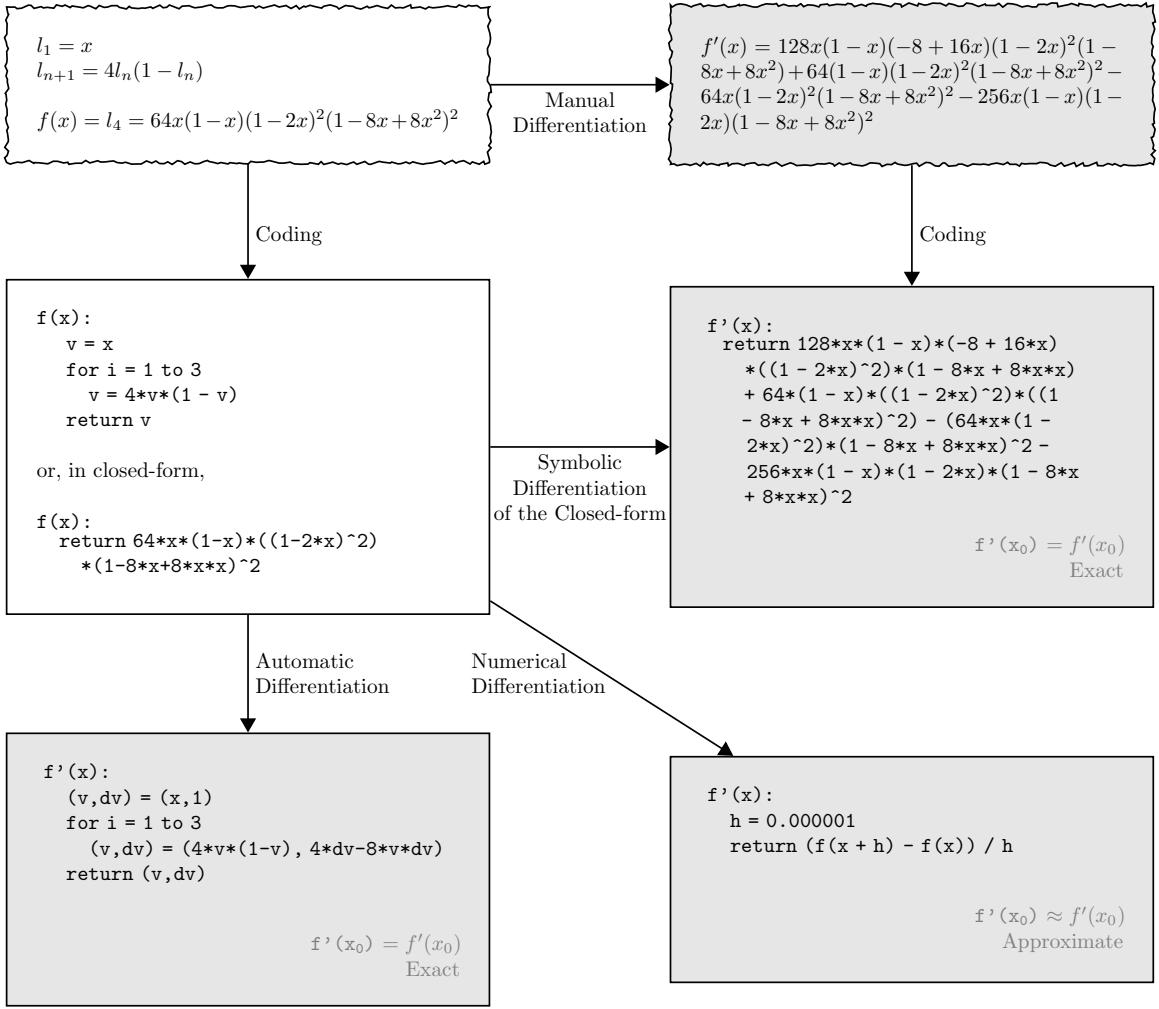
$l_1 = x$
$l_{n+1} = 4l_n(1 - l_n)$
$f(x) = l_4 = 64x(1-x)(1-2x)^2(1-8x+8x^2)^2$
Manual Differentiation
$f'(x) = 128x(1-x)(-8+16x)(1-2x)^2(1-8x+8x^2)+64(1-x)(1-2x)^2(1-8x+8x^2)^2-64x(1-2x)^2(1-8x+8x^2)^2-256x(1-x)(1-2x)(1-8x+8x^2)^2$
Coding
Coding
f(x):
v = x
for i = 1 to 3
v = 4*v*(1 - v)
return v
or, in closed-form,
f(x):
return 64*x*(1-x)*((1-2*x)^2)
*(1-8*x+8*x*x)^2
Symbolic Differentiation of the Closed-form
f'(x):
return 128*x*(1 - x)*(-8 + 16*x)
*((1 - 2*x)^2)*(1 - 8*x + 8*x*x)
+ 64*(1 - x)*((1 - 2*x)^2)*((1
- 8*x + 8*x*x)^2) - (64*x*(1 -
2*x)^2)*(1 - 8*x + 8*x*x)^2 -
256*x*(1 - x)*(1 - 2*x)*(1 - 8*x
+ 8*x*x)^2
f'(x0) = f'(x0)
Exact
Automatic Differentiation
Numerical Differentiation
f'(x):
(v,dv) = (x,1)
for i = 1 to 3
(v,dv) = (4*v*(1-v), 4*dv-8*v*dv)
return (v,dv)
f'(x0) = f'(x0)
Exact
f'(x):
h = 0.000001
return (f(x + h) - f(x)) / h
f'(x0) ≈ f'(x0)
Approximate