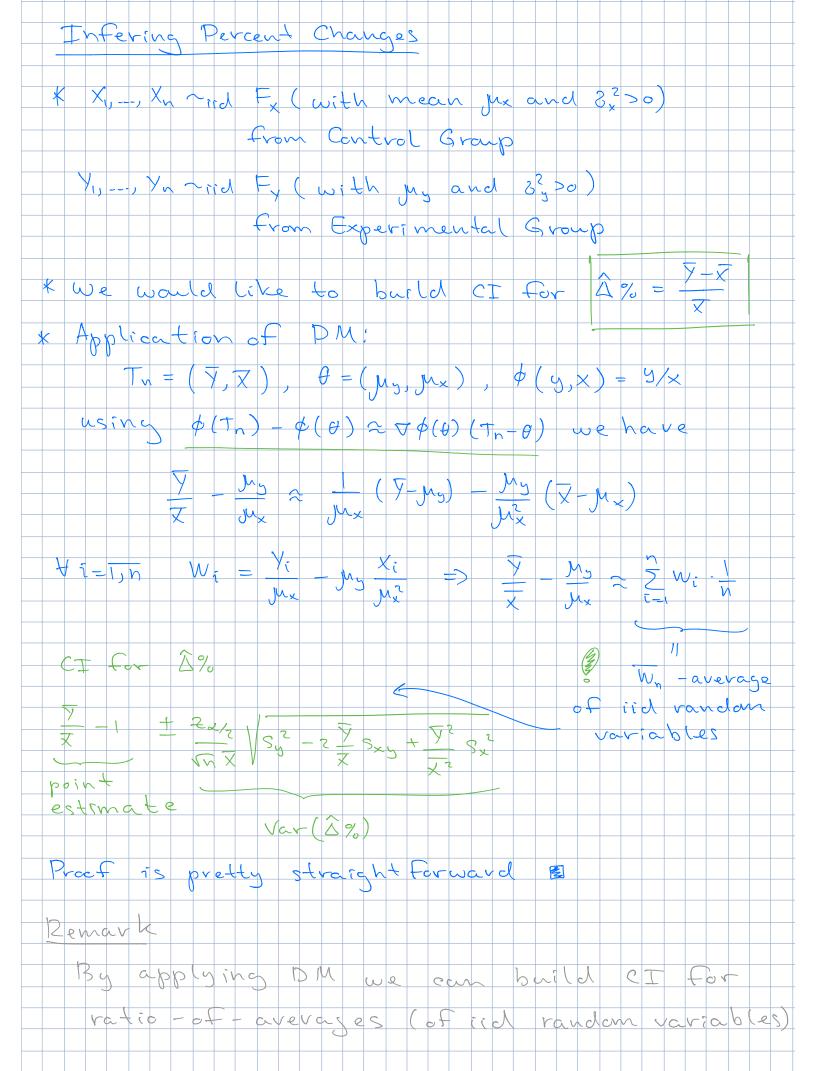
Delta Method Central Limit Theorem \* X, ..., Xn rid F with finite mand 32 so \* X Y Y Y (0, 1) Common Application: Confidence Interval for mi Xn + 2 x2 m Prawback: Assumption of jid of X,,.., X, De Ita Method For simplicity assume that 3=1 and consider The T(X,, -, X,) - some statistic defined on a Sample, A + constant such that  $T_n(T_n-\theta) \rightarrow \mathcal{N}(0,1)$  $T_{N}-\theta=O(1/N)$ Consider 4: IR - IR - continious transformation Using Taylor expansion we have  $\phi(T_n) - \phi(\theta) = \phi'(\theta)(T_n - \theta) + C(T_n + \theta)^2$  $\forall h \mid \phi(T_h) - \phi(\theta) \mid J \rightarrow \mathcal{N}(0, \phi(\theta)^2)$ Remark De la Method allows us to extend asymptotic normality to any continous tvansformation O(Th)



Decading Cluster Randomization \* Key concepts in AB test are \* vandomization unit (for example, user) \* analysis unit (For example, view) \* Analytids is straight forward when vandomization and analysis units agree. (When randomizing by user and computing average revenue per user) \* In practice vandomization unit is a cluster of analysis units KWLCG we will consider only treatment group with k clusters, i=1,-, k Mi-number of analysis units in cluster Vij (j-i, vi) - analysis unit observations 7 - 2 / 2 Ni . Lets rewrite this expression as tio-of-averages (of iid vandom vars) Thus we can apply DM to compute Var (7) 

Hypothesis Testing \* Suppose de measured 7 and X (verchue per view) for treatmend and control groups. \* we would like to test Ho: there is no significant difference between Yandx \* Ho: Mx = My H.: My  $\star$   $\tau(x^n, y^m) = \overline{y} - \overline{x}$ under the Mo T(X, Ym) ~ W (0, 82) Where 32 - Var (7-X) = Var (7) + Var (X) \* We can test 10 in two ways: 1) Build CT For Jux : 7-X + 2 ~ [Vav (7)+Vav(x)] and check OECI IF OECI then we can not reject tho 2) Compute p-value of T(x", ym) and compare it against & IF P < < then we reject Ho in favour of H,

