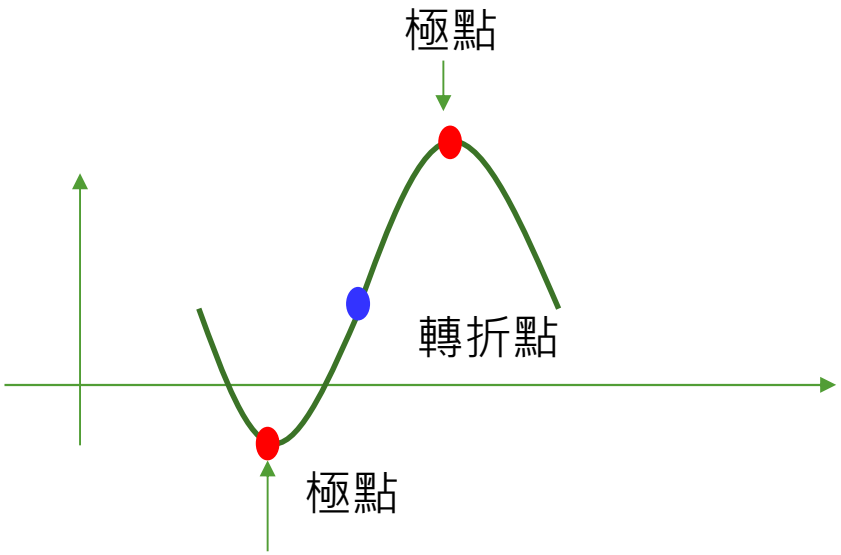
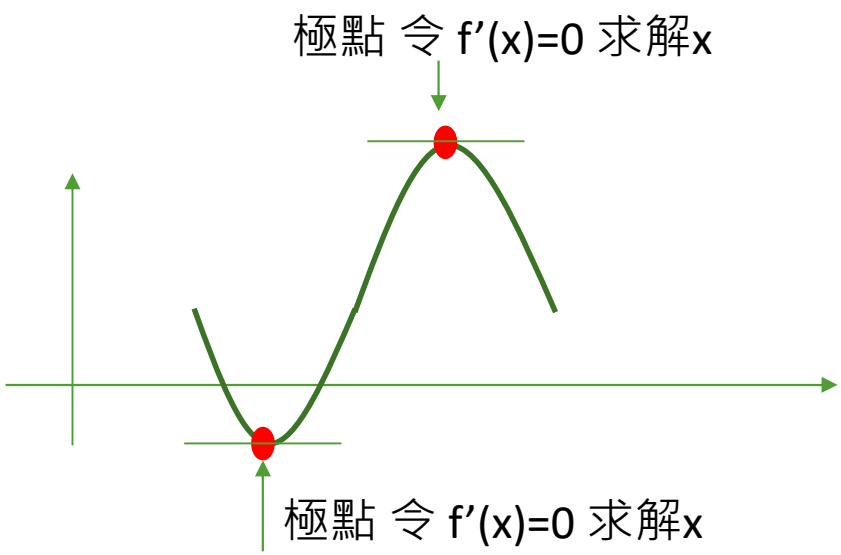
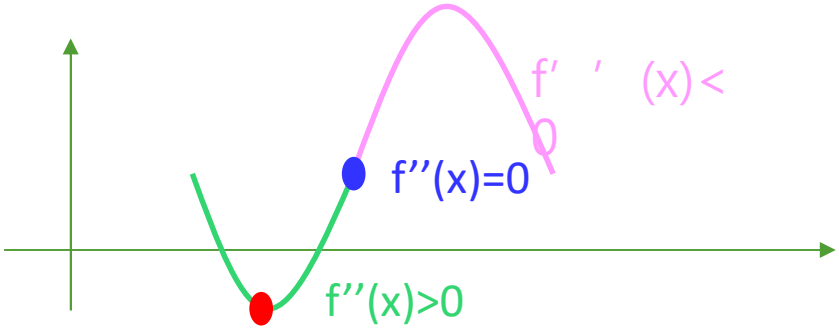
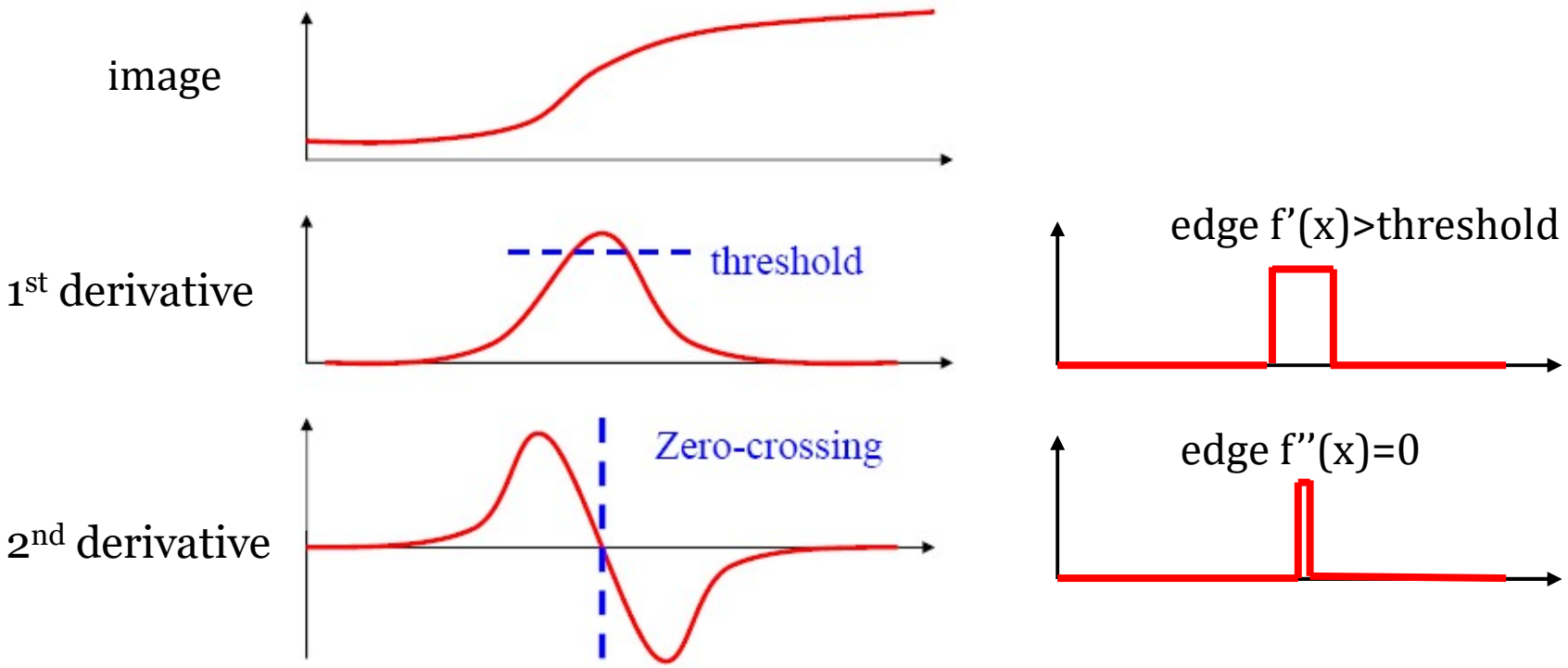
# Mathematic



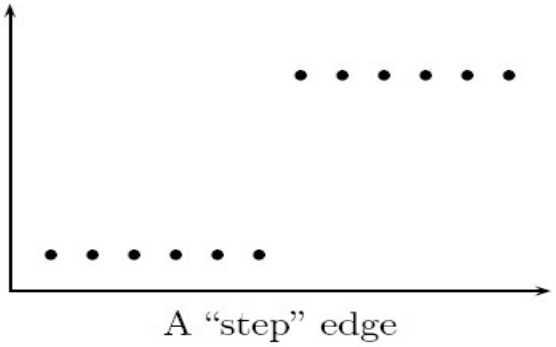



# Derivative Operators

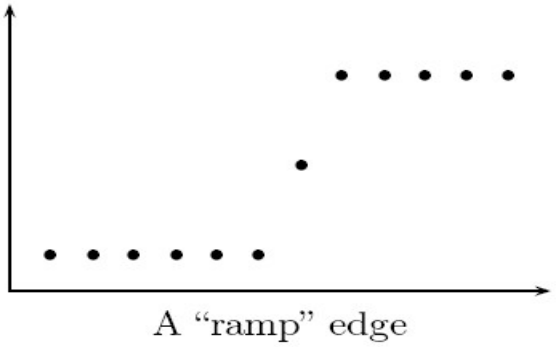


# Zero Crossings

1st derivative

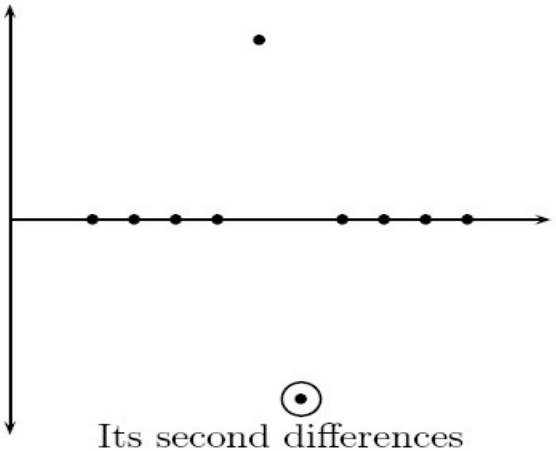


A "step" edge

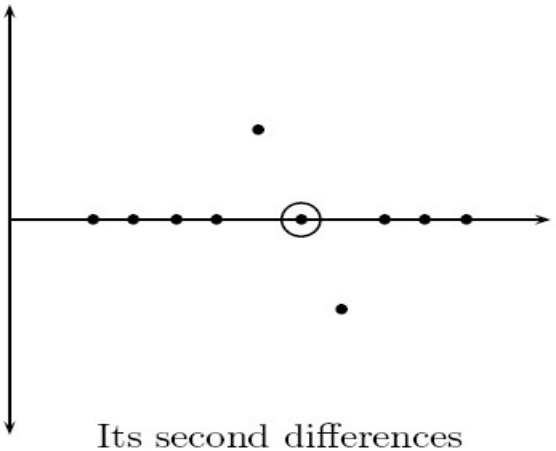


A "ramp" edge

2nd derivative

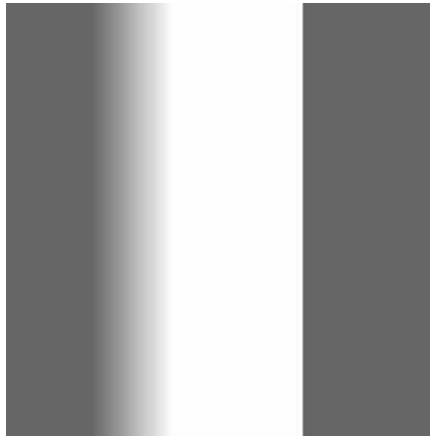


Its second differences



Its second differences

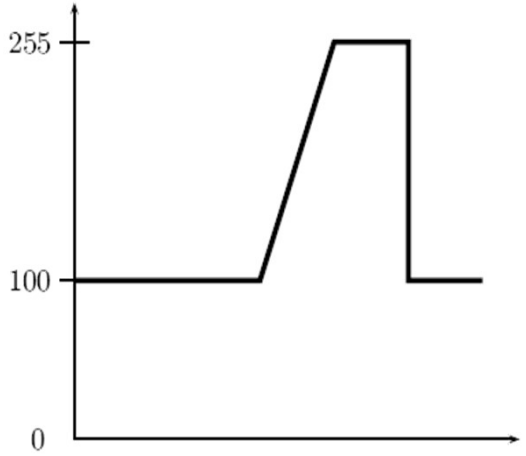
# Derivative Operators

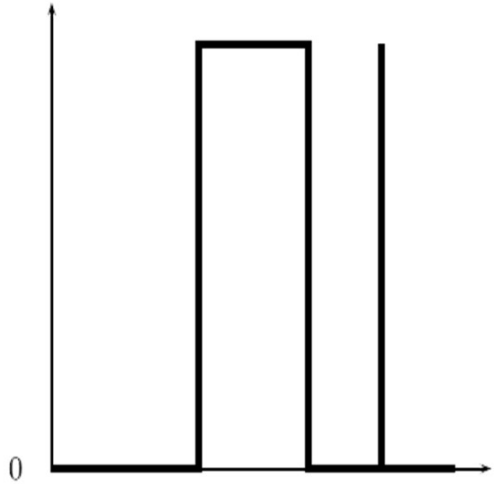


ramp edge



step edge
(ideal edge)

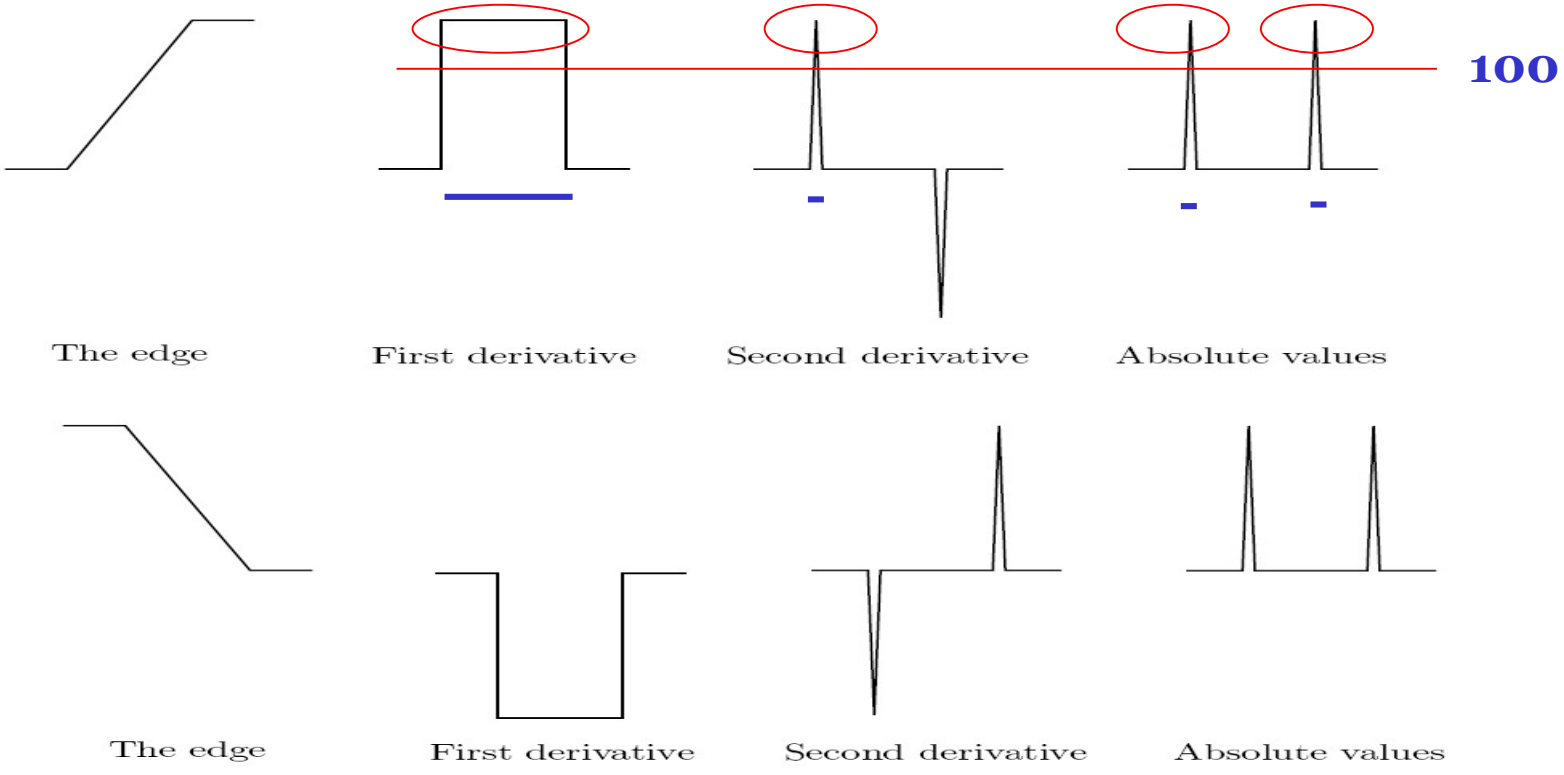



**1st derivatives**

# Derivative Operators

- **Fundamental definitions**



# Zero Crossings

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 50 | 50 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 50 | 50 | 200 | 200 | 200 | 200 | 50 | 50 |
| 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

(a) A simple image

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| −100 | −50 | −50 | −50 | −50 | −50 | −50 | −50 | −50 | −100 |
| −50 | 0 | 150 | 150 | 150 | 150 | 150 | 150 | 0 | −50 |
| −50 | 150 | −300 | −150 | −150 | −150 | −150 | −300 | 150 | −50 |
| −50 | 150 | −150 | 0 | 0 | 0 | 0 | −150 | 150 | −50 |
| −50 | 150 | −150 | 0 | 0 | 0 | 0 | −150 | 150 | −50 |
| −50 | 150 | −300 | −150 | 0 | 0 | 0 | −150 | 150 | −50 |
| −50 | 0 | 150 | 300 | −150 | 0 | 0 | −150 | 150 | −50 |
| −50 | 0 | 0 | 150 | −300 | −150 | −150 | −300 | 150 | −50 |
| −50 | 0 | 0 | 0 | 150 | 150 | 150 | 150 | 0 | −50 |
| −100 | −50 | −50 | −50 | −50 | −50 | −50 | −50 | −50 | −100 |

(b) After laplace filtering