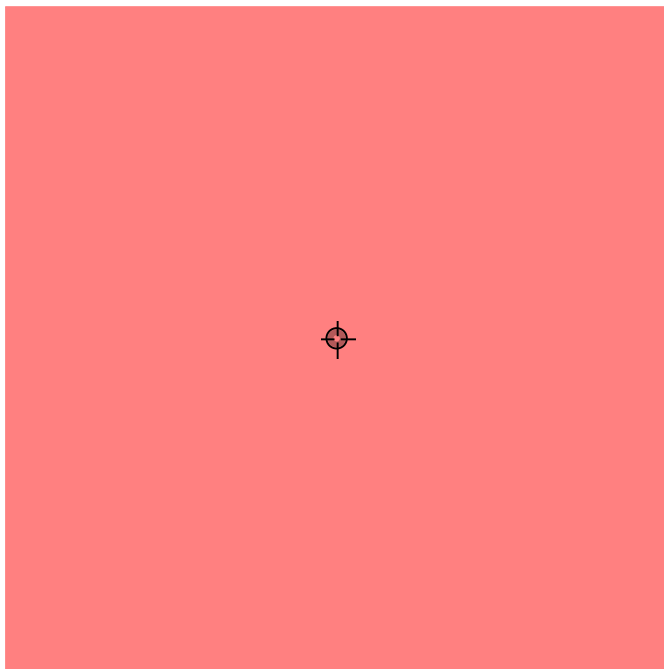


```
as = {{1, 1}/2, {-1, 1}/2, {1, -1}/2, {0, 0}};
LocatorPane[Dynamic[as], Graphics[{{Pink, Rectangle[{-1, -1}, {1, 1}]}}]]
```



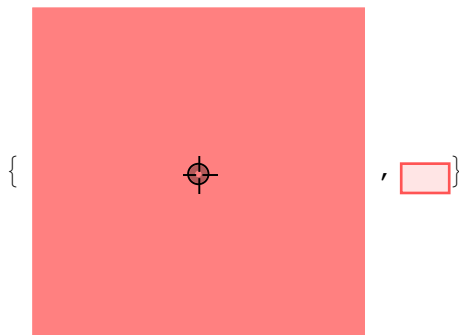
```
Dynamic[ $\prod_{k=1}^{\text{Length}@\text{as}} (\mathbf{x} - (\text{as}[[k, 1]] + \mathbf{i} \text{as}[[k, 2]]))$  // Expand]
```



$$(0.2681293146 - 0.11476744211999995 \mathbf{i})^{1/5}$$

$$0.779027 - 0.0631509 \mathbf{i}$$

```
b = {{1, 1}/2};
{LocatorPane[Dynamic[b], Graphics[{{Pink, Rectangle[{-1, -1}, {1, 1}]}}]],
Dynamic[Graphics[{{LightBlue, Rectangle[{-1, -1}, {1, 1}], Black,
Point[r = (b[[1, 1]] + \mathbf{i} b[[1, 2]])^{1/4}; {Re[r], Im[r]}]}, PlotRange -> {-1, 1}]]]}
```



`sol = Simplify[x /. Solve[x^4 + a3 x^3 + a2 x^2 + a1 x + a0 == 0, x] [[1, 1]]]`

$$\frac{1}{12} \left(-3 a_3 - \sqrt{3} \sqrt{\left(-8 a_2 + 3 a_3^2 + \left(4 \times 2^{1/3} \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right) \right) / \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} + 2 \times 2^{2/3} \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} \right) \right) - \sqrt{6} \sqrt{\left(-8 a_2 + 3 a_3^2 - \left(2 \times 2^{1/3} \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right) \right) / \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} - 2^{2/3} \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} + \left(3 \sqrt{3} \left(8 a_1 - 4 a_2 a_3 + a_3^3 \right) \right) / \left(\sqrt{\left(-8 a_2 + 3 a_3^2 + \left(4 \times 2^{1/3} \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right) \right) / \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} + 2 \times 2^{2/3} \left(27 a_1^2 - 72 a_0 a_2 + 2 a_2^3 - 9 a_1 a_2 a_3 + 27 a_0 a_3^2 + \sqrt{\left(-4 \left(12 a_0 + a_2^2 - 3 a_1 a_3 \right)^3 + \left(27 a_1^2 + 2 a_2^3 - 9 a_1 a_2 a_3 - 9 a_0 \left(8 a_2 - 3 a_3^2 \right) \right)^2} \right)^{1/3} \right) \right) \right) \right) \right) \right)$$

sol1 = Simplify[sol /. t_ /; t == 27 a1^2 -> a4 + 72 a0 a2 - 2 a2^3 + 9 a1 a2 a3 - 27 a0 a3^2]

$$\frac{1}{12} \left(-3 a_3 - \sqrt{3} \sqrt{\left(-8 a_2 + 3 a_3^2 + \frac{4 \times 2^{1/3} (12 a_0 + a_2^2 - 3 a_1 a_3)}{\left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3}} + 2 \times 2^{2/3} \left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3} \right)} \right) - \sqrt{6} \sqrt{\left(-8 a_2 + 3 a_3^2 - \frac{2 \times 2^{1/3} (12 a_0 + a_2^2 - 3 a_1 a_3)}{\left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3}} - 2^{2/3} \left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3} + \left(3 \sqrt{3} (8 a_1 - 4 a_2 a_3 + a_3^3) \right) \right) / \left(\sqrt{\left(-8 a_2 + 3 a_3^2 + \frac{4 \times 2^{1/3} (12 a_0 + a_2^2 - 3 a_1 a_3)}{\left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3}} + 2 \times 2^{2/3} \left(a_4 + \sqrt{-4 (12 a_0 + a_2^2 - 3 a_1 a_3)^3 + a_4^2} \right)^{1/3} \right)} \right) \right) \right)$$

sol2 = Simplify[sol1 /. t_ /; t == 12 a0 + a2^2 - 3 a1 a3 -> a5]

$$\frac{1}{12} \left(-3 a_3 - \sqrt{3} \sqrt{\left(-8 a_2 + 3 a_3^2 + \frac{4 \times 2^{1/3} a_5}{\left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3}} + 2 \times 2^{2/3} \left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3} \right)} \right) - \sqrt{6} \sqrt{\left(-8 a_2 + 3 a_3^2 - \frac{2 \times 2^{1/3} a_5}{\left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3}} - 2^{2/3} \left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3} + \left(3 \sqrt{3} (8 a_1 - 4 a_2 a_3 + a_3^3) \right) \right) / \left(\sqrt{\left(-8 a_2 + 3 a_3^2 + \frac{4 \times 2^{1/3} a_5}{\left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3}} + 2 \times 2^{2/3} \left(a_4 + \sqrt{a_4^2 - 4 a_3^3} \right)^{1/3} \right)} \right) \right) \right)$$

$$\text{sol3} = \text{Simplify}[\text{sol2} /. \text{t_} /; \text{t} == \sqrt{\text{a}_4^2 - 4 \text{a}_3^3} \rightarrow \text{a}_6]$$

$$\frac{1}{12} \left(-3 \text{a}_3 - \sqrt{3} \sqrt{-8 \text{a}_2 + 3 \text{a}_3^2 + \frac{4 \times 2^{1/3} \text{a}_5}{(\text{a}_4 + \text{a}_6)^{1/3}} + 2 \times 2^{2/3} (\text{a}_4 + \text{a}_6)^{1/3}} - \right.$$

$$\left. \sqrt{6} \sqrt{\left(-8 \text{a}_2 + 3 \text{a}_3^2 - \frac{2 \times 2^{1/3} \text{a}_5}{(\text{a}_4 + \text{a}_6)^{1/3}} - 2^{2/3} (\text{a}_4 + \text{a}_6)^{1/3} + \frac{3 \sqrt{3} (8 \text{a}_1 - 4 \text{a}_2 \text{a}_3 + \text{a}_3^3)}{\sqrt{-8 \text{a}_2 + 3 \text{a}_3^2 + \frac{4 \times 2^{1/3} \text{a}_5}{(\text{a}_4 + \text{a}_6)^{1/3}} + 2 \times 2^{2/3} (\text{a}_4 + \text{a}_6)^{1/3}}} \right)} \right)$$

$$\text{sol4} = \text{Simplify}[\text{sol3} /. \{\text{t_} /; \text{t} == (\text{a}_4 + \text{a}_6)^{1/3} \rightarrow \text{a}_7, \text{t_} /; \text{t} == (\text{a}_4 + \text{a}_6)^{-1/3} \rightarrow 1/\text{a}_7\}]$$

$$\frac{1}{12} \left(-3 \text{a}_3 - \sqrt{3} \sqrt{-8 \text{a}_2 + 3 \text{a}_3^2 + \frac{4 \times 2^{1/3} \text{a}_5}{\text{a}_7} + 2 \times 2^{2/3} \text{a}_7} - \right.$$

$$\left. \sqrt{6} \sqrt{\left(-8 \text{a}_2 + 3 \text{a}_3^2 - \frac{2 \times 2^{1/3} \text{a}_5}{\text{a}_7} - 2^{2/3} \text{a}_7 + \frac{3 \sqrt{3} (8 \text{a}_1 - 4 \text{a}_2 \text{a}_3 + \text{a}_3^3)}{\sqrt{-8 \text{a}_2 + 3 \text{a}_3^2 + \frac{4 \times 2^{1/3} \text{a}_5}{\text{a}_7} + 2 \times 2^{2/3} \text{a}_7}} \right)} \right)$$

$$\text{sol5} = \text{Simplify}[\text{sol4} /. \text{t_} /; \text{t} == -8 \text{a}_2 \rightarrow \text{a}_8 - 3 \text{a}_3^2 - \frac{4 \times 2^{1/3} \text{a}_5}{\text{a}_7} - 2 \times 2^{2/3} \text{a}_7]$$

$$\frac{1}{12} \left(-3 \text{a}_3 - \sqrt{3} \sqrt{\text{a}_8} - \sqrt{6} \sqrt{-\frac{6 \times 2^{1/3} \text{a}_5}{\text{a}_7} - 3 \times 2^{2/3} \text{a}_7 + \frac{3 \sqrt{3} (8 \text{a}_1 - 4 \text{a}_2 \text{a}_3 + \text{a}_3^3)}{\sqrt{\text{a}_8}} + \text{a}_8} \right)$$