In[31]:=
```
(* Problem 1 *)

(* Create 3 different sized random arrays *)
small = RandomInteger[{0, 1}, 50];
medium = RandomInteger[{0, 1}, 500];
large = RandomInteger[{0, 1}, 5000];

(* Equipartition of small *)
(* 0 and 1 *)
smallfrq1 = N[Sum[small[[i]], {i, 1, Length[small]}]] / Length[small]
```

Out[34]= 0.42

In[35]:=
```
smallfrq0 = 1 - smallfrq1
```

Out[35]= 0.58

```
(* 00, 01, 10, 11 *)
```

In[36]:=
$$\text{smallfrq00} = N\left[\sum_{k=1}^{\text{Length[small]}-1} ((1 - \text{small}[[k]]) * (1 - \text{small}[[k+1]])) / (\text{Length[small]} - 1)\right]$$

Out[36]= 0.306122

```
NumberForm[smallfrq01, 16]
```

In[37]:=
$$\text{smallfrq01} = N\left[\sum_{k=1}^{\text{Length[small]}-1} ((1 - \text{small}[[k]]) * (\text{small}[[k+1]])) / (\text{Length[small]} - 1)\right]$$

Out[37]= 0.265306

In[38]:=
$$\text{smallfrq10} = N\left[\sum_{k=1}^{\text{Length[small]}-1} ((\text{small}[[k]]) * (1 - \text{small}[[k+1]])) / (\text{Length[small]} - 1)\right]$$

Out[38]= 0.285714

In[39]:=
```
smallfrq11 = 1 - smallfrq00 - smallfrq01 - smallfrq10
```

Out[39]= 0.142857

In[8]:=
```
(* 000, 001, 010, 011, 100, 101, 110, 111 *)
```
$$\text{smallfrq000} = N\left[\sum_{k=1}^{\text{Length[small]}-2} ((1 - \text{small}[[k]]) * (1 - \text{small}[[k+1]]) * (1 - \text{small}[[k+2]])) / (\text{Length[small]} - 2)\right]$$

Out[8]= 0.0833333

In[9]:=
$$N\left[\sum_{k=1}^{\text{Length[small]}-2} ((1 - \text{small}[[k]]) * (1 - \text{small}[[k+1]]) * (\text{small}[[k+2]])) / (\text{Length[small]} - 2)\right]$$

Out[9]= 0.145833

In[10]:=
```
smallfrq010 = N[
  Sum[((1 - small[[k]]) * (small[[k + 1]]) * (1 - small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

Out[10]= 0.145833

In[11]:=
```
smallfrq011 =
 N[Sum[((1 - small[[k]]) * (small[[k + 1]]) * (small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

Out[11]= 0.125

In[12]:=
```
smallfrq100 = N[
  Sum[((small[[k]]) * (1 - small[[k + 1]]) * (1 - small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

Out[12]= 0.166667

In[14]:=
```
smallfrq101 =
 N[Sum[((small[[k]]) * (1 - small[[k + 1]]) * (small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

Out[14]= 0.125

In[15]:=
```
smallfrq110 =
 N[Sum[((small[[k]]) * (small[[k + 1]]) * (1 - small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

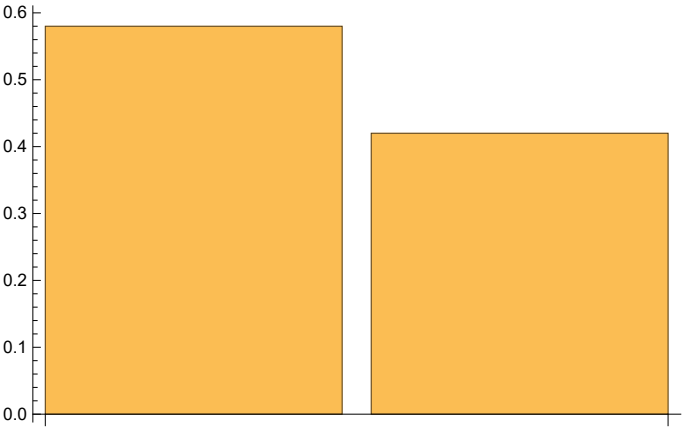
Out[15]= 0.145833

In[17]:=
```
smallfrq111 =
 N[Sum[((small[[k]]) * (small[[k + 1]]) * (small[[k + 2]])) / (Length[small] - 2), {k, 1, Length[small] - 2}]]
```

Out[17]= 0.0625

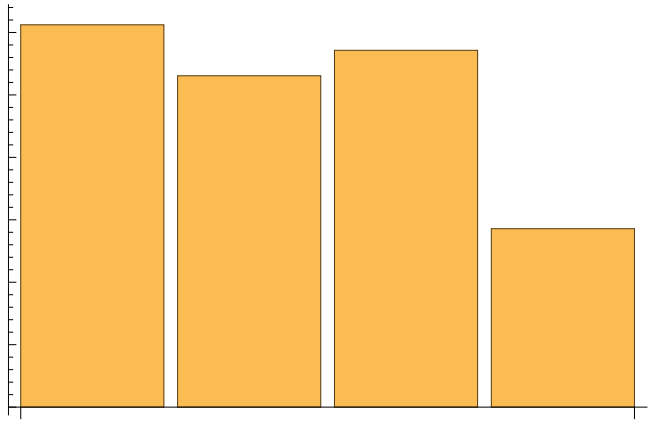
In[40]:=
```
(* Graphing small *)
BarChart[{smallfrq0, smallfrq1}]
```

Out[40]=



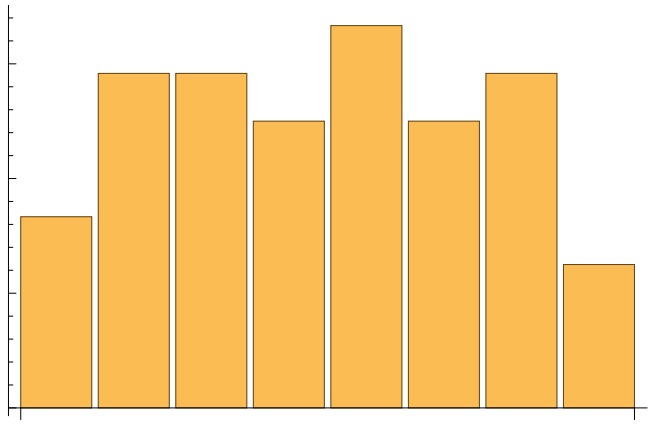
In[41]:=
```
BarChart[{smallfrq00, smallfrq01, smallfrq10, smallfrq11}]
```

Out[41]=



In[42]:=
```
BarChart[{smallfrq000, smallfrq001, smallfrq010,
  smallfrq011, smallfrq100, smallfrq101, smallfrq110, smallfrq111}]
```

Out[42]=



```
(* Equipartition of medium *)
(* 0 and 1 *)
```

In[43]:=
```
mediumfrq1 = N[Sum[medium[[i]], {i, 1, Length[medium]}]] / Length[medium]
```

Out[43]= 0.476

In[45]:=
```
mediumfrq0 = 1 - mediumfrq1
```

Out[45]= 0.524

In[46]:=
```
(* 00, 01, 10, 11 *)
mediumfrq00 =
 N[ Sum[((1 - medium[[k]]) * (1 - medium[[k + 1]])), {k, 1, Length[medium] - 1}] / (Length[medium] - 1)]
```

Out[46]= 0.268537

In[48]:=
```
mediumfrq01 = N[Sum[((1 - medium[[k]]) * (medium[[k + 1]])) / (Length[medium] - 1), {k, 1, Length[medium] - 1}]]
```

Out[48]= 0.256513

In[49]:=
```
mediumfrq11 = N[Sum[((medium[[k]]) * (medium[[k + 1]])) / (Length[medium] - 1), {k, 1, Length[medium] - 1}]]
```

Out[49]= 0.218437

In[50]:=
```
mediumfrq10 = 1 - mediumfrq00 - mediumfrq01 - mediumfrq11
```

Out[50]= 0.256513

In[51]:=
```
(* 000, 001, 010, 011, 100, 101, 110, 111 *)
mediumfrq000 =
 N[Sum[((1 - medium[[k]]) * (1 - medium[[k + 1]]) * (1 - medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[51]= 0.138554

In[52]:=
```
mediumfrq001 = N[Sum[((1 - medium[[k]]) * (1 - medium[[k + 1]]) * (medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[52]= 0.130522

In[53]:=
```
mediumfrq010 = N[Sum[((1 - medium[[k]]) * (medium[[k + 1]]) * (1 - medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[53]= 0.148594

In[54]:=
```
mediumfrq011 = N[Sum[((1 - medium[[k]]) * (medium[[k + 1]]) * (medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[54]= 0.108434

In[55]:=
```
mediumfrq100 = N[Sum[((medium[[k]]) * (1 - medium[[k + 1]]) * (1 - medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[55]= 0.130522

In[56]:=
```
mediumfrq101 = N[Sum[((medium[[k]]) * (1 - medium[[k + 1]]) * (medium[[k + 2]])) /
    (Length[medium] - 2), {k, 1, Length[medium] - 2}]]
```

Out[56]= 0.126506

In[57]:=
```
mediumfrq110 = N[ Sum_{k=1}^{Length[medium]-2} ((medium[[k]]) * (medium[[k+1]]) * (1 - medium[[k+2]])) / (Length[medium] - 2) ]
```

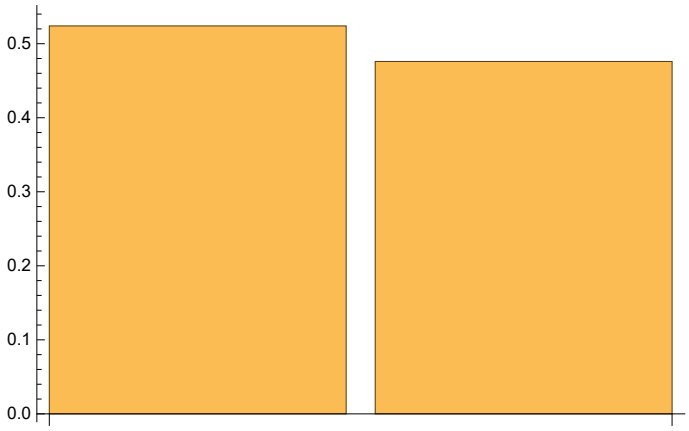
Out[57]= 0.108434

In[58]:=
```
mediumfrq111 = N[ Sum_{k=1}^{Length[medium]-2} ((medium[[k]]) * (medium[[k+1]]) * (medium[[k+2]])) / (Length[medium] - 2) ]
```

Out[58]= 0.108434

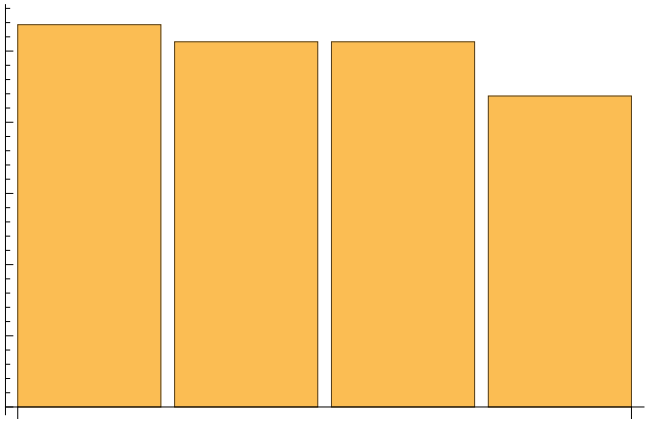
In[59]:=
```
(* Graphing medium *)
BarChart[{mediumfrq0, mediumfrq1}]
```

Out[59]=



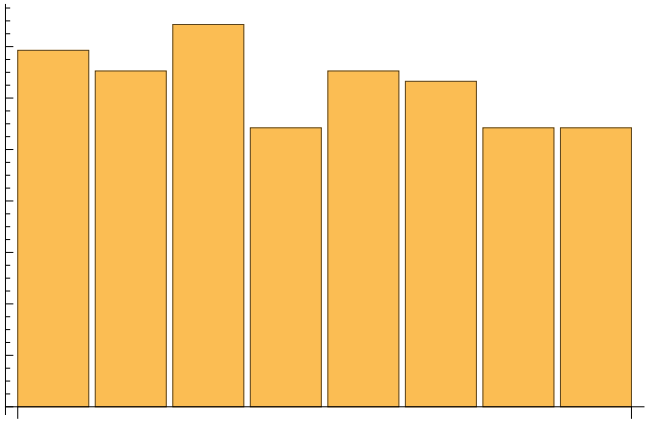
In[60]:=
```
BarChart[{mediumfrq00, mediumfrq01, mediumfrq10, mediumfrq11}]
```

Out[60]=



In[61]:=
```
BarChart[{mediumfrq000, mediumfrq001, mediumfrq010,
  mediumfrq011, mediumfrq100, mediumfrq101, mediumfrq110, mediumfrq111}]
```

Out[61]=



```
(* Equipartition of large *)
(* 0 and 1 *)
largefrq1 = N[Sum[large[[i]], {i, 1, Length[large]}]] / Length[large]
```

Out[62]= 0.5022

In[63]:=
```
largefrq0 = 1 - largefrq1
```

Out[63]= 0.4978

In[64]:=
```
(* 00, 01, 10, 11 *)
largefrq01 =
 N[Sum[(1 - large[[i]]) * (large[[i + 1]]), {i, 1, Length[large] - 1}]] / Length[large - 1]
```

Out[64]= 0.2552

In[65]:=
```
largefrq00 =
 N[Sum[(1 - large[[i]]) * (1 - large[[i + 1]]), {i, 1, Length[large] - 1}]] / Length[large - 1]
```

Out[65]= 0.2424

In[66]:=
```
largefrq11 =
 N[Sum[(large[[i]]) * (large[[i + 1]]), {i, 1, Length[large] - 1}]] / Length[large - 1]
```

Out[66]= 0.247

In[67]:=
```
largefrq10 =
 N[Sum[(large[[i]]) * (1 - large[[i + 1]]), {i, 1, Length[large] - 1}]] / Length[large - 1]
```

Out[67]= 0.2552

```
(* 000, 001, 010, 011, 100, 101, 110, 111 *)
```

... Set: Cannot assign to raw object 1.

... Set: Cannot assign to raw object 1.

... Set: Cannot assign to raw object 1.

... General: Further output of Set::setraw will be suppressed during this calculation.

In[96]:=
```
largefrq000 = N[Sum[((1 - large[[k]]) * (1 - large[[k + 1]]) * (1 - large[[k + 2]])) /
    (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[96]= 0.117847

In[97]:=
```
largefrq001 = N[Sum[((1 - large[[k]]) * (1 - large[[k + 1]]) * (large[[k + 2]])) /
    (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[97]= 0.12465

In[98]:=
```
largefrq010 = N[Sum[((1 - large[[k]]) * (large[[k + 1]]) * (1 - large[[k + 2]])) /
    (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[98]= 0.132853

In[99]:=
```
largefrq011 =
  N[Sum[((1 - large[[k]]) * (large[[k + 1]]) * (large[[k + 2]])) / (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[99]= 0.122449

In[100]:=
```
largefrq100 = N[Sum[((large[[k]]) * (1 - large[[k + 1]]) * (1 - large[[k + 2]])) /
    (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[100]= 0.12445

In[101]:=
```
largefrq101 =
  N[Sum[((large[[k]]) * (1 - large[[k + 1]]) * (large[[k + 2]])) / (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[101]= 0.130652

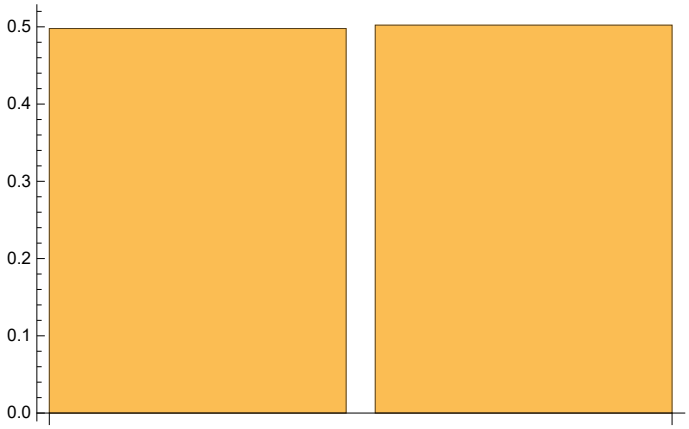
In[102]:=
```
largefrq110 =
  N[Sum[((large[[k]]) * (large[[k + 1]]) * (1 - large[[k + 2]])) / (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[102]= 0.122449

In[103]:=
```
largefrq111 =
  N[Sum[((large[[k]]) * (large[[k + 1]]) * (large[[k + 2]])) / (Length[large] - 2), {k, 1, Length[large] - 2}]]
```
Out[103]= 0.12465

```
(* Graphing large *)
```

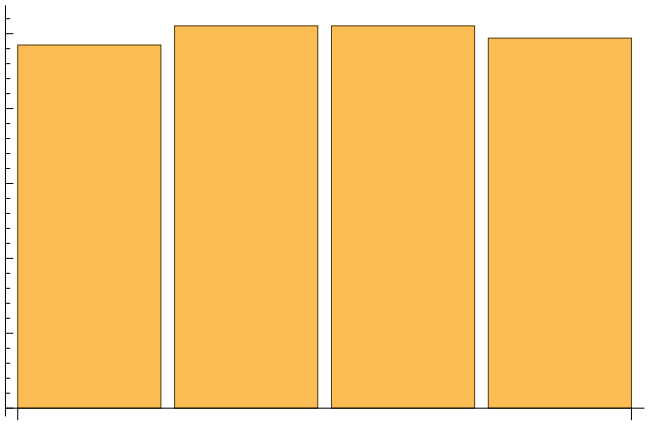
In[104]:=
```
BarChart[{largefrq0, largefrq1}]
```

Out[104]=



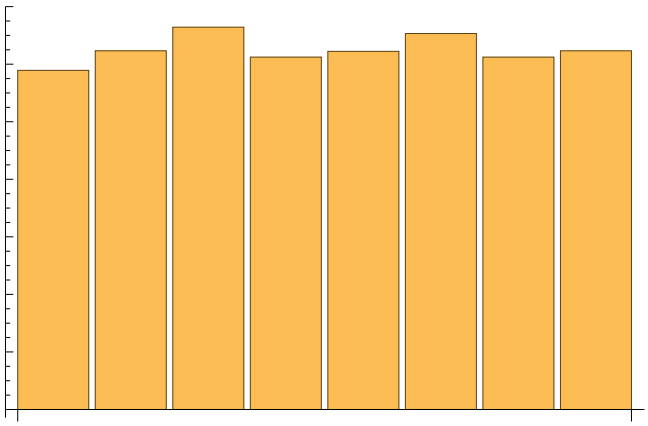
In[105]:=
```
BarChart[{largefrq00, largefrq01, largefrq10, largefrq11}]
```

Out[105]=



In[106]:=
```
BarChart[{largefrq000, largefrq001, largefrq010,
  largefrq011, largefrq100, largefrq101, largefrq110, largefrq111}]
```

Out[106]=



```
(* Champernowne String *)
(* small *)

a = {}; (* The string *)
```

```
(* Gets the each number 1-50 in a binary list,
loops though each list to append to the master list, a *)
i = 1;
While[i < 51,
 x = IntegerDigits[i, 2];
 For[k = 1, k ≤ Length[x], k++, AppendTo[a, x[[k]]]];
 i++]
```

In[192]:=
```
a
```

Out[192]=
```
{1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 1,
 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1,
 0, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0,
 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1,
 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1,
 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0,
 1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1,
 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0}
```

In[193]:=
```
(* 0 and 1 *)
champernowne0 = N[Sum[(a[[i]]), {i, 1, Length[a]}]] / Length[a]
```

Out[193]=
```
0.559671
```

In[194]:=
```
champernowne1 = 1 - champernowne0
```

Out[194]=
```
0.440329
```

In[198]:=
```
(* 00, 01, 10, 11 *)
champernowne00 =
 N[Sum[(1 - a[[i]]) * (1 - a[[i + 1]]), {i, 1, Length[a] - 1}]] / (Length[a] - 1)
```

Out[198]=
```
0.177686
```

In[199]:=
```
champernowne01 = N[Sum[(1 - a[[i]]) * (a[[i + 1]]), {i, 1, Length[a] - 1}]] / (Length[a] - 1)
```

Out[199]=
```
0.260331
```

In[200]:=
```
champernowne10 = N[Sum[(a[[i]]) * (1 - a[[i + 1]]), {i, 1, Length[a] - 1}]] / (Length[a] - 1)
```

Out[200]=
```
0.264463
```

In[201]:=
```
champernowne11 = N[Sum[(a[[i]]) * (a[[i + 1]]), {i, 1, Length[a] - 1}]] / (Length[a] - 1)
```

Out[201]=
```
0.297521
```

In[203]:=
```
(* 000, 001, 010, 011, 100, 101, 110, 111 *)

champernowne000 =
 N[Sum[(1 - a[[i]]) * (1 - a[[i + 1]]) * (1 - a[[i + 2]]), {i, 1, Length[a] - 2}]] /
  (Length[a] - 2)
```

Out[203]=
```
0.06639
```

In[204]:=
```
champernowne001 =
 N[Sum[(1 - a[[i]]) * (1 - a[[i + 1]]) * (a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[204]= 0.112033

In[205]:=
```
champernowne010 =
 N[Sum[(1 - a[[i]]) * (a[[i + 1]]) * (1 - a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[205]= 0.120332

In[206]:=
```
champernowne011 =
 N[Sum[(1 - a[[i]]) * (a[[i + 1]]) * (a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[206]= 0.141079

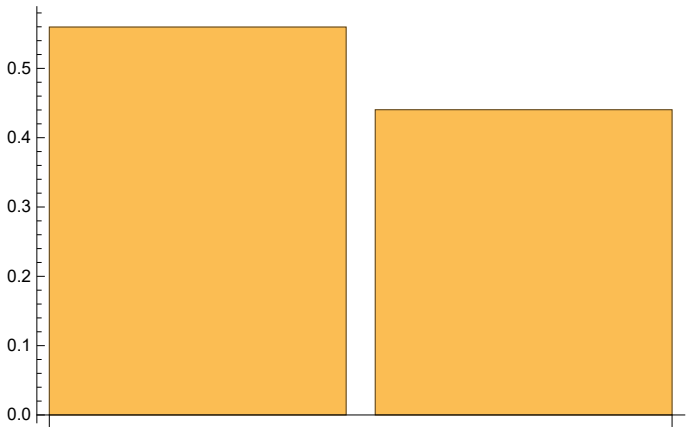
In[207]:=
```
champernowne100 =
 N[Sum[(a[[i]]) * (1 - a[[i + 1]]) * (1 - a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[207]= 0.112033

In[208]:=
```
champernowne101 =
 N[Sum[(a[[i]]) * (1 - a[[i + 1]]) * (a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[208]= 0.149378

In[209]:=
```
champernowne110 =
 N[Sum[(a[[i]]) * (a[[i + 1]]) * (1 - a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[209]= 0.145228

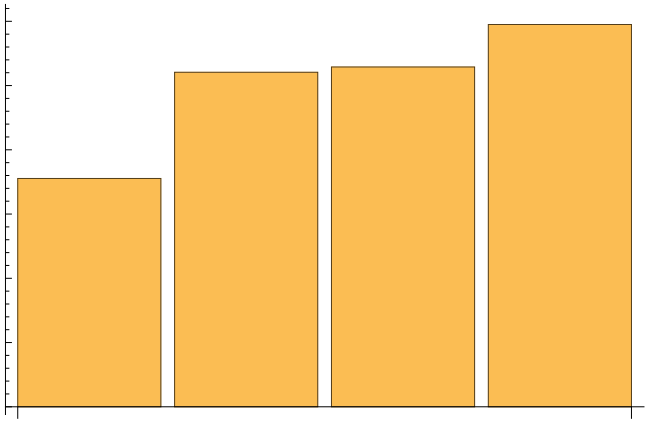
In[210]:=
```
champernowne111 =
 N[Sum[(a[[i]]) * (a[[i + 1]]) * (a[[i + 2]]), {i, 1, Length[a] - 2}]] / (Length[a] - 2)
```
Out[210]= 0.153527

In[211]:=
```
(* Graph 0 and 1 *)
BarChart[{champernowne0, champernowne1}]
```
Out[211]=



```
(* Graph 00, 01, 10, 11 *)
BarChart[{champernowne00, champernowne01, champernowne10, champernowne11}]
```

Out[212]=



```
(* Graph 000, 001, 010, 011, 100, 101, 110, 111 *)
BarChart[{champernowne000, champernowne001, champernowne010, champernowne011,
  champernowne100, champernowne101, champernowne110, champernowne111}]
```

Out[213]=