MULTIPLE COMPARISONS IN QOE ANALYSIS

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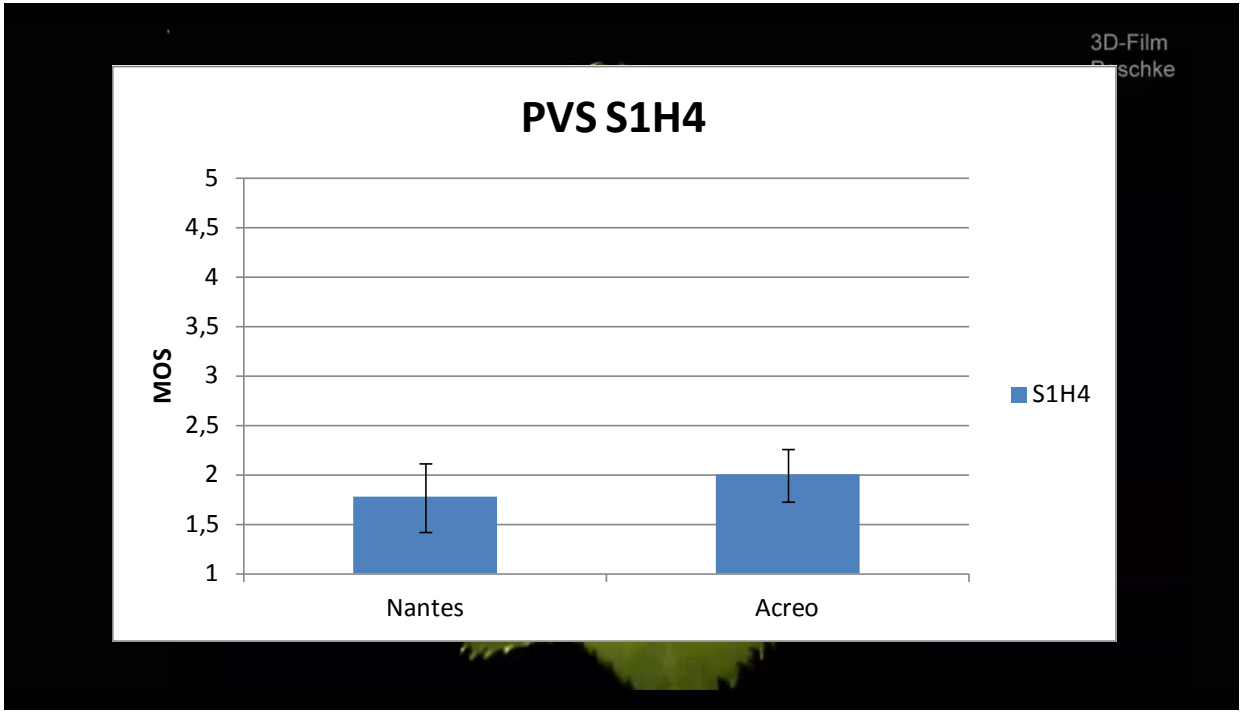
STATISTICAL ANALYSIS OF EXPERIMENTAL DATA

- Data is collected, then what?
- Mean and standard deviation is usually easily computed
- Common question – are two means the same or different?

EXAMPLE

- Example: One video with an error. A number of people in France and an equal number in Sweden rates the quality on a five graded scale



STATISTICAL TEST OR HYPOTHESIS TEST

- Null hypothesis (H_0): One possible arrangement
  - H_0: $\mu_1 = \mu_2$ (in this case)
- Alternative hypothesis (H_1): all other arrangement
  - H_1: $\mu_1 \neq \mu_2$ (in this case)
- Student T-test
  - If $t_{obs} \geq t_{critical}$ reject the null hypothesis
  - For example (unequal sample sizes, unequal variance)

$$t_{obs} = \frac{\mu_1 - \mu_2}{s_{diff}}; s_{diff} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}; df = (n_1 - 1) + (n_2 - 1)$$

- Our example:
  - $\mu_1 = 1.77$; $\mu_2 = 2.00$; $s_1 = 0.869$; $s_2 = 0.667$; $n_1 = 22$; $n_2 = 19$;
  - t = -0.927; df = 39 + Table => t(40) = 2.02 at 0.05 significance level
  - Abs(t) < t(40)
  - Statistics packages gives p = 0.359

MORE THAN TWO MEAN?

- What if there are more than two means?
- Are the mean the same?
- If we test all the pairs with a t-test, then we know they are the same?
- Unfortunately, there is an increased risk of type-I errors
  - Reject the null hypothesis, although it is true
  - At each pairwise test there is small risk
  - Eg significance level $\alpha = 0.05$ gives 5% risk one comparison and about $n*\alpha$ for n comparisons
- Thus we need to handle this

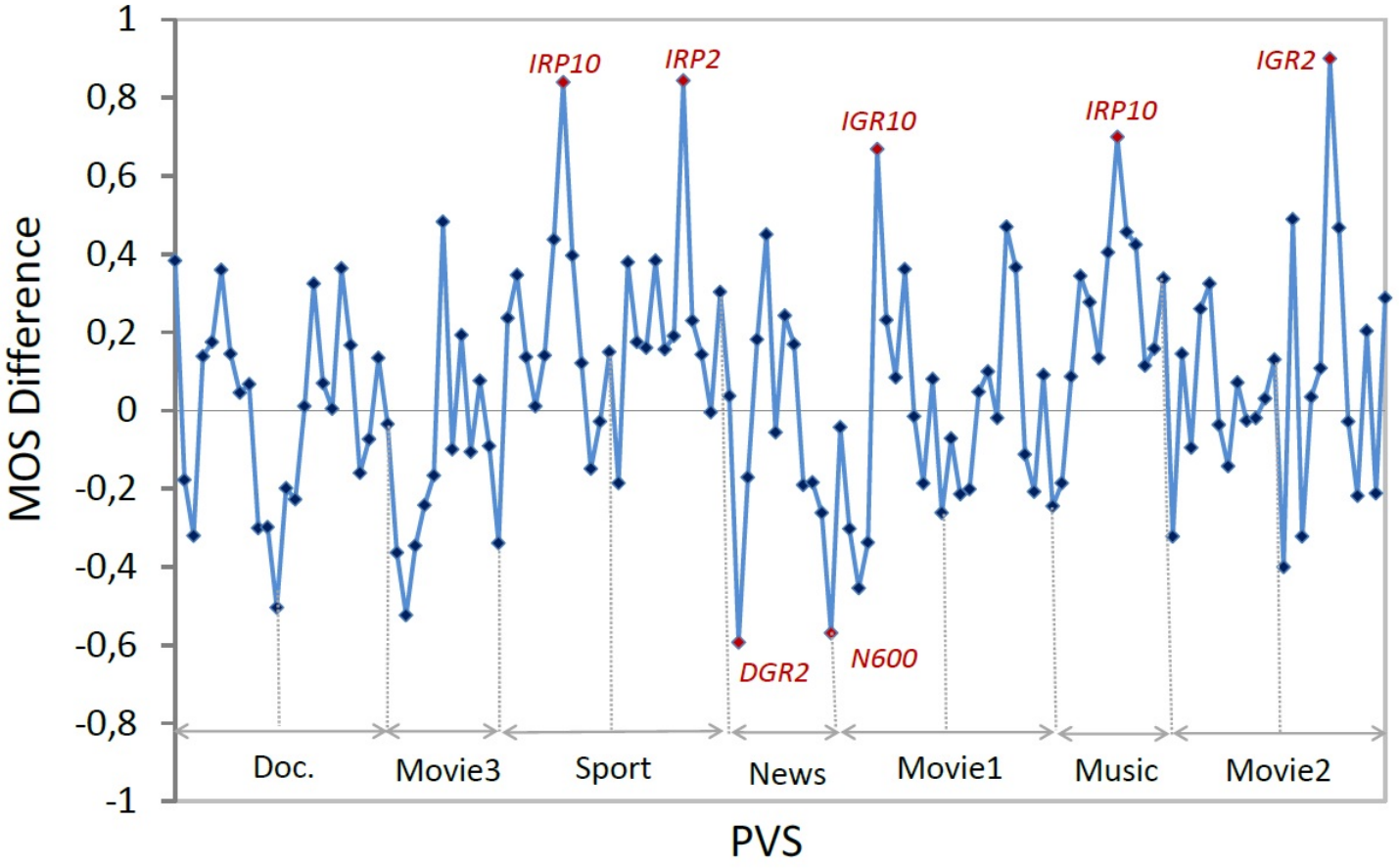
BONFERRONI CORRECTION METHOD

- the signicance level (α) should be divided by the number of comparisons N
- α_comp = α_total/N
- 10 different mean => 10*9/2 comparison 45
- α_comp =0.05/45 = 0.0011

EXAMPLE

- Compare exp 1 and exp 2
  - Same PVSs used in both exp
  - N_PVS = 100
  - Interesting comparison
    - PVS_exp1 (i) with PVS_exp2 (i)
  - If pre-planned gives 100 comparisons
  - If post-hoc gives 100*99/2 = 4950

RECENT RESULT



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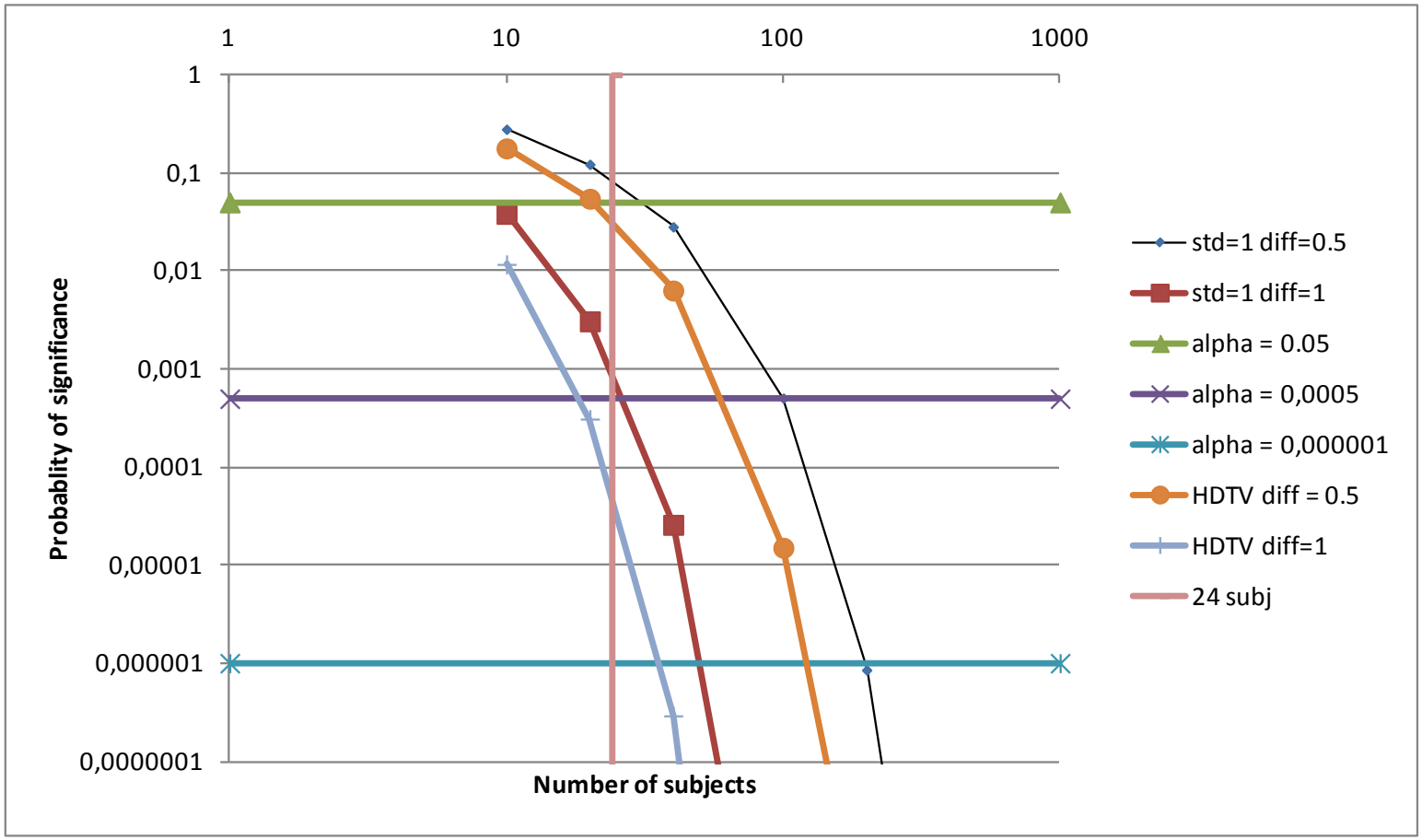
INFLUENCE OF THE NUMBER OF SUBJECTS



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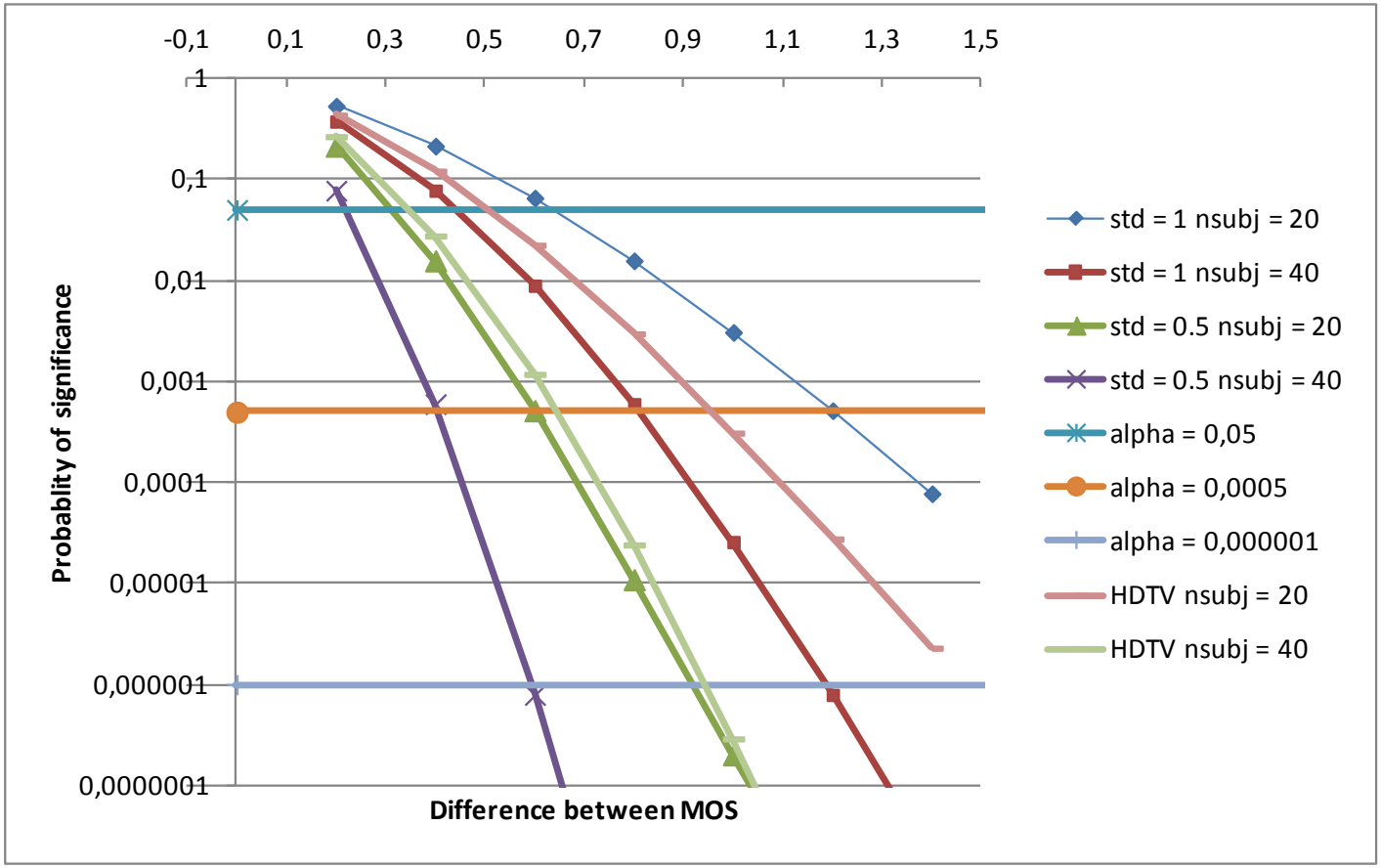
INFLUENCE OF DIFFERENCE



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CORRELATION SIGNIFICANCE TESTING

- Fisher z-statistics
- Compare with two-tailed Student statistics
- If $Z_N \geq t_{critical}$ reject the null hypothesis

$$Z_N = \frac{z1 - z2 - \mu_{(z1-z2)}}{\sigma_{(z1-z2)}}$$

$$\mu_{(z1-z2)} = 0$$

$$\sigma_{(z1-z2)} = \sqrt{\sigma_{z1}^2 + \sigma_{z2}^2}$$

$$\sigma_z = \sqrt{\frac{1}{N-3}}$$

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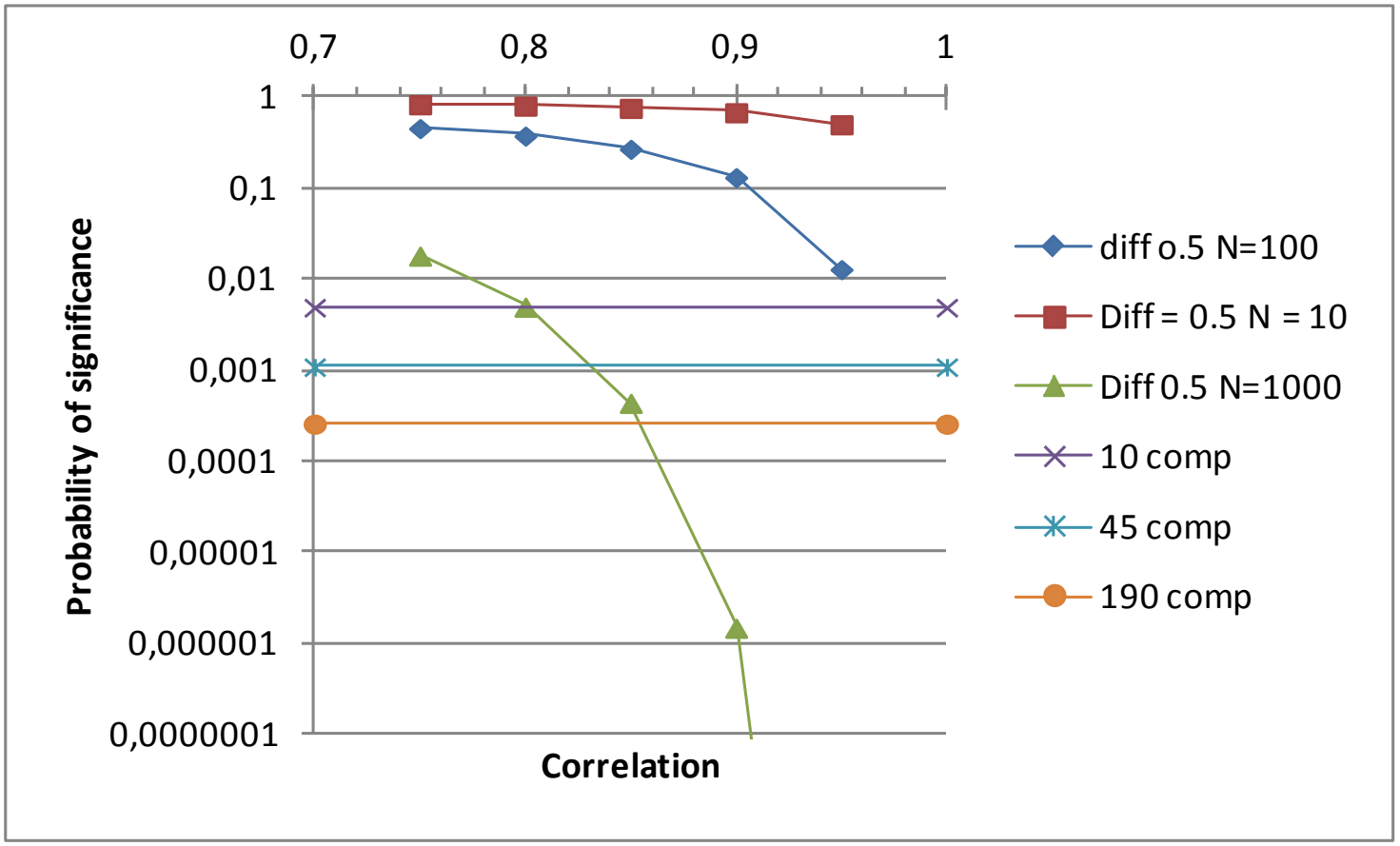
INFLUENCE ON CORRELATION



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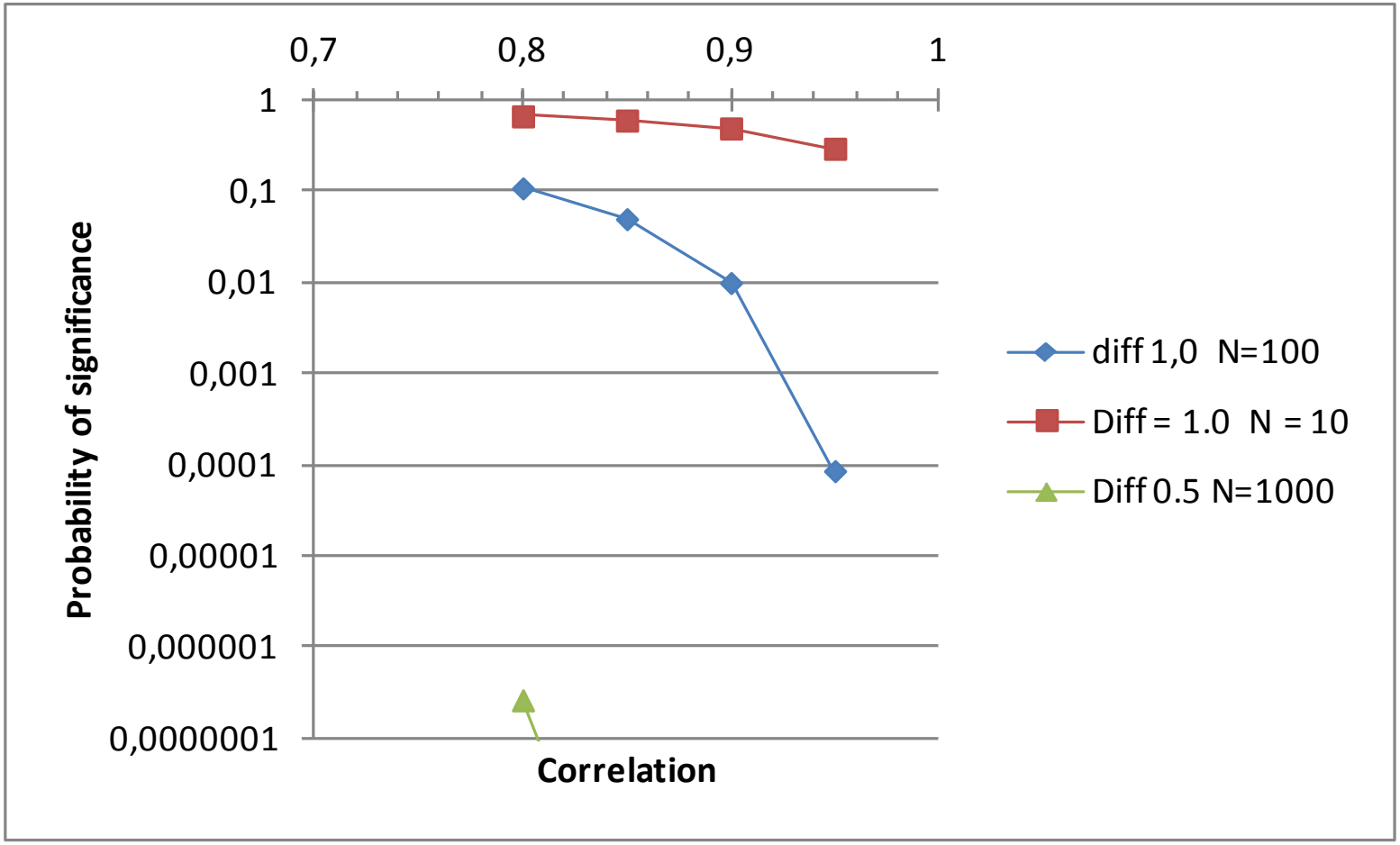
INFLUENCE ON CORRELATION



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INFLUENCE OF RECENT TEST

TABLE II. TEST OF SIGNIFICANT DIFFERENCE FOR SROCC.

	PSNR	SSIM	MS-SSIM	MARZ	VAR	VQM	VQM-VFD	PEVQ	V-BLIINDS
PSNR			-		+		-		+
SSIM				+	+			+	+
MS-SSIM	+			+	+			+	+
MARZ		-	-		-	-	-		
VAR	-	-	-	+		-	-	+	
VQM				+	+			+	+
VQM-VFD	+			+	+			+	+
PEVQ		-	-		-	-	-		
V-BLIINDS	-	-	-			-	-		

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INFLUENCE OF RECENT TEST

TABLE II. TEST OF SIGNIFICANT DIFFERENCE FOR SROCC.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PSNR			-		-		+
SSIM						+	+
MS-SSIM	+					+	+
VQM						+	+
VQM-VFD	+					+	+
PEVQ		-	-	-	-		
V-BLIINDS	-	-	-	-	-		

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DISCUSSION

- Not correcting for Type-I error may see effect that are not there.
- Correcting will lower efficeincy
- What can be done:
  - More test subjects may be needed
  - Reduce variance
  - Plan comparisons ahead

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