocks : 0
True heap size : 163840 (96 used in System startup)
True free heap : 163744
```