In[21]:=
```
AB2Roots = z /. Solve[z^(2) - (1 + (3 / 2) * r) * z + (1 / 2) * r == 0, z, Complexes]
```

Out[21]= $\left\{\frac{1}{4}\left(2+3r-\sqrt{4+4r+9r^2}\right), \frac{1}{4}\left(2+3r+\sqrt{4+4r+9r^2}\right)\right\}$

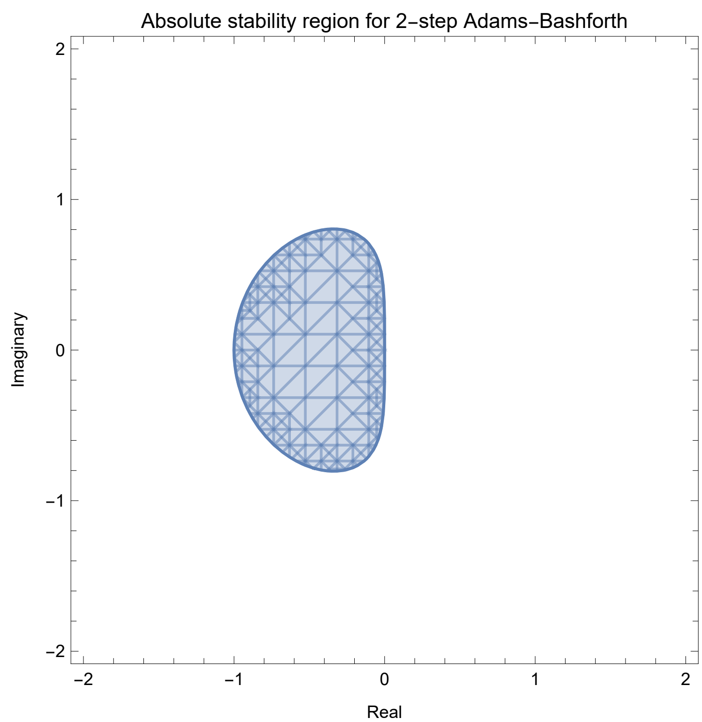
In[12]:=
```
AB2Roots1 = AB2Roots[[1]]
AB2Roots2 = AB2Roots[[2]]
```

Out[12]= $\frac{1}{4}\left(2+3r-\sqrt{4+4r+9r^2}\right)$

Out[13]= $\frac{1}{4}\left(2+3r+\sqrt{4+4r+9r^2}\right)$

In[48]:=
```
ComplexRegionPlot[{Abs[AB2Roots1] ≤ 1 && Abs[AB2Roots2] ≤ 1},
 {r, 2}, FrameLabel → {"Real", "Imaginary"},
 PlotLabel → "Absolute stability region for 2-step Adams-Bashforth"]
```

Out[48]=



In[18]:=
```
AB3Roots =
  z /. Solve[z^(3) - (1 + (23 / 12) * r) * z^(2) + (4 / 3) * r * z - (5 / 12) * r == 0, z, Complexes]
```

Out[18]=

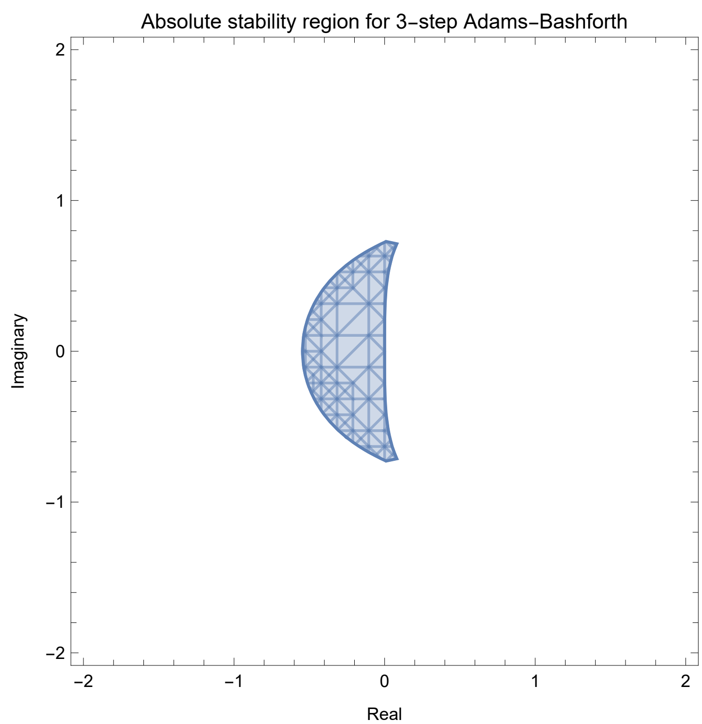
$$\left\{\frac{1}{36}(12+23\,r)-\frac{4\left(-1+\frac{r}{6}-\frac{529\,r^2}{144}\right)}{\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3}}+\frac{1}{36}\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3},\right.$$

$$\frac{1}{36}(12+23\,r)+\frac{2\left(1+i\sqrt{3}\right)\left(-1+\frac{r}{6}-\frac{529\,r^2}{144}\right)}{\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3}}-\frac{1}{72}\left(1-i\sqrt{3}\right)\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3},$$

$$\left.\frac{1}{36}(12+23\,r)+\frac{2\left(1-i\sqrt{3}\right)\left(-1+\frac{r}{6}-\frac{529\,r^2}{144}\right)}{\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3}}-\frac{1}{72}\left(1+i\sqrt{3}\right)\left(1728+9288\,r-828\,r^2+12\,167\,r^3+108\,\sqrt{r}\,\sqrt{2880+4308\,r+3228\,r^2+8993\,r^3}\right)^{1/3}\right\}$$

In[50]:=
```
ComplexRegionPlot[
  {Abs[AB3Roots[[1]]] ≤ 1 && Abs[AB3Roots[[2]]] ≤ 1 && Abs[AB3Roots[[3]]] ≤ 1},
  {r, 2}, FrameLabel → {"Real", "Imaginary"},
  PlotLabel → "Absolute stability region for 3-step Adams-Bashforth"]
```

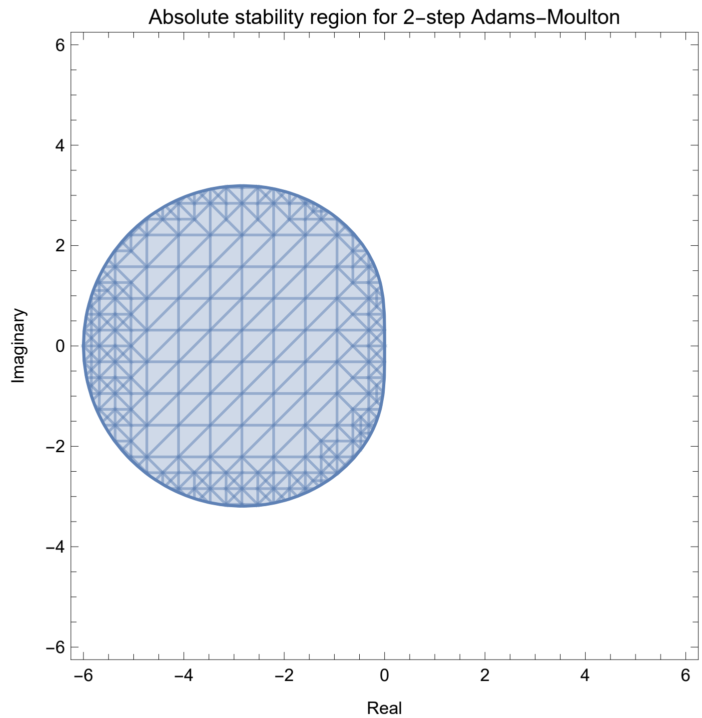
Out[50]=



In[27]:=
```
AM2Roots =
 z /. Solve[(1 - (5 / 12) * r) * z^(2) - (1 + (2 / 3) * r) * z + (1 / 12) * r == 0, z, Complexes]
```

Out[27]=
$$\left\{\frac{-6-4r-\sqrt{3}\ \sqrt{12+12r+7r^2}}{-12+5r},\ \frac{-6-4r+\sqrt{3}\ \sqrt{12+12r+7r^2}}{-12+5r}\right\}$$

In[36]:=
```
ComplexRegionPlot[{Abs[AM2Roots[[1]]] ≤ 1 && Abs[AM2Roots[[2]]] ≤ 1},
 {r, 6}, FrameLabel → {"Real", "Imaginary"},
 PlotLabel → "Absolute stability region for 2-step Adams-Moulton"]
```

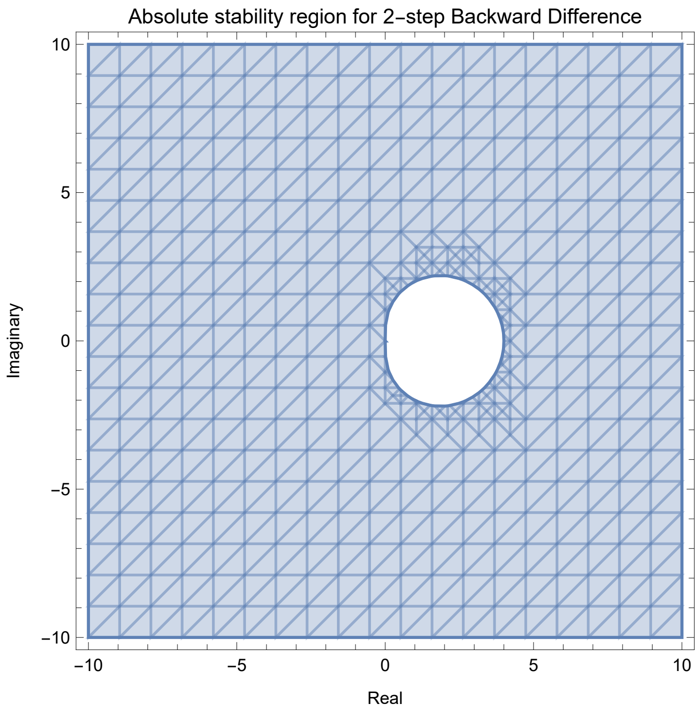
Out[36]=


In[37]:=
```
BDF2Roots = z /. Solve[(1 - (2 / 3) * r) * z^(2) - (4 / 3) * z + (1 / 3) == 0, z, Complexes]
```

Out[37]=
$$\left\{\frac{-2-\sqrt{1+2r}}{-3+2r},\ \frac{-2+\sqrt{1+2r}}{-3+2r}\right\}$$

In[42]:=
```
ComplexRegionPlot[{Abs[BDF2Roots[[1]]] ≤ 1 && Abs[BDF2Roots[[2]]] ≤ 1},
  {r, 10}, FrameLabel → {"Real", "Imaginary"},
  PlotLabel → "Absolute stability region for 2-step Backward Difference"]
```

Out[42]=



In[39]:=
```
BDF3Roots = z /.
  Solve[(1 - (6 / 11) * r) * z^(3) - (18 / 11) * z^(2) + (9 / 11) * z - (2 / 11) == 0, z, Complexes]
```

Out[39]=

$$\left\{\frac{6}{11-6r} - \frac{-27-162r}{9(11-6r)\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}} + \frac{\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}}{11-6r},\right.$$

$$\frac{6}{11-6r} + \frac{\left(1+i\sqrt{3}\right)(-27-162r)}{18(11-6r)\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}} - \frac{\left(1-i\sqrt{3}\right)\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}}{2(11-6r)},$$

$$\left.\frac{6}{11-6r} + \frac{\left(1-i\sqrt{3}\right)(-27-162r)}{18(11-6r)\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}} - \frac{\left(1+i\sqrt{3}\right)\left(40+30r+36r^2+\sqrt{1573+1914r+864r^2-3672r^3+1296r^4}\right)^{1/3}}{2(11-6r)}\right\}$$

In[41]:=
```
ComplexRegionPlot[
 {Abs[BDF3Roots[[1]]] ≤ 1 && Abs[BDF3Roots[[2]]] ≤ 1 && Abs[BDF3Roots[[3]]] ≤ 1},
 {r, 10}, FrameLabel → {"Real", "Imaginary"},
 PlotLabel → "Absolute stability region for 3-step Backward Difference"]
```

LessEqual: Internal precision limit $MaxExtraPrecision = 50.` reached while evaluating

$$\frac{5}{11} - \frac{3}{11\left(40 + 11\sqrt{13}\right)^{1/3}} - \frac{1}{11}\left(40 + 11\sqrt{13}\right)^{1/3}.$$

Out[41]=