

MAJ3

```
In[901]:= k = 2;
n = 2 k - 1;
Pdiff[p_] = 1 - p^k - (1 - p)^k;
Plot[Pdiff[p], {p, 0, 1}]

P1[p_] = Sum[Binomial[n, i] * p^i * (1 - p)^(n - i), {i, k, n}];
Plot[P1[p], {p, 0, 1}]
Palt[p_] = 1 - P1[p]^k - (1 - P1[p])^k;
pss[p_] = p * P1[p] + (1 - p) (1 - P1[p]);

A1[p_] = (2 + Pdiff[p]) (2 + Palt[p]);
A4[p_] =
  2 + Pdiff[p] + 1 + (pss[p] + P1[p] (1 - P1[p]) (1 - p) + (1 - P1[p]) P1[p] p) * (1 + Pdiff[p]) +
  ((1 - pss[p]) + P1[p] p (1 - p)^2 + (1 - P1[p]) (1 - p) p^2) * (2 + Pdiff[p]);
A3[p_] = 2 + Pdiff[p] + 1 + (1 - P1[p] (1 - p) + P1[p] (1 - P1[p]) (1 - p)) * (1 + Pdiff[p]) +
  (P1[p] (1 - p) + P1[p] p (1 - p)^2 + (1 - P1[p]) p (1 - (1 - p)^2) + (1 - P1[p]) (1 - p) p^2) *
  (2 + Pdiff[p]);
A2[p_] = A3[1 - p];

A2new[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
  P1[p] (1 - p) (1 + p + (1 - p)^2 (2 + Pdiff[p])) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
Expand[A2new[p]]
A2hs[p_] = 4 p^0 + 4 p^1 + 7 p^2 + 6 p^3 + -54 p^4 + 12 p^5 + 75 p^6 + -66 p^7 + 16 p^8 + 0 p^9

A3new[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
Expand[A3new[p]]
Expand[A2new[1 - p]]
A3hs[p_] = 4 p^0 + 4 p^1 + 8 p^2 + 4 p^3 + -59 p^4 + 28 p^5 + 61 p^6 + -62 p^7 + 16 p^8 + 0 p^9

A4new[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
  P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
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Expand[A4new[p]]

A4hs[p_] = 4 p^0 + 4 p^1 + 7 p^2 + 6 p^3 + -57 p^4 + 20 p^5 + 68 p^6 + -64 p^7 + 16 p^8 + 0 p^9

A4hs[1/2]

Plot[{A1[p], A2new[p], A3new[p], A4new[p]}, {p, 0, 1}]

Maximize[{A1[p], 0 < p < 1}, p]

Maximize[{A2new[p], 0 < p < 1}, p]

Maximize[{A3new[p], 0 < p < 1}, p]

Maximize[{A4new[p], 0 < p < 1}, p]

Atest[p_] = 2 + Pdiff[p] + 1 +

(1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
 (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
 P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
 P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));

Expand[Atest[p]]

Atest2[p_] = 2 + Pdiff[p] + 1 +

(1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
 (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
 P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
 P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));

Expand[Atest2[p]]

Atest3[p_] = 2 + Pdiff[p] + 1 +

(1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
 (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
 P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
 P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));

Expand[Atest3[p]]

Atest4[p_] = 2 + Pdiff[p] + 1 +

(1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
 (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
 P1[p] (1 - p) (1 + p + (1 - p^2) (2 + Pdiff[p])) +
 P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));

Expand[Atest4[p]]

Atest5[p_] = 2 + Pdiff[p] + 1 +

(1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
 (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
 P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
 P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));

Expand[Atest5[p]]

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Atest6[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
  (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
  P1[p] (1 - p) (1 + p + (1 - p)^2 (2 + Pdiff[p])) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
Expand[Atest6[p]]

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Atest7[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
Expand[Atest7[p]]

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Atest8[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (1 + p + (1 - p)^2 (2 + Pdiff[p])) +
  P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));
Expand[Atest8[p]]

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Atest9[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (2 + Pdiff[p] + P1[p] (1 + (1 - p))) +
  P1[p] (1 - p) (1 + p + (1 - p)^2 (2 + Pdiff[p])) +
  P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));
Expand[Atest9[p]]

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Atest10[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (2 + Pdiff[p] + (1 - P1[p]) (1 + p)) +
  P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));
Expand[Atest10[p]]

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Atest11[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (2 + Pdiff[p] + P1[p] (1 + p)) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (1 + p + (1 - p)^2 (2 + Pdiff[p])) +
  P1[p] p (1 + (1 - p) + (1 - p)^2 (2 + Pdiff[p]));
Expand[Atest11[p]]

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Atest12[p_] = 2 + Pdiff[p] + 1 +
  (1 - P1[p]) (1 - p) (1 + p + p^2 (2 + Pdiff[p])) +
  (1 - P1[p]) p (1 + (1 - p) + (1 - (1 - p)^2) (2 + Pdiff[p])) +
  P1[p] (1 - p) (1 + p + (1 - p^2) (2 + Pdiff[p])) +
  P1[p] p (2 + Pdiff[p] + (1 - P1[p]) (1 + (1 - p)));
Expand[Atest12[p]]

b = {A1[p], A2new[p], A3new[p], A4new[p], Atest[p], Atest2[p], Atest3[p], Atest4[p], Atest5[p],
  Atest6[p], Atest7[p], Atest8[p], Atest9[p], Atest10[p], Atest11[p], Atest12[p]};
Plot[{A1[p], A2new[p], A3new[p], A4new[p], Atest[p], Atest2[p], Atest3[p], Atest4[p],
  Atest5[p], Atest6[p], Atest7[p], Atest8[p], Atest9[p], Atest10[p], Atest11[p], Atest12[p]},
  {p, 0, 1}, PlotStyle → ColorData["Rainbow"] /@ (Range[0, Length@b] / Length@b),
  PlotLegends → "Expressions"]

c = Subtract[{A1[p], A2new[p], A3new[p], A4new[p], Atest[p],
  Atest2[p], Atest3[p], Atest4[p], Atest5[p], Atest6[p], Atest7[p],
  Atest8[p], Atest9[p], Atest10[p], Atest11[p], Atest12[p]}, A4hs[p]];
Plot[c, {p, 0, 1}, PlotStyle → ColorData["Rainbow"] /@ (Range[0, Length@c] / Length@c),
  PlotLabel → "All algorithms subtracted by the minimal one"]

NSolve[Atest2[p] == A4hs[p] && p < 1 && p > 0]
NSolve[Atest10[p] == A4hs[p] && p < 1 && p > 0]
NSolve[A3hs[p] == A4hs[p] && p < 1 && p > 0]

Expand[A1[p]]
A1[1 / 2]
Expand[A2[p]]
Expand[A3[p]]
Expand[A4[p]]
A4[1 / 2]
d = {A1[p], A2[p], A3[p], A4[p], A2hs[p], A4hs[p], Atest[p], Atest2[p]};
Plot[{A1[p], A2[p], A3[p], A4[p], A2hs[p], A4hs[p], Atest[p], Atest2[p]}, {p, 0, 1},
  PlotStyle → ColorData["Rainbow"] /@ (Range[0, Length@d] / Length@d),
  PlotLegends → "Expressions"]
e = {A1[p] - A4[p], A2[p] - A4[p], A3[p] - A4[p], A4[p] - A4[p],
  A2hs[p] - A4[p], A3hs[p] - A4[p], A4hs[p] - A4[p], Atest2[p] - A4[p]};
Plot[{A1[p] - A4[p], A2[p] - A4[p], A3[p] - A4[p], A4[p] - A4[p],
  A2hs[p] - A4[p], A3hs[p] - A4[p], A4hs[p] - A4[p], Atest2[p] - A4[p]}, {p, 0, 1},
  PlotStyle → ColorData["Rainbow"] /@ (Range[0, Length@e] / Length@e),
  PlotLegends → "Expressions"]
Expand[A1[1 - eps]]
Expand[A2[1 - eps]]
Expand[A3[1 - eps]]

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Expand[A4[1 - eps]]
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intersect1 = NSolve[A3[p] == A4[p] && p < 1 && p > 0]
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A4'[p /. intersect1]
```

```
A3'[p /. intersect1]
```

```
intersect2 = NSolve[A2[p] == A4[p] && p < 1 && p > 0]
```

```
A4'[p /. intersect2]
```

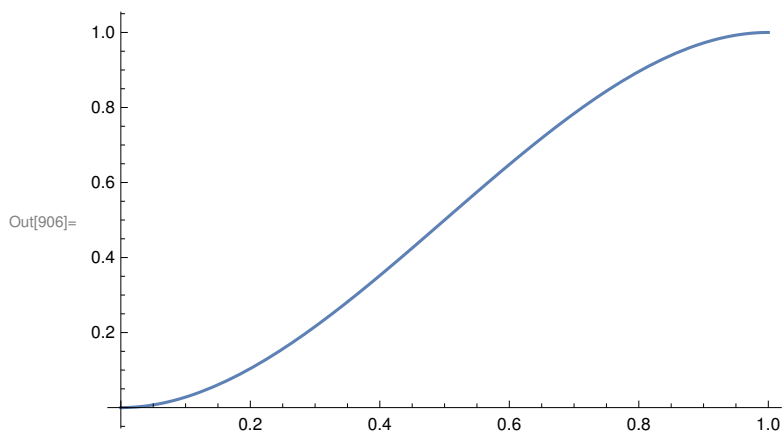
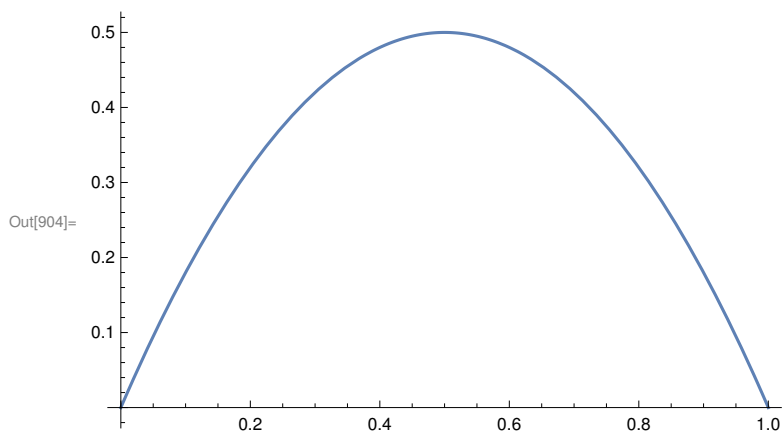
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A2'[p /. intersect2]
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```
intersect3 = NSolve[A2[p] == A1[p] && p ≤ 1 && p > 0]
```

```
Expand[A1[eps]]
```

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Expand[A3[eps]]
```

```
Plot[Min[A3[p], A2[p], A4[p]], {p, 0, 1}]
```



Out[914]= $4 + 4p + 7p^2 + 6p^3 - 54p^4 + 12p^5 + 75p^6 - 66p^7 + 16p^8$

Out[915]= $4 + 4p + 7p^2 + 6p^3 - 54p^4 + 12p^5 + 75p^6 - 66p^7 + 16p^8$

Out[917]= $4 + 4p + 8p^2 + 4p^3 - 59p^4 + 28p^5 + 61p^6 - 62p^7 + 16p^8$

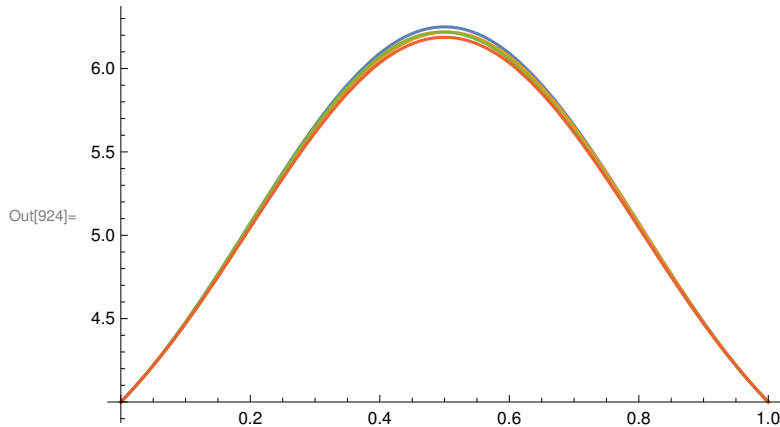
Out[918]= $4 + 4p + 8p^2 + 4p^3 - 59p^4 + 28p^5 + 61p^6 - 62p^7 + 16p^8$

$$\text{Out}[919]= 4 + 4 p + 8 p^2 + 4 p^3 - 59 p^4 + 28 p^5 + 61 p^6 - 62 p^7 + 16 p^8$$

$$\text{Out}[921]= 4 + 4 p + 7 p^2 + 6 p^3 - 57 p^4 + 20 p^5 + 68 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[922]= 4 + 4 p + 7 p^2 + 6 p^3 - 57 p^4 + 20 p^5 + 68 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[923]= \frac{99}{16}$$



$$\text{Out}[925]= \left\{ \frac{25}{4}, \left\{ p \rightarrow \frac{1}{2} \right\} \right\}$$

$$\text{Out}[926]= \left\{ 4 + 4 \sqrt[4]{0.503...} + 7 \left(\sqrt[4]{0.503...} \right)^2 + 6 \left(\sqrt[4]{0.503...} \right)^3 - 54 \left(\sqrt[4]{0.503...} \right)^4 + 12 \left(\sqrt[4]{0.503...} \right)^5 + 75 \left(\sqrt[4]{0.503...} \right)^6 - 66 \left(\sqrt[4]{0.503...} \right)^7 + 16 \left(\sqrt[4]{0.503...} \right)^8, \left\{ p \rightarrow \sqrt[4]{0.503...} \right\} \right\}$$

$$\text{Out}[927]= \left\{ 4 + 4 \sqrt[4]{0.497...} + 8 \left(\sqrt[4]{0.497...} \right)^2 + 4 \left(\sqrt[4]{0.497...} \right)^3 - 59 \left(\sqrt[4]{0.497...} \right)^4 + 28 \left(\sqrt[4]{0.497...} \right)^5 + 61 \left(\sqrt[4]{0.497...} \right)^6 - 62 \left(\sqrt[4]{0.497...} \right)^7 + 16 \left(\sqrt[4]{0.497...} \right)^8, \left\{ p \rightarrow \sqrt[4]{0.497...} \right\} \right\}$$

$$\text{Out}[928]= \left\{ \frac{99}{16}, \left\{ p \rightarrow \frac{1}{2} \right\} \right\}$$

$$\text{Out}[930]= 5 + 4 p + 2 p^2 + 8 p^3 - 38 p^4 - 4 p^5 + 76 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[932]= 4 + 4 p + 7 p^2 + 6 p^3 - 45 p^4 + 79 p^6 - 66 p^7 + 16 p^8$$

$$\text{Out}[934]= 5 + 4 p + 3 p^2 + 6 p^3 - 40 p^4 + 4 p^5 + 69 p^6 - 62 p^7 + 16 p^8$$

$$\text{Out}[936]= 5 + 4 p + 2 p^2 + 8 p^3 - 35 p^4 - 12 p^5 + 83 p^6 - 66 p^7 + 16 p^8$$

$$\text{Out}[938]= 5 + 4 p + 2 p^2 + 8 p^3 - 50 p^4 + 16 p^5 + 65 p^6 - 62 p^7 + 16 p^8$$

$$\text{Out}[940]= 5 + 4 p + 2 p^2 + 8 p^3 - 47 p^4 + 8 p^5 + 72 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[942]= 5 + 4 p + 3 p^2 + 6 p^3 - 52 p^4 + 24 p^5 + 58 p^6 - 60 p^7 + 16 p^8$$

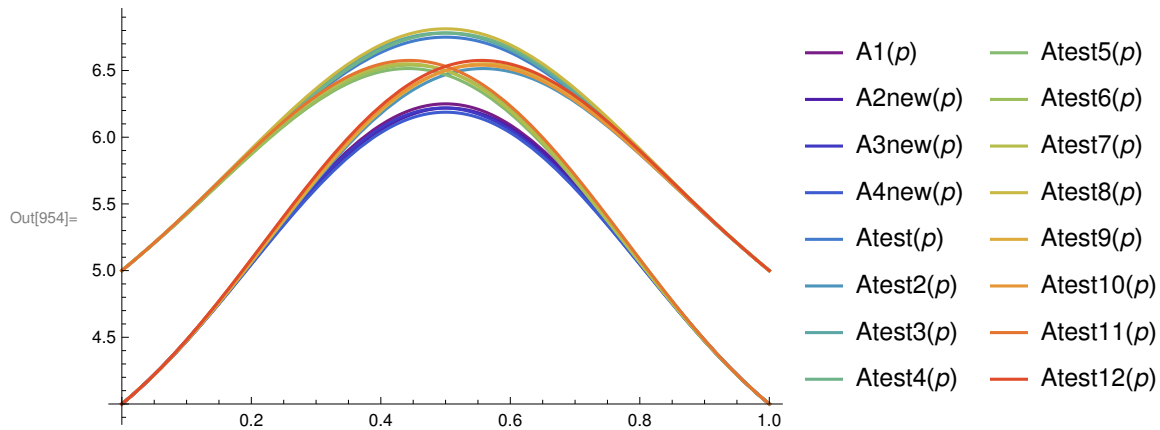
$$\text{Out}[944]= 5 + 4 p + 3 p^2 + 6 p^3 - 37 p^4 - 4 p^5 + 76 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[946]= 4 + 4 p + 7 p^2 + 6 p^3 - 42 p^4 - 8 p^5 + 86 p^6 - 68 p^7 + 16 p^8$$

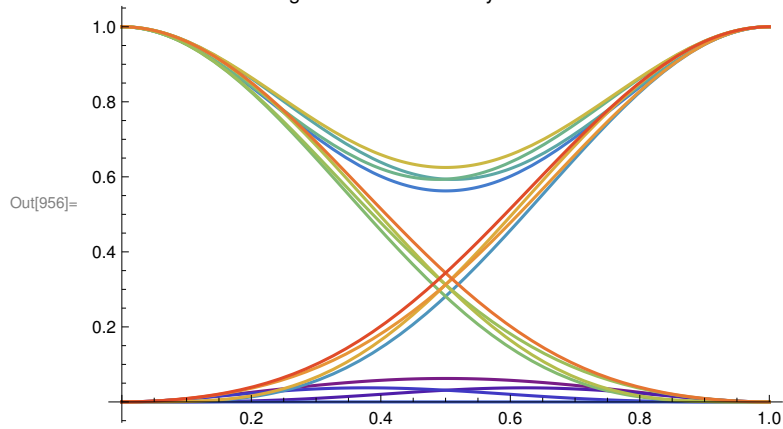
$$\text{Out}[948]= 4 + 4 p + 8 p^2 + 4 p^3 - 47 p^4 + 8 p^5 + 72 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[950]= 5 + 4 p + 3 p^2 + 6 p^3 - 49 p^4 + 16 p^5 + 65 p^6 - 62 p^7 + 16 p^8$$

$$\text{Out}[952]= 4 + 4 p + 8 p^2 + 4 p^3 - 44 p^4 + 79 p^6 - 66 p^7 + 16 p^8$$



All algorithms subtracted by the minimal one



$$\text{Out}[957]= \{\}$$

$$\text{Out}[958]= \{\}$$

$$\text{Out}[959]= \{\}$$

$$\text{Out}[960]= 4 + 4 p + 8 p^2 + 4 p^3 - 56 p^4 + 20 p^5 + 68 p^6 - 64 p^7 + 16 p^8$$

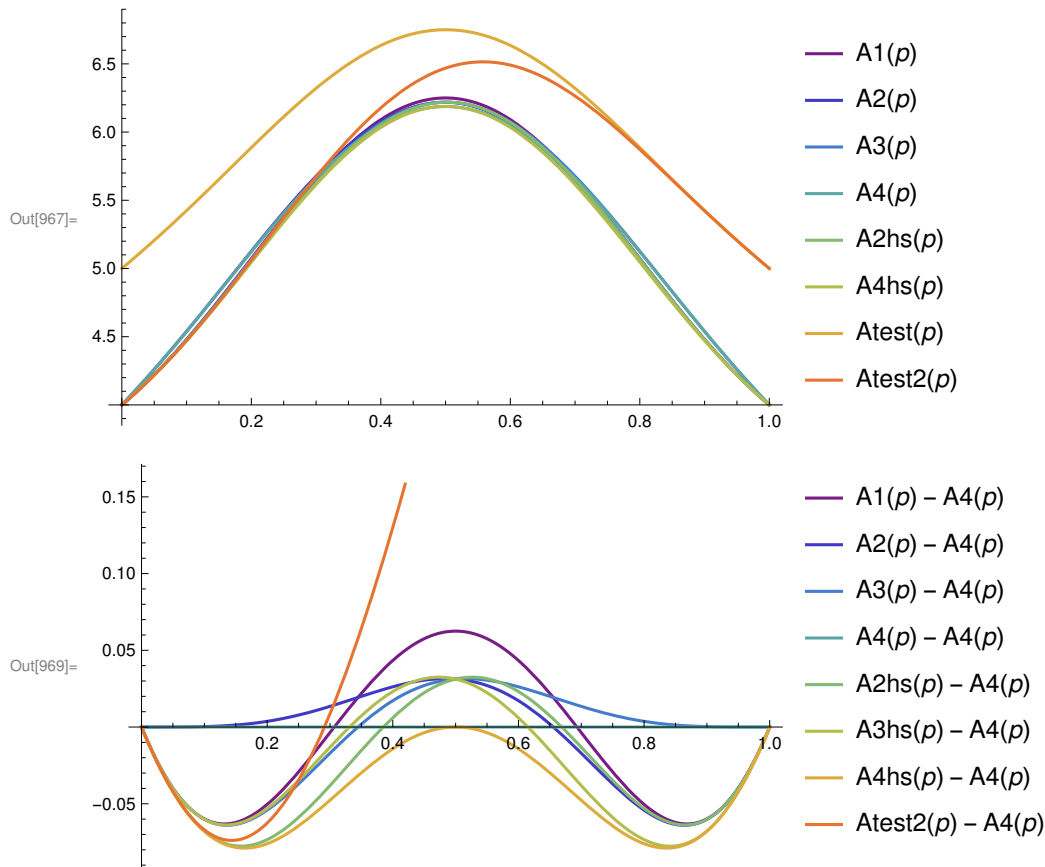
$$\text{Out}[961]= \frac{25}{4}$$

$$\text{Out}[962]= 4 + 5 p + 4 p^2 + 2 p^3 - 32 p^4 - 3 p^5 + 44 p^6 - 8 p^7 - 20 p^8 + 8 p^9$$

$$\text{Out}[963]= 4 + 4 p + 8 p^2 + 4 p^3 - 59 p^4 + 19 p^5 + 100 p^6 - 120 p^7 + 52 p^8 - 8 p^9$$

$$\text{Out}[964]= 4 + 5 p + 4 p^2 + 2 p^3 - 35 p^4 - 4 p^5 + 76 p^6 - 64 p^7 + 16 p^8$$

$$\text{Out}[965]= \frac{99}{16}$$



$$\text{Out}[970] = 4 + 4 \text{ eps} + 8 \text{ eps}^2 + 4 \text{ eps}^3 - 56 \text{ eps}^4 + 20 \text{ eps}^5 + 68 \text{ eps}^6 - 64 \text{ eps}^7 + 16 \text{ eps}^8$$

$$\text{Out}[971] = 4 + 4 \text{ eps} + 8 \text{ eps}^2 + 4 \text{ eps}^3 - 59 \text{ eps}^4 + 19 \text{ eps}^5 + 100 \text{ eps}^6 - 120 \text{ eps}^7 + 52 \text{ eps}^8 - 8 \text{ eps}^9$$

$$\text{Out}[972] = 4 + 5 \text{ eps} + 4 \text{ eps}^2 + 2 \text{ eps}^3 - 32 \text{ eps}^4 - 3 \text{ eps}^5 + 44 \text{ eps}^6 - 8 \text{ eps}^7 - 20 \text{ eps}^8 + 8 \text{ eps}^9$$

$$\text{Out}[973] = 4 + 5 \text{ eps} + 4 \text{ eps}^2 + 2 \text{ eps}^3 - 35 \text{ eps}^4 - 4 \text{ eps}^5 + 76 \text{ eps}^6 - 64 \text{ eps}^7 + 16 \text{ eps}^8$$

$$\text{Out}[974] = \{\{p \rightarrow 0.344446\}\}$$

$$\text{Out}[975] = \{4.001\}$$

$$\text{Out}[976] = \{4.35897\}$$

$$\text{Out}[977] = \{\{p \rightarrow 0.655554\}\}$$

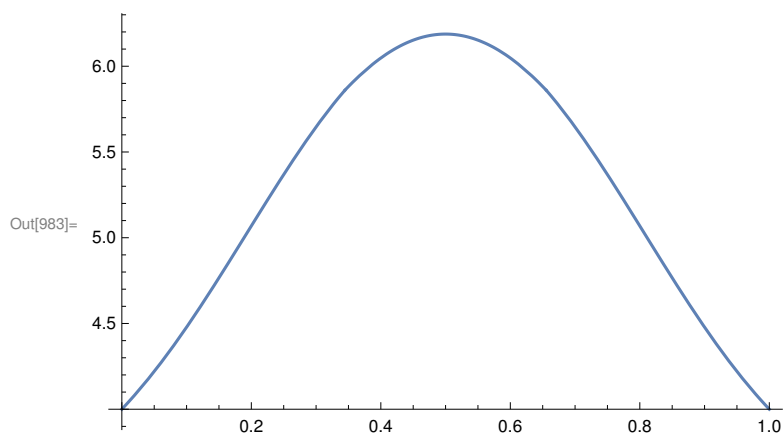
$$\text{Out}[978] = \{-4.001\}$$

$$\text{Out}[979] = \{-4.35897\}$$

$$\text{Out}[980] = \{\{p \rightarrow 0.344446\}, \{p \rightarrow 1.\}, \{p \rightarrow 1.\}, \{p \rightarrow 1.\}, \{p \rightarrow 1.\}\}$$

$$\text{Out}[981] = 4 + 4 \text{ eps} + 8 \text{ eps}^2 + 4 \text{ eps}^3 - 56 \text{ eps}^4 + 20 \text{ eps}^5 + 68 \text{ eps}^6 - 64 \text{ eps}^7 + 16 \text{ eps}^8$$

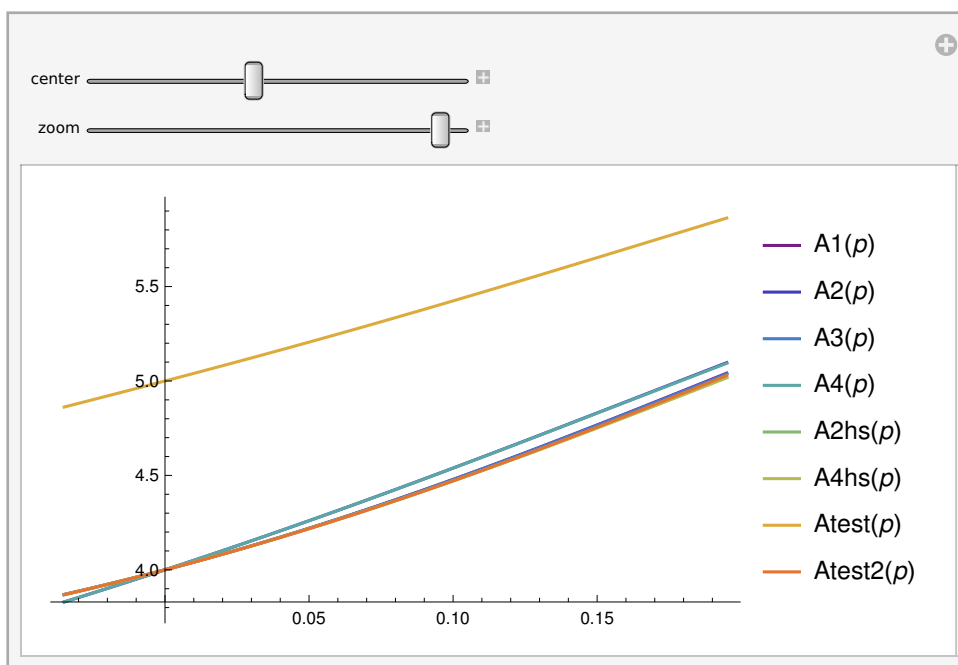
$$\text{Out}[982] = 4 + 4 \text{ eps} + 8 \text{ eps}^2 + 4 \text{ eps}^3 - 59 \text{ eps}^4 + 19 \text{ eps}^5 + 100 \text{ eps}^6 - 120 \text{ eps}^7 + 52 \text{ eps}^8 - 8 \text{ eps}^9$$



In[]:=

▶ interactive plot %716

Out[]:=



... **Power:** Infinite expression $\frac{1}{0}$ encountered.

... **Infinity:** Indeterminate expression 0 ComplexInfinity encountered.

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... **Infinity**: Indeterminate expression 0 ComplexInfinity encountered.

... **Power**: Infinite expression $\frac{1}{0}$ encountered.

... **General**: Further output of Power::infy will be suppressed during this calculation.

... **Infinity**: Indeterminate expression 0 ComplexInfinity encountered.

... **General**: Further output of Infinity::indet will be suppressed during this calculation.