Class 7

$$NPV = \sum_{j=0}^{N_{years}} \frac{cashflow_j}{(1+i)^j} \qquad Cashflow_j = Revenue_j - CAPEX_j - DRILLEX_j - OPEX_j - \dots$$

find $q_{plateau}$ such that NPV max for revenue is max when $q_{plateau}$ = max
N_{well} = max

$$\frac{\partial Revenue}{\partial q_{p,f}} = 0$$

Neglecting OPEX, all DRILLEX and CAPEX are invested in year "0"

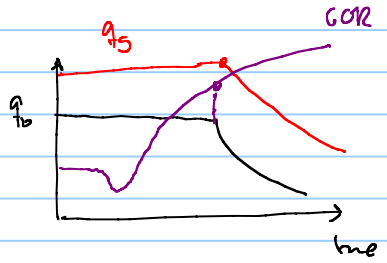
$$NPV(q_{pf}, N_w) = PV\ Revenue - DRILLEX - CAPEX$$

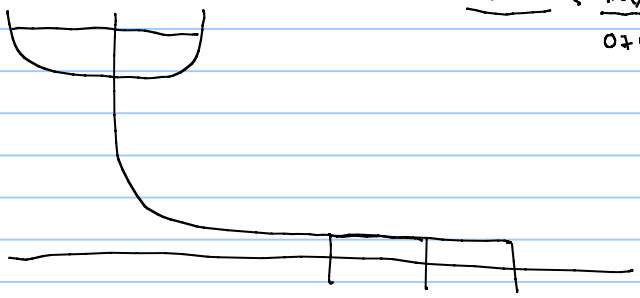
$$DRILLEX = P_w \cdot N_w \neq f(q_{R,f})$$

$$CAPEX = CAPEX_{TOPSIDES} + CAPEX_{SUBSEA}$$

$CAPEX_{TOPSIDES} = f(Nw)$ → f(weight)

$$weight = f(q_{max\,liq} + q_{max\,gas})$$





$$CAPEX_{TOPSIDES} = f(q_{max\,liquid}, q_{max\,gas})$$

q_{f-p} GOR, q_{f-p}

$$CAPEX_{TOPSIDES} = A + B\,q_{f-p} + C\,q_g$$

GOR q_{f-p}

$$\frac{\partial NPV}{\partial q_{pf}} = \frac{\partial Revenue}{\partial q_{pf}} - \frac{\partial CAPEX_{TOPSIDES}}{\partial q_{f-p}} = 0$$

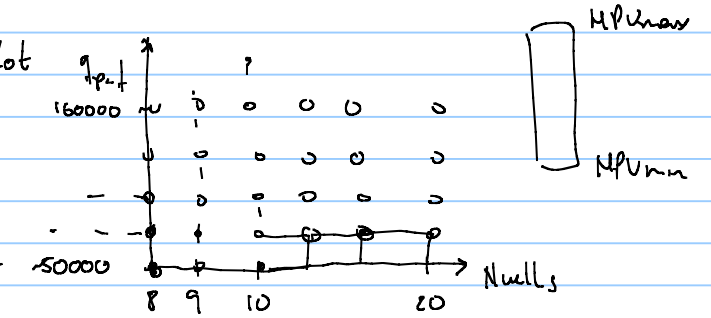
$(B+C)$

$-(B+C)$

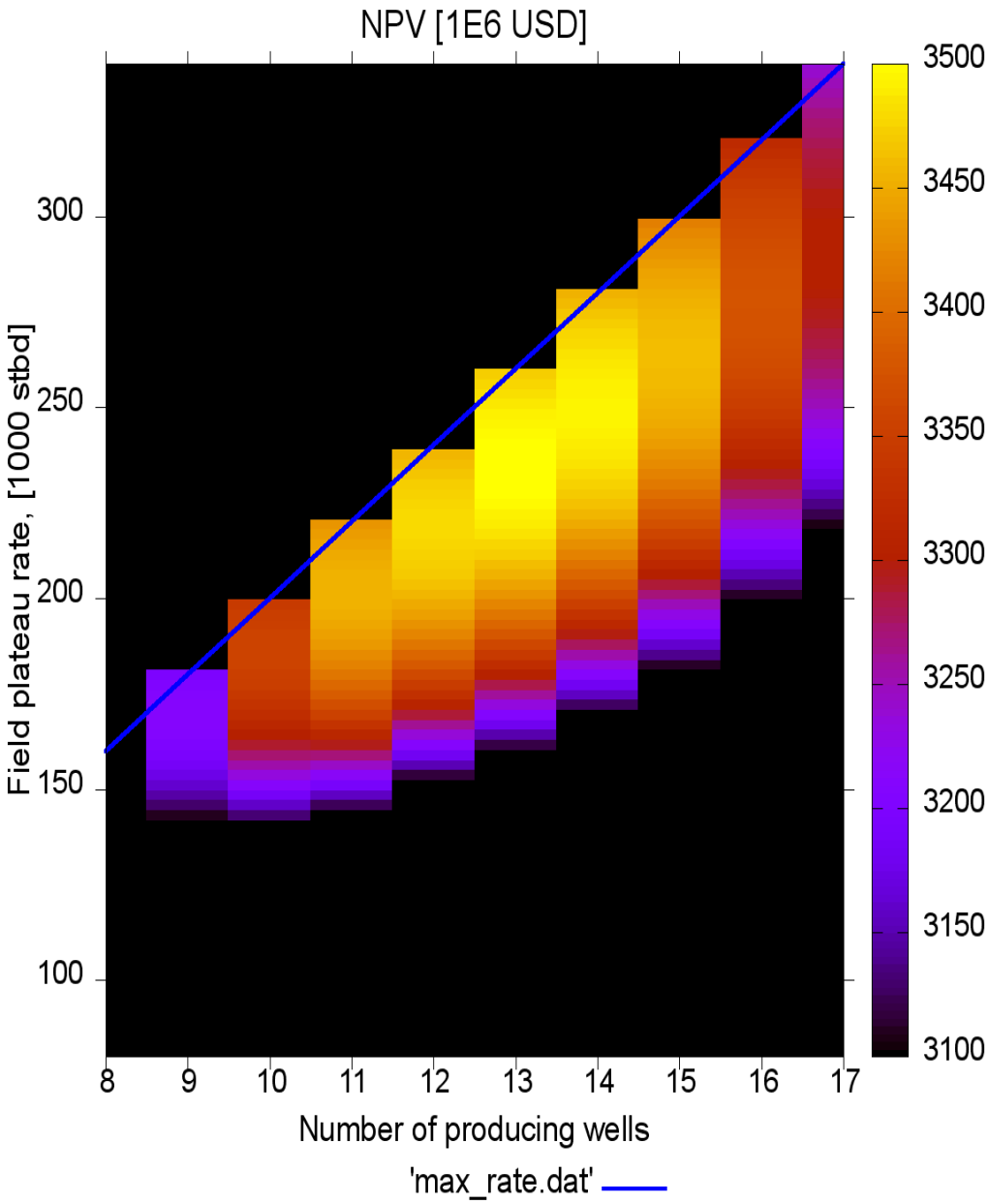
$$\frac{\partial Revenue}{\partial q_{pf}} = (B+C)$$

$$CAPEX_{SUBSEA} = f(N_w, q_{pf}, N_{flowlines}, N_{templates})$$

to see effect of Nw Color Plot



Using GNU plot:



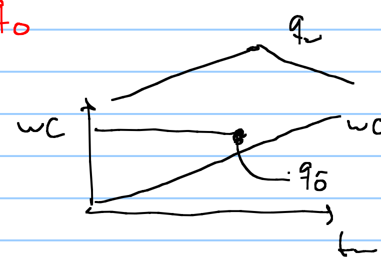
what happens when producing water?

$$CAPEX_{manifolds} = A + B\, q_{f-p} + C\, q_g$$

q_g = GOR q_{f-p}

$$B\,(q_{w\,max} + q_{p-f})$$

$$wc = \frac{q_w}{q_o + q_w} \rightarrow q_w = \frac{wc}{1-wc}\, q_o$$



$$B\left(q_{p-f} + \frac{wc}{1-wc}\, q_{p-f}\right)$$

$$B\, q_{p-f}\left(1 + \frac{wc}{1-wc}\right)$$

$$q_{p-f}\left(\frac{1}{1-wc}\right)$$

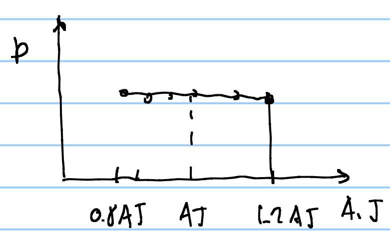
wc = 30% constant

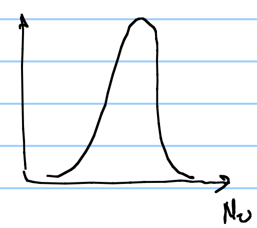
$$wc = f(N_p) = C \cdot N_p$$

$$\text{at } t_p \quad wc^* = C \cdot N_p^*$$

$$q_{w\,max} = \left(\frac{wc^*}{1-wc^*}\right) q_{p-f}$$

Effect of uncertainty in the input (in this case well productivity index J, +-20%)





Monte Carlo sampling

$$AJ = AJ_{min} + Rand\,(AJ_{max} - AJ_{min})$$

Homework: compute optimal qf_p and Nwells for variations of +-20% in J. Calculate the probability distribution of optimal qpf, Nwells and NPV

Last point: effect of a linear variation of oil price with time - descending, ascending.

END OF LECTURES