If F is antiderivative for f,
G is antiderivative for g,

$$\int_a^b F g = [F G]_a^b - \int_a^b f G,$$

$$\int F g = F G - \int f G$$

$$\int f g = F g - \int F \frac{d}{dx}[g]$$

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kind of like

$$\int \left(\int f\right) g = \left(\int f\right)\left(\int g\right) - \int f \left(\int g\right)$$

$$\int j h = \left(\int j\right) h - \int \left(\int j\right) \frac{d}{dx}[h]$$

If F is antiderivative for f,
G is antiderivative for g.

$$\int u\,dv = uv - \int v\,du$$

$$\int F \frac{d}{dx}[G] = FG - \int G \frac{d}{dx}[F]$$

$$\int f'g\,dx = fg - \int f g'\,dx$$

$\int j$ is a family of functions

e.g. $J + C$

- $\int x \cdot \text{arctangent}(x)\,dx$

- $\int \ln(x)\,dx$

- $\int (x^3 + x^5)\ln(x)\,dx$

$\int x \arctan(x)$

Maybe? $\int (\sqrt{x})(\sqrt{x} \arctan(x))$

$(x)(\arctan(x))$

$$\int \frac{\frac{1}{2}x^2 + c}{x^2+1}$$

$c = \frac{1}{2}$

$\downarrow$

$$\frac{1}{2}\left(\frac{x^2+1}{x^2+1}\right)$$

$\frac{d}{dx}\frac{d}{dx}$	0
$\frac{d}{dx}$	1
x	x
$\int$	$\frac{1}{2}x^2 + c$
$\int\int$	

$\frac{d}{dx}$	
$\frac{d}{dx}$	$\frac{1}{1+x^2}$
arctan	$\arctan(x)$
$\int$	
$\int\int$	

$$\int f'g\,dx = fg - \int f g'\,dx$$

$$\int x \arctan(x)$$

$$= \int \frac{d}{dx}\left[\frac{1}{2}x^2 + \frac{1}{2}\right]\arctan(x)$$

$$= \left(\frac{1}{2}x^2 + \frac{1}{2}\right)\arctan(x) - \int \frac{1}{2}\left(\frac{x^2+1}{x^2+1}\right)$$

$$= \left(\frac{1}{2}x^2 + \frac{1}{2}\right)\arctan(x) - \frac{1}{2}x.$$

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(2) Polynomial → (algebraic)

(1) trig, exponential

(3) log, inverse trig

$$\left((1) \rightarrow (2) \rightarrow (3) \right.$$

$$\left. \text{move } \frac{d}{dx} \text{ to the right} \right)$$

$$\int f(x)\, g(x)\, dx$$

$$\left(\frac{x^2+1}{x^3+2}\right) \quad \left(\frac{\sqrt{x^2+1}}{x^3+2}\right)$$

- Polynomial or rational or algebraic (2)
- inverse trig or log (3)
- trig & e^x (1)

$$\frac{d}{dx}[\ln x] = \frac{1}{x}$$

$$(1) \xrightarrow{\frac{d}{dx}} (2) \xrightarrow{\frac{d}{dx}} (3)$$

"move $\frac{d}{dx}$ to the right w/ IBP"

LIATE

log · inv trig · alg · trig · exp

"For 'liate' more. d/dx to the Left"

$$\int \frac{d}{dx}[f(x)]\, g(x)\, dx$$

$$= f(x)g(x) - \int f(x) \frac{d}{dx}[g(x)]\, dx$$

$$\int \ln(x)\, dx$$

$$\int (x^3 + x^5) \ln(x)\, dx$$

$$\frac{d}{dx}\left[\frac{x^4}{4}+\frac{x^6}{6}+c\right]=x^3+x^5$$

$$\frac{d}{dx}\left[\ln(x)\right]$$

$$\int \frac{d}{dx}\left[\frac{x^4}{4}+\frac{x^6}{6}+c\right]\cdot \ln(x)\,dx$$

$$=\left(\frac{x^4}{4}+\frac{x^6}{6}+c\right)\cdot \ln(x)-\int\left(\frac{x^4}{4}+\frac{x^6}{6}+c\right)\cdot\frac{1}{x}$$

$$=\left(\frac{x^4}{4}+\frac{x^6}{6}+c\right)\cdot \ln(x)-\int\left(\frac{x^3}{4}+\frac{x^5}{6}+\frac{c}{x}\right)dx$$

$c=0$

$$=\left(\frac{x^4}{4}+\frac{x^6}{6}\right)\ln x-\int\left(\frac{x^3}{4}+\frac{x^5}{6}\right)dx$$

$$\int 1\cdot\ln(x)\,dx = \int \frac{d}{dx}[x]\cdot\ln(x)\,dx$$

$$= x\ln(x) - \int x\,\frac{d}{dx}[\ln(x)]\,dx$$

$$= x\ln(x) - \int 1\,dx$$

$$= x\ln(x) - x + C$$

$$\frac{d}{dx}\left[\underline{x\ln x} - x\right]$$

$$\ln x + 1 - 1 = \ln x$$